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Space Administration
Langley Research Center

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Information Program Office

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STAR

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WHAT'S INSIDE

NASA STI Program ... in Profile

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- TECHNICAL PUBLICATION. Reports of completed research or a major significant phase of research that present the results of NASA Programs and include extensive data or theoretical analysis. Includes compilations of significant scientific and technical data and information deemed to be of continuing reference value. NASA counterpart of peer-reviewed formal professional papers but has less stringent limitations on manuscript length and extent of graphic presentations.

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- SPECIAL PUBLICATION. Scientific, technical, or historical information from NASA programs, projects, and missions, often concerned with subjects having substantial public interest.

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STAR includes citations to R&D results reported in:

- NASA, NASA contractor, and NASA grantee reports
- Reports issued by other U.S. Government agencies, domestic and foreign institution, universities, and private firms
- Translations
- NASA-owned patents and patent applications
- Other U.S. Government agency and foreign patents and patent applications
- Domestic and foreign dissertations and theses

The NASA STI Program

The NASA STI Program was established to support the objectives of NASA's missions and research to advance aeronautics and space science. By sharing information, the NASA STI Program ensures that the U.S. maintains its preeminence in aerospace-related industries and education, minimizes duplication of research, and increases research productivity.

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The National Technical Information Service serves the American public as a central resource for unlimited, unclassified U.S. Government scientific, technical, engineering, and business related information. For more than 50 years NTIS has provided businesses, universities, and the public timely access to well over 2 million publications covering over 350 subject areas. Visit NTIS at http://www.ntis.gov.

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The U.S. Congress established the **Federal Depository Library Program** to ensure access for the American public to U.S. Government information. The program acquires and disseminates information products from all three branches of the U.S. Government to nearly 1,300 Federal depository libraries nationwide. The libraries maintain these information products as part of their existing collections and are responsible for assuring that the public has free access to the information. Locate the Federal depository libraries at http://www.gpoaccess.gov/index.html.

The U.S. Patent and Trademark Office (USPTO)

The U.S. Patent and Trademark Office provides online access to full text patents and patent applications. The database includes patents back to 1976 plus some pre-1975 patents. Visit the USPTO at http://www.uspto.gov/patft/.

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Subject Divisions/Categories

Document citations are grouped by division and then by category, according to the *NASA Scope and Subject Category Guide.*

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Mathematical and Computer Sciences

Physics

Social and Information Sciences

Space Sciences

Indexes

Two indexes are available. You may use the find command under the tools menu while viewing the PDF file for direct match searching on any text string. You may also select either of the two indexes provided for linking to the corresponding document citation from *NASA Thesaurus* terms and personal author names.

SCIENTIFIC AND TECHNICAL AEROSPACE REPORTS

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01
AERONAUTICS (GENERAL)

Includes general research topics related to manned and unmanned aircraft and the problems of flight within the Earth's atmosphere. Also includes manufacturing, maintenance, and repair of aircraft. For specific topics in aeronautics, see categories 02 through 09. For information related to space vehicles see 12 Astronautics.

20080012497 NASA Langley Research Center, Hampton, VA, USA

Silent Aircraft Initiative Concept Risk Assessment

Nickol, Craig L.; February 2008; 83 pp.; In English; Original contains color and black and white illustrations

Contract(s)/Grant(s): WBS 561581.02.08.07.13.05

Report No.(s): NASA/TM-2008-215112; L-19438; No Copyright; Avail.: CASI: A05, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080012497

A risk assessment of the Silent Aircraft Initiative's SAX-40 concept design for extremely low noise has been performed. A NASA team developed a list of 27 risk items, and evaluated the level of risk for each item in terms of the likelihood that the risk would occur and the consequences of the occurrence. The following risk items were identified as high risk, meaning that the combination of likelihood and consequence put them into the top one-fourth of the risk matrix: structures and weight prediction; boundary-layer ingestion (BLI) and inlet design; variable-area exhaust and thrust vectoring; displaced-threshold and continuous descent approach (CDA) operational concepts; cost; human factors; and overall noise performance. Several advanced-technology baseline concepts were created to serve as a basis for comparison to the SAX-40 concept. These comparisons indicate that the SAX-40 would have significantly greater research, development, test, and engineering (RDT&E) and production costs than a conventional aircraft with similar technology levels. Therefore, the cost of obtaining the extremely low noise capability that has been estimated for the SAX-40 is significant. The SAX-40 concept design proved successful in focusing attention toward low noise technologies and in raising public awareness of the issue.

Author

Risk; Aeronautics; Commercial Aircraft; Fixed Wings; Noise Reduction; Mathematical Models; Computational Fluid Dynamics; Aircraft Configurations

20080012550 NASA Dryden Flight Research Center, Edwards, CA, USA

Western Aeronautical Test Range

Sakahara, Robert D.; February 2008; 18 pp.; In English; NAVAIR Meeting, 7 Feb. 2008, Edwards AFB, CA, USA; Original contains color illustrations; No Copyright; Avail.: CASI: A03, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080012550

NASA's Western Aeronautical Test Range (WATR) is a network of facilities used to support aeronautical research, science missions, exploration system concepts, and space operations. The WATR resides at NASA's Dryden Flight Research Center located at Edwards Air Force Base, California. The WATR is a part of NASA's Corporate Management of Aeronautical Facilities and funded by the Strategic Capability Asset Program (SCAP). It is managed by the Aeronautics Test Program (ATP) of the Aeronautics Research Mission Directorate (ARMD) to provide the right facility at the right time. NASA is a tenant on Edwards Air Force Base and has an agreement with the Air Force Flight Test Center to use the land and airspace controlled by the Department of Defense (DoD). The topics include: 1) The WATR supports a variety of vehicles; 2) Dryden shares airspace with the AFFTC; 3) Restricted airspace, corridors, and special use areas are available for experimental aircraft; 4) WATR Products and Services; 5) WATR Support Configuration; 6) Telemetry Tracking; 7) Time Space Positioning; 8) Video; 9) Voice Communication; 10) Mobile Operations Facilities; 11) Data Processing; 12) Mission Control Center; 13) Real-Time Data Analysis; and 14) Range Safety.

Derived from text

Test Ranges; Aeronautics; Flight Tests; Defense Program; Research Aircraft

03
AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; airport ground operations; flight safety and hazards; and aircraft accidents. Systems and hardware specific to ground operations of aircraft and to airport construction are covered in 09 Research and Support Facilities (Air). Air traffic control is covered in 04 Aircraft Communications and Navigation. For related information see also 16 Space Transportation and Safety and 85 Technology Utilization and Surface Transportation.

20080012601 NASA Langley Research Center, Hampton, VA, USA

Information Requirements for Supervisory Air Traffic Controllers in Support of a Mid-Term Wake Vortex Departure System

Lohr, Gary W.; Williams, Daniel M.; Trujillo, Anna C.; Johnson, Edward J.; Domino, David A.; February 2008; 40 pp.; In English; Original contains color illustrations

Contract(s)/Grant(s): WBS 305295.02.07.07.20

Report No.(s): NASA/TM-2008-215114; L-19428; Copyright; Avail.: CASI: A03, Hardcopy

A concept focusing on wind dependent departure operations has been developed the current version of this concept is called the Wake Turbulence Mitigation for Departures (WTMD). This concept takes advantage the fact that cross winds of sufficient velocity blow wakes generated by 'heavy' and B757 category aircraft on the downwind runway away from the upwind runway. Supervisory Air Traffic Controllers would be responsible for authorization of the Procedure. An investigation of the information requirements necessary to for Supervisors to approve monitor and terminate the Procedure was conducted. Results clearly indicated that the requisite information is currently available in air traffic control towers and that additional information was not required.

Author

Wakes; Vortices; Air Traffic Control; Turbulence; Air Traffic Controllers (Personnel); Runways

20080013153 Government Accountability Office, Washington, DC, USA

FAA Is Reevaluating Services at Key Centers; Both FAA and the National Weather Service Need to Better Ensure Product Quality

January 2008; 31 pp.; In English; Original contains black and white illustrations

Report No.(s): GAO-08-258; No Copyright; Avail.: CASI: A03, Hardcopy

The National Weather Service's (NWS) weather products are a vital component of the Federal Aviation Administration's (FAA) air traffic control system. In addition to providing aviation weather products developed at its own facilities, NWS also provides staff on-site at each of FAA's en route centers. This group of NWS meteorologists -- called a center weather service unit -- provides air traffic managers with forecasts and briefings on regional conditions including turbulence, icing, and freezing precipitation. GAO agreed to (1) determine the status of NWS s plans for restructuring the offices that provide aviation weather services at FAA's en route centers, (2) identify FAA's requirements and its alternative sources for these services, and (3) evaluate both agencies current abilities to ensure the consistency and quality of these services. To do so, GAO evaluated agency plans for restructuring offices, defining requirements, and ensuring quality products, and interviewed agency officials. GAO is recommending that Commerce and Transportation define performance measures for aviation weather services and evaluate the quality of these services. Commerce agreed with the recommendations. Transportation did not agree or disagree with the recommendations, but stated that its just-released requirements include performance measures and evaluation procedures.

Derived from text

Air Traffic Control; Flight Conditions; Aviation Meteorology; Meteorological Services; Aircraft Safety; Flight Safety

20080013361 NASA Langley Research Center, Hampton, VA, USA

Incorporating Data Link Features into a Multi-Function Display to Support Self-Separation and Spacing Tasks for General Aviation Pilots

Adams, Catherine A.; Murdoch, Jennifer L.; Consiglio, Maria C.; WIlliams, Daniel M.; January 2005; 8 pp.; In English; Journal of Applied Ergonomics to be published in volume 38, no. 4, pp. 465-471, July 2007

Contract(s)/Grant(s): 23-786-10-10; No Copyright; Avail.: CASI: A02, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080013361

One objective of the Small Aircraft Transportation System (SATS) Higher Volume Operations (HVO) project is to increase the capacity and utilization of small non-towered, non-radar equipped airports by transferring traffic management activities to an automated Airport Management Module (AMM) and separation responsibilities to general aviation (GA) pilots.

Implementation of this concept required the development of a research Multi-Function Display (MFD) to support the interactive communications between pilots and the AMM. The interface also had to accommodate traffic awareness, self-separation, and spacing tasks through dynamic messaging and symbology for flight path conformance and conflict detection and alerting (CDA). The display served as the mechanism to support the examination of the viability of executing instrument operations designed for SATS designated airports. Results of simulation and flight experiments conducted at the National Aeronautics and Space Administration's (NASA) Langley Research Center indicate that the concept, as facilitated by the research MFD, did not increase pilots subjective workload levels or reduce their situation awareness (SA). Post-test usability assessments revealed that pilots preferred using the enhanced MFD to execute flight procedures, reporting improved SA over conventional instrument flight rules (IFR) procedures.
Author
Data Links; General Aviation Aircraft; NASA Programs; Automatic Control; Air Traffic Control

05
AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes all stages of design of aircraft and aircraft structures and systems. Also includes aircraft testing, performance and evaluation, and aircraft and flight simulation technology. For related information see also 18 Spacecraft Design, Testing and Performance and 39 Structural Mechanics. For land transportation vehicles see 85 Technology Utilization and Surface Transportation.

20080012474 NASA Dryden Flight Research Center, Edwards, CA, USA
Fiber Optic Wing Shape Sensing on NASA's Ikhana UAV
Richards, Lance; Parker, Allen R.; Ko, William L.; Piazza, Anthony; February 07, 2008; 19 pp.; In English; NAVAIR Meeting, 7 Feb. 2008, Edwards, CA, USA; Original contains color and black and white illustrations; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012474

This document discusses the development of fiber optic wing shape sensing on NASA's Ikhana vehicle. The Dryden Flight Research Center's Aerostructures Branch initiated fiber-optic instrumentation development efforts in the mid-1990s. Motivated by a failure to control wing dihedral resulting in a mishap with the Helios aircraft, new wing displacement techniques were developed. Research objectives for Ikhana included validating fiber optic sensor measurements and real-time wing shape sensing predictions; the validation of fiber optic mathematical models and design tools; assessing technical viability and, if applicable, developing methodology and approaches to incorporate wing shape measurements within the vehicle flight control system; and, developing and flight validating approaches to perform active wing shape control using conventional control surfaces and active material concepts.
CASI
Fiber Optics; Wings; Aircraft Design; Pattern Recognition; Displacement

20080012495 NASA Langley Research Center, Hampton, VA, USA
A Piloted Simulator Evaluation of Transport Aircraft Rudder Pedal Force/Feel Characteristics
Stewart, Eric C.; January 2008; 38 pp.; In English; Original contains black and white illustrations
Contract(s)/Grant(s): WU 457280.02
Report No.(s): NASA/TP-2008-215109; L-19330; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012495

A piloted simulation study has been conducted in a fixed-base research simulator to assess the directional handling qualities for various rudder pedal feel characteristics for commercial transport airplanes. That is, the effects of static pedal force at maximum pedal travel, breakout force, and maximum pedal travel on handling qualities were studied. An artificial maneuver with a severe lateral wind shear and requiring runway tracking at an altitude of 50 feet in a crosswind was used to fully exercise the rudder pedals. Twelve active airline pilots voluntarily participated in the study and flew approximately 500 maneuvers. The pilots rated the maneuver performance with various rudder pedal feel characteristics using the Cooper- Harper rating scale. The test matrix had 15 unique combinations of the 3 static pedal feel characteristics. A 10-term, second-order equation for the Cooper-Harper pilot rating as a function of the 3 independent pedal feel parameters was fit to the data. The test matrix utilized a Central Composite Design that is very efficient for fitting an equation of this form. The equation was used to produce contour plots of constant pilot ratings as a function of two of the parameters with the third parameter held constant. These contour plots showed regions of good handling qualities as well as regions of degraded handling qualities. In addition, a numerical equation solver was used to predict the optimum parameter values (those with the lowest pilot rating). Quantitative

pilot performance data were also analyzed. This analysis found that the peak values of the cross power spectra of the pedal force and heading angle could be used to quantify the tendency toward directional pilot induced oscillations (PIO). Larger peak values of the cross power spectra were correlated with larger (degraded) Cooper-Harper pilot ratings. Thus, the subjective data (Cooper-Harper pilot ratings) were consistent with the objective data (peak values of the cross power spectra).
Author
Simulators; Transport Aircraft; Pilot Performance; Pedals; Aerial Rudders

20080012498 NASA Dryden Flight Research Center, Edwards, CA, USA
When All the Ducks Line Up
Henwood, Bart E.; December 2007; 53 pp.; In English; Georgia National Guard Safety Day, 1 Dec. 2007, Dobbins AFB GA, USA; Original contains color and black and white illustrations; No Copyright; Avail.: CASI: A04, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012498

This viewgraph presentation gives an overview of the N2NA Pylon overheat mishap. The contents include: 1) Investigation Process; 2) Bottom Line; 3) Event Description / Damage; 4) Causal Tree Analysis; 5) Significant Observations; and 6) Major Recommendations.
CASI
Pylons; Aircraft Design; Aircraft Maintenance; Pylon Mounting; Thermal Degradation

20080012554 NASA Glenn Research Center, Cleveland, OH, USA
Supersonics--Airport Noise
Bridges, James; October 30, 2007; 17 pp.; In English; NASA Aeronautics Research Mission Directorate Annual Meeting, 30 Oct. - 1 Nov. 2007, New Orleans, LA, USA; Original contains color and black and white illustrations
Contract(s)/Grant(s): WBS 984754.02.07.03.17.03; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012554

At this, the first year-end meeting of the Fundamental Aeronautics Program, an overview of the Airport Noise discipline of the Supersonics Project leads the presentation of technical plans and achievements in this area of the Project. The overview starts by defining the Technical Challenges targeted by Airport Noise efforts, and the Approaches planned to meet these challenges. These are fleshed out in Elements, namely Prediction, Diagnostics, and Engineering, and broken down into Tasks. The Tasks level is where individual researchers' work is defined and from whence the technical presentations to follow this presentation come. This overview also presents the Milestones accomplished to date and to be completed in the next year. Finally, the NASA Research Announcement cooperative agreement activities are covered and tied to the Tasks and Milestones.
Author
Supersonics; Aircraft Noise; Jet Aircraft Noise

20080012555 NASA Glenn Research Center, Cleveland, OH, USA
Application of Time-resolved PIV to Supersonic Hot Jets
Bridges, James; Wernet, Mark P.; October 30, 2007; 25 pp.; In English; NASA Aeronautics Research Mission Directorate Annual Meeting, 30 Oct. -1 Nov. 2007, New Orleans, LA, USA; Original contains color and black and white illustrations
Contract(s)/Grant(s): WBS 984754.02.07.03.17.03; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012555

This presentation lays out the ground-breaking work at bringing high-speed (25kHz) particle image velocimetry (PIV) to bear on measurements of noise-producing turbulence in hot jets. The work is still in progress in that the tremendous amount of data obtained are still be analyzed, but the method has been validated and initial results of interest to jet noise modeling have been obtained. After a brief demonstration of the validation process used on the data, results are shown for hot jets at different temperatures and Mach numbers. Comparisons of first order statistics show the relative indifference of the turbulence to the presence of shocks and independence to jet temperature. What does come out is that when the shock-containing jets are in a screech mode the turbulence is highly elevated, showing the importance of removing screech phenomena from model-scale jets before applying findings to full-scale aircraft which typically do not contain shocks.
Author
Jet Aircraft Noise; Sound Waves; Turbulence; Particle Image Velocimetry; Supersonic Jet Flow; Jet Flow

20080013250 NASA Dryden Flight Research Facility, Edwards, CA, USA

Results of NASA/DARPA Automatic Probe and Drogue Refueling Flight Test

Schweikhard, Keith; February 07, 2008; 23 pp.; In English; NAVAIR Meeting; Original contains color and black and white illustrations; No Copyright; Avail.: CASI: A03, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080013250

This presentation reports the results of the NASA/DARPA automatic probe and drogue refueling flight test. The program met several of its objectives including the design, development and successful testing of a prototype system to autonomously perform probes to drogue refueling; demonstrated acquisition and tracking capability of the video tracking system; demonstrated autonomous rendezvous capability; demonstrated ability to plug in a turn; and, demonstrated ability to plug in mild turbulence.

Derived from text

Flight Tests; Prototypes; Air to Air Refueling; Towed Bodies; Flight Test Vehicles; Autonomy

20080013293 NASA Glenn Research Center, Cleveland, OH, USA

Airfoil Ice-Accretion Aerodynamics Simulation

Bragg, Michael B.; Broeren, Andy P.; Addy, Harold E.; Potapczuk, Mark G.; Guffond, Didier; Montreuil, E.; January 2007; 28 pp.; In English; 45th AIAA Aerospace Sciences Meeting and Exhibit, 8-11 Jan. 2007, Reno, NV, USA; Original contains color and black and white illustrations

Contract(s)/Grant(s): NCC3-1039; WBS 457280.02.07.03.02

Report No.(s): NASA/TM--2008-214830; AIAA Paper-2007-0085; E-16025; Copyright; Avail.: CASI: A03, Hardcopy

NASA Glenn Research Center, ONERA, and the University of Illinois are conducting a major research program whose goal is to improve our understanding of the aerodynamic scaling of ice accretions on airfoils. The program when it is completed will result in validated scaled simulation methods that produce the essential aerodynamic features of the full-scale iced-airfoil. This research will provide some of the first, high-fidelity, full-scale, iced-airfoil aerodynamic data. An initial study classified ice accretions based on their aerodynamics into four types: roughness, streamwise ice, horn ice, and spanwise-ridge ice. Subscale testing using a NACA 23012 airfoil was performed in the NASA IRT and University of Illinois wind tunnel to better understand the aerodynamics of these ice types and to test various levels of ice simulation fidelity. These studies are briefly reviewed here and have been presented in more detail in other papers. Based on these results, full-scale testing at the ONERA F1 tunnel using cast ice shapes obtained from molds taken in the IRT will provide full-scale iced airfoil data from full-scale ice accretions. Using these data as a baseline, the final step is to validate the simulation methods in scale in the Illinois wind tunnel. Computational ice accretion methods including LEWICE and ONICE have been used to guide the experiments and are briefly described and results shown. When full-scale and simulation aerodynamic results are available, these data will be used to further develop computational tools. Thus the purpose of the paper is to present an overview of the program and key results to date.

Author

Aerodynamics; Airfoils; Simulation; Wind Tunnel Tests; Ice Formation

06
AVIONICS AND AIRCRAFT INSTRUMENTATION

Includes all avionics systems, cockpit and cabin display devices, and flight instruments intended for use in aircraft. For related information see also 04 Aircraft Communications and Navigation; 08 Aircraft Stability and Control; 19 Spacecraft Instrumentation and Astrionics; and 35 Instrumentation and Photography.

20080012699 TERMA G.m.b.H., Darmstadt, Germany

A Contingency in the Rosetta Reaction Control System: Alternative Cruise Trajectory Strategies to Cope with Degraded Delta-V Resources

Bauske, Rainer; Companys, Vincente; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 9 pp.; In English; See also 20080012629; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

Since August 2006 a pressure transducer of the Rosetta Reaction Control System (RCS) shows anomalous telemetries indicating a possible leak in a pressurant line. The future operation mode of the RCS may be affected by this problem, resulting in performance degradation. The current propellant budget and its future evolution are evaluated to show the possible states

w.r.t. the required mission delta-V. Alternative cruise trajectory strategies are analyzed, providing delta-V savings, to compensate for the expected performance loss of the RCS.
Author
Reaction Control; Telemetry; Avionics; Contingency; Degradation; Delta Launch Vehicle; Trajectories

07
AIRCRAFT PROPULSION AND POWER

Includes primary propulsion systems and related systems and components, e.g., gas turbine engines, compressors, and fuel systems; and onboard auxiliary power plants for aircraft. For related information see also 20 Spacecraft Propulsion and Power; 28 Propellants and Fuels; and 44 Energy Production and Conversion.

20080012556 NASA Glenn Research Center, Cleveland, OH, USA
System Analysis and Performance Benefits of an Optimized Rotorcraft Propulsion System
Bruckner, Robert J.; October 30, 2007; 29 pp.; In English; Fundamental Aeromautics Program Technical Forum, 30 Oct. - 1 Nov. 2007, New Orleans, LA, USA; Original contains color and black and white illustrations
Contract(s)/Grant(s): WBS 877868.02.07.03.01.01; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012556

The propulsion system of rotorcraft vehicles is the most critical system to the vehicle in terms of safety and performance. The propulsion system must provide both vertical lift and forward flight propulsion during the entire mission. Whereas propulsion is a critical element for all flight vehicles, it is particularly critical for rotorcraft due to their limited safe, un-powered landing capability. This unparalleled reliability requirement has led rotorcraft power plants down a certain evolutionary path in which the system looks and performs quite similarly to those of the 1960 s. By and large the advancements in rotorcraft propulsion have come in terms of safety and reliability and not in terms of performance. The concept of the optimized propulsion system is a means by which both reliability and performance can be improved for rotorcraft vehicles. The optimized rotorcraft propulsion system which couples an oil-free turboshaft engine to a highly loaded gearbox that provides axial load support for the power turbine can be designed with current laboratory proven technology. Such a system can provide up to 60% weight reduction of the propulsion system of rotorcraft vehicles. Several technical challenges are apparent at the conceptual design level and should be addressed with current research.
Author
Rotary Wing Aircraft; Propulsion; Systems Analysis; Turboshafts; Axial Loads; Transmissions (Machine Elements); Propulsion System Performance

20080012571 Army Research Lab., Cleveland, OH, USA; NASA Glenn Research Center, Cleveland, OH, USA
Thermal and Environmental Barrier Coating Development for Advanced Propulsion Engine Systems
Zhu, Dongming; Miller, Robert A.; Fox, Dennis S.; January 2008; 21 pp.; In English; 48th Structures, Structural Dynamics, and Materials Conference, 23-26 Apr. 2008, Waikiki, HI, USA; Original contains color and black and white illustrations
Contract(s)/Grant(s): WBS 984754.02.07.03.05.01
Report No.(s): NASA/TM-2008-215040; ARL-TR-4368; AIAA Paper 2007-2130; E-16206; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012571

Ceramic thermal and environmental barrier coatings (TEBCs) are used in gas turbine engines to protect engine hot-section components in the harsh combustion environments, and extend component lifetimes. Advanced TEBCs that have significantly lower thermal conductivity, better thermal stability and higher toughness than current coatings will be beneficial for future low emission and high performance propulsion engine systems. In this paper, ceramic coating design and testing considerations will be described for turbine engine high temperature and high-heat-flux applications. Thermal barrier coatings for metallic turbine airfoils and thermal/environmental barrier coatings for SiC/SiC ceramic matrix composite (CMC) components for future supersonic aircraft propulsion engines will be emphasized. Further coating capability and durability improvements for the engine hot-section component applications can be expected by utilizing advanced modeling and design tools.
Author
Ceramic Coatings; Gas Turbine Engines; Thermal Conductivity; Thermal Control Coatings; Thermal Stability; Engine Parts; Carbon-Silicon Carbide Composites

20080012736 NASA Glenn Research Center, Cleveland, OH, USA

Damping of High-temperature Shape Memory Alloys

Duffy, Kirsten P.; Padula, Santo A., II; Scheiman, Daniel A.; [2008]; 10 pp.; In English; SPIE Smart Materials and Structures Conference, 9-13 Mar. 2008, San Diego, CA, USA; Original contains black and white illustrations

Contract(s)/Grant(s): NNC07TA60T; WBS 561581.02.08.03.15.03; Copyright; Avail.: CASI: A02, Hardcopy

Researchers at NASA Glenn Research Center have been investigating high temperature shape memory alloys as potential damping materials for turbomachinery rotor blades. Analysis shows that a thin layer of SMA with a loss factor of 0.04 or more would be effective at reducing the resonant response of a titanium alloy beam. Two NiTiHf shape memory alloy compositions were tested to determine their loss factors at frequencies from 0.1 to 100 Hz, at temperatures from room temperature to 300 C, and at alternating strain levels of 34-35x10(exp -6). Elevated damping was demonstrated between the M(sub s) and M(sub f) phase transformation temperatures and between the A(sub s) and A(sub f) temperatures. The highest damping occurred at the lowest frequencies, with a loss factor of 0.2-0.26 at 0.1 Hz. However, the peak damping decreased with increasing frequency, and showed significant temperature hysteresis in heating and cooling. Keywords: High-temperature, shape memory alloy, damping, aircraft engine blades, NiTiHf

Author

Shape Memory Alloys; Heat Resistant Alloys; Damping; Turbomachinery; Titanium Alloys; Phase Transformations

20080013147 NASA Glenn Research Center, Cleveland, OH, USA

Halbach Magnetic Rotor Development

Gallo, Christopher A.; February 2008; 27 pp.; In English; Original contains black and white illustrations

Contract(s)/Grant(s): WBS 599489.02.07.03.03.03.03.

Report No.(s): NASA/TM-2008-215056; E-16281; No Copyright; Avail.: CASI: A03, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080013147

The NASA John H. Glenn Research Center has a wealth of experience in Halbach array technology through the Fundamental Aeronautics Program. The goals of the program include improving aircraft efficiency, reliability, and safety. The concept of a Halbach magnetically levitated electric aircraft motor will help reduce harmful emissions, reduce the Nation s dependence on fossil fuels, increase efficiency and reliability, reduce maintenance and decrease operating noise levels. Experimental hardware systems were developed in the GRC Engineering Development Division to validate the basic principles described herein and the theoretical work that was performed. A number of Halbach Magnetic rotors have been developed and tested under this program. A separate test hardware setup was developed to characterize each of the rotors. A second hardware setup was developed to test the levitation characteristics of the rotors. Each system focused around a unique Halbach array rotor. Each rotor required original design and fabrication techniques. A 4 in. diameter rotor was developed to test the radial levitation effects for use as a magnetic bearing. To show scalability from the 4 in. rotor, a 1 in. rotor was developed to also test radial levitation effects. The next rotor to be developed was 20 in. in diameter again to show scalability from the 4 in. rotor. An axial rotor was developed to determine the force that could be generated to position the rotor axially while it is rotating. With both radial and axial magnetic bearings, the rotor would be completely suspended magnetically. The purpose of this report is to document the development of a series of Halbach magnetic rotors to be used in testing. The design, fabrication and assembly of the rotors will be discussed as well as the hardware developed to test the rotors.

Author

Magnetic Bearings; Product Development; Rotors; Fly By Wire Control; Magnetic Suspension; Noise Intensity

20080013304 NASA Glenn Research Center, Cleveland, OH, USA

Design, Fabrication, and Performance of Foil Gas Thrust Bearings for Microturbomachinery Applications

Dykas, Brian; Bruckner, Robert; DellaCorte, Christopher; Edmonds, Brian; Prahl, Joseph; January 2008; 18 pp.; In English; Turbo Expo 2008 Gas Turbine Technical Congress and Exposition, 9-13 Jun. 2008, Berlin, Germany; Original contains color and black and white illustrations

Contract(s)/Grant(s): WBS 877868.02.07.03.01.01

Report No.(s): NASA/TM-2008-215062; GT2008-50377; E-16284; Copyright; Avail.: CASI: A03, Hardcopy

A methodology for the design and construction of simple foil thrust bearings intended for parametric performance testing and low marginal costs is presented. Features drawn from a review of the open literature are discussed as they relate to bearing performance. The design of fixtures and tooling required to fabricate foil thrust bearings is presented, using conventional machining processes where possible. A prototype bearing with dimensions drawn from the literature is constructed, with all fabrication steps described. A load-deflection curve for the bearing is presented to illustrate structural stiffness characteristics.

Start-top cycles are performed on the bearing at a temperature of 425 C to demonstrate early-life wear patterns. A test of bearing load capacity demonstrates useful performance when compared with data obtained from the open literature.
Author
Gas Bearings; Foil Bearings; Thrust Bearings; Structural Design; Low Cost; Loads (Forces); Performance Tests

08
AIRCRAFT STABILITY AND CONTROL

Includes flight dynamics, aircraft handling qualities, piloting, flight controls, and autopilots. For related information see also 05 Aircraft Design, Testing and Performance; and 06 Avionics and Aircraft Instrumentation.

20080012502 NASA Langley Research Center, Hampton, VA, USA
Flight Test Experiment Design for Characterizing Stability and Control of Hypersonic Vehicles
Morelli, Eugene A.; February 05, 2008; 20 pp.; In English; U.S. Air Force T&E Days, 5-7 Feb. 2008, Los Angeles, CA, USA; Original contains color and black and white illustrations
Contract(s)/Grant(s): WBS 561581; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012502

A maneuver design method that is particularly well-suited for determining the stability and control characteristics of hypersonic vehicles is described in detail. Analytical properties of the maneuver design are explained. The importance of these analytical properties for maximizing information content in flight data is discussed, along with practical implementation issues. Results from flight tests of the X-43A hypersonic research vehicle (also called Hyper-X) are used to demonstrate the excellent modeling results obtained using this maneuver design approach. A detailed design procedure for generating the maneuvers is given to allow application to other flight test programs.
Author
Experiment Design; Flight Tests; X-43 Vehicle; Mathematical Models; Attitude Stability; Aircraft Control

13
ASTRODYNAMICS

Includes powered and free flight trajectories; orbital and launching dynamics.

20080012639 GMV S.A., Darmstadt, Germany
Optimisation of the Future Routine Orbit for Mars Express
Carranza, Manuel; Companys, Vincente; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 8 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

Mars Express (MEX), the first planetary mission of the European Space Agency (ESA), reached Mars on December 25th 2003. Since then it is performing routine operations. Its operational phase had to cover one Martian year, with the possibility of an extension for a second Martian year (i.e. until November 2007). The end of the mission extension is approaching but, given the good health of the payload instruments and the high science return of the mission, there is a strong will to achieve further extensions. Mars Express is also seen as an important asset, capable to provide relay functions for future Martian missions. The ESA Science Program Committee has recently approved a second extension of the MEX mission until May 2009 and even further extensions are possible. Mars Express has an eccentric quasi-polar orbit with a period of approximately 6.72 hours and a pericentre height of about 300 km. Science observations are mainly performed at pericentre (but not only). In addition the orbit has a resonance of 11 revolutions per 3 Martian days. This means that ground tracks corresponding to orbits separated by 11 revolutions are adjacent, such that a given area can be covered by the on-board camera without leaving gaps. The J2 effect of Mars causes a drift of both ascending node and argument of pericentre. The drift of argument of pericentre makes it possible to observe periodically all Mars latitudes from close distance. Illumination conditions at pericentre are influenced by both the drift of the argument of pericentre and the drift of ascending node, as well as by the rotation of Mars around the Sun. The original MEX routine orbit was optimized for the duration of the nominal mission and extension, such that it produced a balanced share of day-side observations (for the optical instruments) and night-side observations (for the radar). The orbit was thus not optimized for the time beyond the assumed extension. Indeed, the evolution of the ascending node and argument of pericentre would cause in the following years a drift of the pericentre towards night-side observation conditions, hence uninteresting for the optical instruments. In order to prevent this an optimisation process for the future

routine orbit has taken place. The share between day-side and night-side observations can be controlled by adjusting the drift of argument of pericentre and ascending node. This can in particular be achieved by changing the semimajor axis, eccentricity and/or inclination. A change of inclination is inefficient compared to a change in semimajor axis and eccentricity, and has therefore been discarded. An in-plane maneuvre can be performed to change both semi-major axis and eccentricity, and thus the period of the orbit. Although an apocentre manoeuvre is cheaper in terms of deltaV, it would result in raising the pericentre height, which is unfavourable for close observations. Hence a pericentre manoeuvre is proposed, which will increase the apocentre height. A repeat cycle is still required to allow mapping areas with adjacent ground tracks, so the change of semimajor axis must result in a new resonance. Resonances 18:5, 25:7 and 7:2 have been considered as potential candidates. The resulting long term evolution of the observation conditions has been analysed. Finally it has been decided to perform a change of orbit to reach the 18:5. Another aspect of the optimisation process is the control of the ground track. The previous MEX reference trajectory included regular maneuvres at every apocentre in order to adjust the orbital period, such that the separation of the ground tracks would be optimal, regardless of the latitude of pericentre. The implementation of the actual delatVs on-board was done partly by optimizing the attitude of reaction-wheel desaturation activities. Despite of it, this strategy has a significant propellant cost, because it prevents to optimize reaction wheel de-saturation activities to minimize propellant consumption. Therore, with the aim at preserving propellant resources for a long time extension it has been agreed to stop the ground-track control. This requires now a more accurate science operation planning, with improved attitude pointing control. Finally, the approach to phase Mars Express to provide back-up relay functions for NASA Phoenix landing is explained. In the context of the routine trajectory optimisation a new requirement for close fly-bys at Phobos, with different observation geometries, has been specified. The approach to fulfill this requirement is explained.
Author
Mars Express; Optimization; Mars (Planet); Planetary Orbits; Polar Orbits

20080012661 Instituto Tecnologico de Aeronautica, Sao Jose dos Campos, Brazil
Optimal Low-Thrust Limited-Power Transfers between Arbitrary Elliptic Coplanar Orbits
daSilvaFernandes, Sandro; dasChagasCarvalho, Francisco; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

In this work, a complete first order analytical solution, which includes the short periodic terms, for the problem of optimal low-thrust limited-power transfers between arbitrary elliptic coplanar orbits in a Newtonian central gravity field is obtained through Hamilton-Jacobi theory and a perturbation method based on Lie series.
Author
Planar Structures; Low Thrust; Elliptical Orbits; Optimization; Numerical Analysis; Control Theory

20080012700 Nanjing Univ., China
Transfer to the Collinear Libration Point L3 in the Sun-Earth+Moon System
Hou, Xi-yun; Tang, Jing-shi; Liu, Lin; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 10 pp.; In English; See also 20080012629; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The collinear libration point L3 of the sun-earth+moon system is an ideal place for some space missions. Although there has been a great amount of work concerning the applications of the other two collinear libration points L1 and L2, little work has been done about the point L3. In this paper, the dynamics of the libration points was briefly introduced first. Then a way to transfer the spacecraft to the collinear libration point L3 via the invariant manifolds of the other two collinear libration points was proposed. Theoretical works under the model of circular restricted three-body problem were done. For the sun-earth+moon system, this model is a good approximation. The results obtained are useful when a transfer trajectory under the real solar system is designed.
Author
Collinearity; Libration; Earth-Moon System; Librational Motion; Sun; Astrodynamics

20080012701 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Orbit Determination and Navigation of the Time History of Events and Macroscale Interactions during Substorms (THEMIS)

Morinelli, Patrick; Cosgrove, Jennifer; Blizzard, Mike; Robertson, Mike; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 14 pp.; In English; See also 20080012629; Original contains color illustrations

Contract(s)/Grant(s): NNG04DA01C; FDF-28-012; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

This paper provides an overview of the launch and early orbit activities performed by the NASA Goddard Space Flight Center's (GSFC) Flight Dynamics Facility (FDF) in support of five probes comprising the Time History of Events and Macroscale Interactions during Substorms (THEMIS) spacecraft. The FDF was tasked to support THEMIS in a limited capacity providing backup orbit determination support for validation purposes for all five THEMIS probes during launch plus 30 days in coordination with University of California Berkeley Flight Dynamics Center (UCB/FDC)2. The FDF's orbit determination responsibilities were originally planned to be as a backup to the UCB/FDC for validation purposes only. However, various challenges early on in the mission and a Spacecraft Emergency declared thirty hours after launch placed the FDF team in the role of providing the orbit solutions that enabled contact with each of the probes and the eventual termination of the Spacecraft Emergency. This paper details the challenges and various techniques used by the GSFC FDF team to successfully perform orbit determination for all five THEMIS probes during the early mission. In addition, actual THEMIS orbit determination results are presented spanning the launch and early orbit mission phase. Lastly, this paper enumerates lessons learned from the THEMIS mission, as well as demonstrates the broad range of resources and capabilities within the FDF for supporting critical launch and early orbit navigation activities, especially challenging for constellation missions. Author

Navigation; Orbit Determination; Spacecraft Maneuvers; Space Probes; Space Missions

20080012714 Fachhochschule, Wiesbaden, Germany

Estimation of Cometary Rotation Parameters Based on Camera Images

Spindler, Karlheinz; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629

Contract(s)/Grant(s): GFM-1763X07; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The purpose of the Rosetta mission is the in situ analysis of a cometary nucleus using both remote sensing equipment and scientific instruments delivered to the comet surface by a lander and transmitting measurement data to the comet-orbiting probe. Following a tour of planets including one Mars swing-by and three Earth swing-bys, the Rosetta probe is scheduled to rendezvous with comet 67P/Churyumov-Gerasimenko in May 2014. The mission poses various flight dynamics challenges, both in terms of parameter estimation and maneuver planning. Along with spacecraft parameters, the comet's position, velocity, attitude, angular velocity, inertia tensor and gravitatonal field need to be estimated. The measurements on which the estimation process is based are ground-based measurements (range and Doppler) yielding information on the heliocentric spacecraft state and images taken by an on-board camera yielding informaton on the comet state relative to the spacecraft. The image-based navigation depends on te identification of cometary landmarks (whose body coordinates also need to be estimated in the process). The paper will describe the estimation process involved, focusing on the phase when, after orbit insertion, the task arises to estimate the cometary rotational motion from camera images on which individual landmarks begin to become identifiable. Author

Cameras; Estimating; Image Analysis; Parameter Identification; Rosetta Mission; Rotation; Comet Nuclei

15
LAUNCH VEHICLES AND LAUNCH OPERATIONS

Includes all classes of launch vehicles, launch/space vehicle systems, and boosters; and launch operations. For related information see also *18 Spacecraft Design, Testing and Performance*; and *20 Spacecraft Propulsion and Power*.

20080012476 NASA Glenn Research Center, Cleveland, OH, USA
Evaluation of Separation Mechanism Design for the Orion/Ares Launch Vehicle
Konno, Kevin E.; Catalano, Daniel A.; Krivanek, Thomas M.; [2008]; 14 pp.; In English; 39th Aerospace Mechanisms Symposium, 7-9 May 2008, Huntsville, AL, USA; Original contains color and black and white illustrations
Contract(s)/Grant(s): WBS 644423.06.32.03.06.03; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012476

As a part of the preliminary design work being performed for the Orion vehicle, the Orion to Spacecraft Adaptor (SA) separation mechanism was analyzed and sized, with findings presented here. Sizing is based on worst case abort condition as a result of an anomaly driving the launch vehicle engine thrust vector control hard-over causing a severe vehicle pitch over. This worst case scenario occurs just before Upper Stage Main Engine Cut-Off (MECO) when the vehicle is the lightest and the damping effect due to propellant slosh has been reduced to a minimum. To address this scenario and others, two modeling approaches were invoked. The first approach was a detailed Simulink model to quickly assess the Service Module Engine nozzle to SA clearance for a given separation mechanism. The second approach involved the generation of an Automatic Dynamic Analysis of Mechanical Systems (ADAMS) model to assess secondary effects due to mass centers of gravity that were slightly off the vehicle centerline. It also captured any interference between the Solar Arrays and the Spacecraft Adapter. A comparison of modeling results and accuracy are discussed. Most notably, incorporating a larger SA flange diameter allowed for a natural separation of the Orion and it's engine nozzle even at relatively large pitch rates minimizing the kickoff force. Advantages and disadvantages of the Simulink model vs. a full geometric ADAMS model are discussed as well.
Author
Crew Exploration Vehicle; Launch Vehicle Configurations; Adapters; Ares 1 Upper Stage; Launch Vehicles; Separation; Mathematical Models

20080012599 NASA Glenn Research Center, Cleveland, OH, USA
NASA's PEM Fuel Cell Power Plant Development Program for Space Applications
Hoberecht, Mark A.; January 2008; 11 pp.; In English; 2006 Fuel Cell Seminar, 13-17 Nov. 2007, Honolulu, HI, USA; Original contains color illustrations
Contract(s)/Grant(s): WBS 083229.04.14.01.01.05
Report No.(s): NASA/TM-2008-214991; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012599

A three-center NASA team led by the Glenn Research Center in Cleveland, Ohio is completing a five-year PEM fuel cell power plant development program for future space applications. The focus of the program has been to adapt commercial PEM fuel cell technology for space applications by addressing the key mission requirements of using pure oxygen as an oxidant and operating in a multi-gravity environment. Competing vendors developed breadboard units in the 1 to 5 kW power range during the first phase of the program, and a single vendor developed a nominal 10-kW engineering model power pant during the second phase of the program. Successful performance and environmental tests conducted by NASA established confidence that PEM fuel cell technology will be ready to meet the electrical power needs of future space missions.
Author
Fuel Cells; Performance Tests; Environmental Tests; Breadboard Models

20080013374 NASA Langley Research Center, Hampton, VA, USA
Integrated Flight Performance Analysis of a Launch Abort System Concept
Tartabini, Paul V.; January 2007; 11 pp.; In English; AIAA Modeling and Simulation Technologies Conference and Exhibit, 20-23 Aug. 2007, Hilton Head, SC, USA; Original contains color illustrations
Contract(s)/Grant(s): WBS 644423.06.34.02.04; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080013374

This paper describes initial flight performance analyses conducted early in the Orion Project to support concept feasibility studies for the Crew Exploration Vehicle s Launch Abort System (LAS). Key performance requirements that significantly affect abort capability are presented. These requirements have implications on sizing the Abort Motor, tailoring its thrust profile to meet escape requirements for both launch pad and high drag/high dynamic pressure ascent aborts. Additional

performance considerations are provided for the Attitude Control Motor, a key element of the Orion LAS design that eliminates the need for ballast and provides performance robustness over a passive control approach. Finally, performance of the LAS jettison function is discussed, along with implications on Jettison Motor sizing and the timing of the jettison event during a nominal mission. These studies provide an initial understanding of LAS performance that will continue to evolve as the Orion design is matured.
Author
Flight Characteristics; Reliability Analysis; Feasibility; Jettison Systems; Attitude Control; Launching

16
SPACE TRANSPORTATION AND SAFETY

Includes passenger and cargo space transportation, e.g., shuttle operations; and space rescue techniques. For related information see also *03 Air Transportation and Safety; 15 Launch Vehicles and Launch Operations*; and *18 Spacecraft Design, Testing and Performance*. For space suits see *54 Man/System Technology and Life Support*.

20080012446 American Inst. of Aeronautics and Astronautics, Reston, VA, USA
Safe Haven on Crew Life Stations
Hancock, Thomas M., III; Aerospace America; September 2007; ISSN 0740-722X; Volume 45, No. 9, pp. 39-42; In English; Original contains color illustrations; Copyright; Avail.: Other Sources

The current plan for rescuing astronauts from an Orion spacecraft, called Project Constellation, calls for the launch of a second, unmanned Orion spacecraft that would meet with the stricken spacecraft in lunar orbit. The crew would transfer to the rescue spacecraft and return to earth. This plan would require both the Ares I and Ares V launch vehicles, an Earth departure stage, and a second Orion ready for launch within a few days notice of a declared emergency. This operation would be extremely expensive, places constraints on facilities and hardware, and requires standing investments of resources during the lunar mission. The risk of failure increases because of the critical schedule pressure to launch and rendezvous within a few days. This article discusses one way to reduce cost, risk and schedule pressures by prepositioning crew life stations (CLSs) that can support four astronauts for up to 60 days, thereby allowing NASA to mount a rescue mission only when it is needed rather than to have one on standby. The design, operating modes, structure and docking of the CLS are highlighted and an operational scenario is provided.
Derived from text
Astronauts; Emergencies; Rescue Operations; Crew Exploration Vehicle; Emergency Life Sustaining Systems

20080012612 NASA Glenn Research Center, Cleveland, OH, USA
Spacecraft Fire Detection: Smoke Properties and Transport in Low-Gravity
Urban, David L.; Ruff, Gary A.; Brooker, John E.; Cleary, Thomas; Yang, Jiann; Mulholland, George; Yuan, Zeng-guang; [2007]; 9 pp.; In English; 2008 AIAA Aerospace Sciences Meeting, 7-10 Jan. 2008, Reno, NV, USA; Original contains color and black and white illustrations
Contract(s)/Grant(s): WBS 526282.01.03.02.02.21; Copyright; Avail.: CASI: A02, Hardcopy

Results from a recent smoke particle size measurement experiment conducted on the International Space Station (ISS) are presented along with the results from a model of the transport of smoke in the ISS. The experimental results show that, for the materials tested, a substantial portion of the smoke particles are below 500 nm in diameter. The smoke transport model demonstrated that mixing dominates the smoke transport and that consequently detection times are longer than in normal gravity.
Author
Fires; Detection; Gravitation; International Space Station; Microgravity

20080012677 Tokyo Univ., Japan
Deep Space Transportation System Using the Sun-Earth L2 Point
Matsumoto, Michihiro; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 7 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

Recently, various kinds of planetary explorations have become more feasible, taking the advantage of low thrust propulsion means such as ion engines that have come into practical use. The field of space activity has now been expanded even to the rim of the outer solar system. In this context, the Japan Aerospace Exploration Agency (JAXA) has started

investigating a Deep Space Port built at the L2 Lagrange point in the Sun-Earth system. For the purpose of making the deep space port practically useful, there is a need to establish a method to making spaceship depart and return from/to the port. This paper first discusses the escape maneuvers originating from the L2 point under the restricted three-body problem. Impulsive maneuvers from the L2 point are extensively studied here, and using the results, optimal low-thrust escape strategies are synthesized. Furthermore, this paper proposes the optimal escape and acceleration maneuvers schemes using Electric Delta-V Earth Gravity Assist (EDVEGA) technique.
Author
Deep Space; Space Transportation System; Space Exploration; Trajectories

20080012734 NASA Glenn Research Center, Cleveland, OH, USA
Assessing MMOD Impacts on Seal Performance
deGroh, Henry C., III; Daniels, C.; Dunlap, P.; Steinetz, B.; November 13, 2007; 24 pp.; In English; 2007 NASA Seal/Secondary Air Systems Workshop, 13-14 Nov. 2007, Cleveland, OH, USA; Original contains color and black and white illustrations
Contract(s)/Grant(s): WBS 644423.06.31.04.01.03.22; Copyright; Avail.: CASI: A03, Hardcopy

The elastomer seal needed to seal in cabin air when NASA s Crew Exploration Vehicle is docked is exposed to space prior to docking. While open to space, the seal might be hit by orbital debris or meteoroids. The likelihood of damage of this type depends on the size of the particle. Our campaign is designed to find the smallest particle that will cause seal failure resulting in loss of mission. We will then be able to estimate environmental risks to the seal. Preliminary tests indicate seals can withstand a surprising amount of damage and still function. Collaborations with internal and external partners are in place and include seal leak testing, modeling of the space environment using a computer code known as BUMPER, and hypervelocity impact (HVI) studies at Caltech. Preliminary work at White Sands Test Facility showed a 0.5 mm diameter HVI damaged areas about 7 times that diameter, boring deep (5 mm) into elastomer specimens. BUMPER simulations indicate there is a 1 in 1440 chance of getting hit by a particle of diameter 0.08 cm for current Lunar missions; and 0.27 cm for a 10 year ISS LIDS seal area exposure.
Author
Leakage; Elastomers; Seals (Stoppers); Crew Exploration Vehicle; Space Debris; Hypervelocity Impact; Failure; Exposure

20080013142 Ohio Aerospace Inst., Brook Park, OH, USA
Estimation of the Unsteady Aerodynamic Load on Space Shuttle External Tank Protuberances from a Component Wind Tunnel Test
Panda, J.; Martin, F. W.; Sutliff, D. L.; January 2008; 1 pp.; In English
Contract(s)/Grant(s): NNC07ZA08A
Report No.(s): AIAA Paper 2008-0232; No Copyright; Avail.: Other Sources; Abstract Only

At the wake of the Columbia (STS-107) accident it was decided to remove the Protuberance Aerodynamic Load (PAL) Ramp that was originally intended to protect various protuberances outside of the Space Shuttle External Tank from high buffet load induced by cross-flows at transonic speed. In order to establish the buffet load without the PAL ramp, a wind tunnel test was conducted where segments of the protuberances were instrumented with dynamic pressure transducers; and power-spectra of sectional lift and drag forces at various span-wise locations between two adjacent support brackets were measured under different cross flow angles, Mach number and other conditions. Additionally, frequency-dependent spatial correlations between the sectional forces were also established. The sectional forces were then adjusted by the correlation length to establish span-averaged spectra of normal and lateral forces that can be suitably ‘added’ to various other unsteady forces encountered by the protuberance. This paper describes the methodology used for calculating the correlation-adjusted power spectrum of the buffet load. A second part of the paper describes wind-tunnel results on the difference in the buffet load on the protuberances with and without the PAL ramp. In general when the ramp height is the same as that of the protuberance height, such as that found on the liquid Oxygen part of the tank, the ramp is found to cause significant reduction of the unsteady aerodynamic load. However, on the liquid Hydrogen part of the tank, where the Oxygen feed-line is far larger in diameter than the height of the PAL ramp, little protection is found to be available to all but the Cable Tray.
Author
Aerodynamic Loads; External Tanks; Protuberances; Space Shuttles; Transonic Speed; Unsteady Aerodynamics; Wind Tunnel Tests; Propellant Tanks

20080013143 Ohio Aerospace Inst., Brook Park, OH, USA

Vibration Analysis of the Space Shuttle External Tank Cable Tray Flight Data with and without PAL Ramp

Walker, B. E.; Panda, B. E.; Sutliff, D. L.; January 2008; 2 pp.; In English

Contract(s)/Grant(s): NNC07ZA08A

Report No.(s): AIAA Paper 2008-0312; Copyright; Avail.: Other Sources; Abstract Only

External Tank Cable Tray vibration data for three successive Space Shuttle flights were analyzed to assess response to buffet and the effect of removal of the Protuberance Air Loads (PAL) ramp. Waveform integration, spectral analysis, cross-correlation analysis and wavelet analysis were employed to estimate vibration modes and temporal development of vibration motion from a sparse array of accelerometers and an on-board system that acquired 16 channels of data for approximately the first two minutes of each flight. The flight data indicated that PAL ramp removal had minimal effect on the fluctuating loads on the cable tray. The measured vibration frequencies and modes agreed well with predicted structural response.

Author

Aerodynamic Loads; Dynamic Structural Analysis; External Tanks; Protuberances; Space Shuttles; Vibration

20080013326 NASA Johnson Space Center, Houston, TX, USA

A Comparison of Three Catastrophic On-Orbit Collisions

Stansbery, Gene; Matney, Mark; Liou, J. C.; Whitlock, Dave; [2007]; 1 pp.; In English; International Astronautical Federation Mtg., 29 Sept. 2003 - 3 Oct. 2008, Glasgow, UK; Copyright; Avail.: Other Sources; Abstract Only

Orbital debris environment models, such as NASA's LEGEND model, show that accidental collisions between satellites will begin to be the dominant cause for future debris population growth within the foreseeable future. The collisional breakup models employed are obviously a critical component of the environment models. The Chinese Anti-Satellite (ASAT) test which destroyed the Fengyun-1C weather satellite provided a rare, but not unique, chance to compare the breakup models against an actual on-orbit collision. Measurements from the U.S. Space Surveillance Network (SSN), for debris larger than 10-cm, and from Haystack, for debris larger than 1-cm, show that the number of fragments created from Fengyun significantly exceeds model predictions using the NASA Standard Collisional Breakup Model. However, it may not be appropriate to alter the model to match this one, individual case. Two other on-orbit collisions have occurred in the past which have produced significant numbers of debris fragments. In September 1985, the U.S. conducted an ASAT test against the Solwind P-78 spacecraft at an altitude of approximately 525 km. A year later, in September 1986, the Delta 180 payload was struck by its Delta II rocket body in a planned collision at 220 km altitude. Although no Haystack data is available in 1985-6 and very few debris pieces were cataloged from Delta 180 due to its low altitude, measurements were collected in dedicated tests by phased array radars in the SSN in the days after each test. This paper will examine the available radar data from each test and compare and contrast the results with model predictions and with the results from the more recent Fengyun ASAT test.

Author

Space Debris; Low Altitude; Artificial Satellites; Collisions; Environment Models; Indexes (Documentation); Payloads; Accidents

20080013357 NASA Glenn Research Center, Cleveland, OH, USA

Orion Crew Member Injury Predictions during Land and Water Landings

Lawrence, Charles; Littell, Justin D.; Fasanella, Edwin L.; Tabiei, Ala; March 03, 2008; 14 pp.; In English; Earth and Space Conference, 11th Intrnational Conference on Engineering, Science, Construction, and Operations in Challenging Environments, 3-5 Mar. 2008, Long Beach, CA, USA; Original contains color and black and white illustrations

Contract(s)/Grant(s): WBS 510505.01.03.01.06; Copyright; Avail.: CASI: A03, Hardcopy

A review of astronaut whole body impact tolerance is discussed for land or water landings of the next generation manned space capsule named Orion. LS-DYNA simulations of Orion capsule landings are performed to produce a low, moderate, and high probability of injury. The paper evaluates finite element (FE) seat and occupant simulations for assessing injury risk for the Orion crew and compares these simulations to whole body injury models commonly referred to as the Brinkley criteria. The FE seat and crash dummy models allow for varying the occupant restraint systems, cushion materials, side constraints, flailing of limbs, and detailed seat/occupant interactions to minimize landing injuries to the crew. The FE crash test dummies used in conjunction with the Brinkley criteria provides a useful set of tools for predicting potential crew injuries during vehicle landings.

Author

Flight Crews; Water Landing; Impact Tolerances; Crew Exploration Vehicle; Landing Aids; Crash Injuries

17
SPACE COMMUNICATIONS, SPACECRAFT COMMUNICATIONS, COMMAND AND TRACKING

Includes space systems telemetry; space communications networks; astronavigation and guidance; and spacecraft radio blackout. For related information see also *04 Aircraft Communications and Navigation*; and *32 Communications and Radar*.

20080012561 NASA Glenn Research Center, Cleveland, OH, USA

High-Capacity Communications from Martian Distances

Williams, W. Dan; Collins, Michael; Hodges, Richard; Orr, Richard S.; Sands, O. Scott; Schuchman, Leonard; Vyas, Hemali; December 2007; 162 pp.; In English; See also 20080012562 - 20080012569; Original contains color and black and white illustrations

Contract(s)/Grant(s): WBS 439432.07.04.03.01

Report No.(s): NASA/TM-2007-214415; E-15695; Copyright; Avail.: CASI: A08, Hardcopy

High capacity communications from Martian distances, required for the envisioned human exploration and desirable for data-intensive science missions, is challenging. NASA s Deep Space Network currently requires large antennas to close RF telemetry links operating at kilobit-per-second data rates. To accommodate higher rate communications, NASA is considering means to achieve greater effective aperture at its ground stations. This report, focusing on the return link from Mars to Earth, demonstrates that without excessive research and development expenditure, operational Mars-to-Earth RF communications systems can achieve data rates up to 1 Gbps by 2020 using technology that today is at technology readiness level (TRL) 4-5. Advanced technology to achieve the needed increase in spacecraft power and transmit aperture is feasible at an only moderate increase in spacecraft mass and technology risk. In addition, both power-efficient, near-capacity coding and modulation and greater aperture from the DSN array will be required. In accord with these results and conclusions, investment in the following technologies is recommended:(1) lightweight (1 kg/sq m density) spacecraft antenna systems; (2) a Ka-band receive ground array consisting of relatively small (10-15 m) antennas; (3) coding and modulation technology that reduces spacecraft power by at least 3 dB; and (4) efficient generation of kilowatt-level spacecraft RF power.

Author

Telecommunication; Spacecraft Antennas; Antenna Arrays; Radio Frequencies; Microwave Antennas; Extremely High Frequencies

20080012562 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Assumed Design Scenarios

Vyas, Hemali; Noreen, Gary; Schuchman, Leonard; High-Capacity Communications from Martian Distances; December 2007, pp. 7-10; In English; See also 20080012561; Original contains color illustrations; Copyright; Avail.: CASI: A01, Hardcopy

This chapter begins by describing an assumed communication scenario for human and robotic exploration of Mars. It is followed by a scenario relating to the CEV that will carry humans to and from Mars. These two scenarios capture the key aspects of communication needs for Mars mission support. The Mars exploration communication scenario has been derived from a strawman set of requirements for human and robotic missions in the 2020 to 2030 timeframe found in references 2-1, and 2-2. Figure 2-1 show the span of data rates required for several kinds of applications that make up the scenario (ref. 2-3). A speech channel, for example, fits within 2 kbps with compression but takes up to 80 kbps in telecom pulse code modulation (PCM) format. Synthetic aperture radar might output from as little as a few hundred kbps up to three orders of magnitude more. Similarly, a multispectral imager may output 100 kbps, but a hyperspectral imager will output four orders of magnitude more. Per-channel values for each type of application used in this report are (1) 10 kbps for speech; (2) 100 kbps for helmet-camera imaging; (3) 20 Mbps for HDTV; (4) 100 Mbps for radar; and (5) 150 Mbps for hyperspectral imaging.3 The data rate for engineering telemetry is 20 kbps from most sources (astronauts, transports, and robotic spacecraft), but 100 kbps from the base. Table 2-1 shows the basic and full forms of the communication scenario along with the per channel and total data rates. For each data type, a number of simultaneous channels has been assumed for purposes of constructing the working scenario. These communication scenarios assume a Mars Design Reference Mission (DRM) for human communications, possibly along with a set of four science orbiters and a set of eight robotic surface vehicles (landers, rovers, etc.). Communications links to and from the Earth are via a pair of telecom orbiters around Mars. For the exercise of the trade space and its associated technology challenges, data rates of 100 Mbps, 500 Mbps, and 1 Gbps are assumed for the partial and full scenarios. The 100 Mbps scenario would support basic operational activities; 500 Mbps case adds data from the set of robotic operations; and setting of 1 Gbps adds data from the science orbiters. The sources for these assumptions are discussed below. The DRM presumes six astronauts on the surface, two active in a base station and four roving away from the base station in two human transports. All astronauts have two-way audio (speech) channels on radios using omnidirectional antennas, to be

monitored by a relay orbiter. For numbers of channel and bandwidth sizing, the four science orbiters are presumed to have identical communications needs, as do the eight robotic rovers.
Author
Communication Networks; Synthetic Aperture Radar; Rates (Per Time); Radio Equipment; Bandwidth; Robotics; Mars Missions; Mars Exploration; Crew Exploration Vehicle

20080012563 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Enabling Technologies for Earth-Mars Communications, Part 2, Power System Technologies
Collins, Michael; Cook, Brian; Epp, Larry; Kerslake, Thomas; Kodis, Mary; Komm, David; Sands, O. Scott; Silva, Arnold; Simons, Rainee; Wintucky, Edward; Wilson, Jeffrey; High-Capacity Communications from Martian Distances; December 2007, pp. 97-122; In English; See also 20080012561; Original contains color and black and white illustrations; Copyright; Avail.: CASI: A03, Hardcopy

This chapter concludes the discussion of technical challenges and enabling technologies for realization of a high-capacity Gbps-class RF communications system at TRL 6 by the year 2020. It focuses on technologies to generate high RF transmit power and the associated prime DC power (solar cells and batteries). Thermal design and issues associated with the heat dissipation system are not included. Both TWTA and SSPA technologies appear to be capable of supporting RF power requirements needed to close a high-rate link. However, it should be noted that TWTA-based systems capable of supporting Gbps data rates from Mars are significantly more mature than SSPA-based systems at the time of this report. Much effort has been directed at the development of high-power TWTA technology at Ka-band. Current efforts in this area are focused on moving high-power Ka-band TWTAs out of the laboratory and infusing this technology into demonstration space-flight missions and operational space- flight missions. Power combining is the current focus for laboratory development of SSPA-based devices. SSPA-based systems development is testing architectures that combine the power of dozens of discrete SSPA modules into a single amplifier. While a large number of power-combined discrete SSPA modules should be able to match the power achievable with TWTA technology, it is not clear that this approach will be able to match the overall DC-to-RF power conversion efficiency obtainable with a TWTA. However, conversion efficiency is less important for missions that employ nuclear power for propulsion. Additionally note that a power-combined architecture should provide a 'graceful degradation' characteristic to SSPA-based amplifiers and mitigate concerns that may exist regarding the reliability of SSPA technology for high-power amplification at Ka-band. Continuous technological research and improvement has occurred in the area of power subsystems. Estimates of spacecraft burden associated with the needed raw power requirements are discussed based on today s technology as well as prognostications regarding the power system technology that will be available in the 2020 timeframe. While the spacecraft burden associated with generating the necessary power for 1 Gbps system can approach 100 kg, for missions that employ nuclear power for propulsion, the needed power subsystem may be essentially 'free' once the spacecraft has arrived on station.
Author
Radio Frequencies; Communication Equipment; Traveling Wave Amplifiers; Radio Communication; Rates (Per Time); Energy Conversion Efficiency; Extremely High Frequencies; Power Efficiency

20080012564 Satel, LLC, Rockville, MD, USA
Technology Complexity and Mass Minimization Approaches
Schuchman, Leonard; Hodges, Richard; Orr, Richard; Vyas, Hemali; High-Capacity Communications from Martian Distances; December 2007, pp. 123-138; In English; See also 20080012561; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy

In this chapter an approach is presented that for a given G/T at the Earth terminal, provides the satellite EIRP required for a given data rate in terms of minimum technology risk design, as defined in section 7.1.1. The approach starts from an initial design made according to the criterion of minimum total mass of the antenna and RF power subsystems. Using definitions of technology risk, or complexity, for both subsystems, the design is refined such that the minimum technology complexity is provided at the lowest possible total mass. The approach is quite general. Results are presented for transmission of three data rates at the maximum Mars-Earth range (2.67 AU, the furthest point from Earth for the relay satellite): 1 Gbps, 500 Mbps, and 100 Mbps. All designs are for a Ka-band downlink with 90 percent link availability, a bandwidth of 500 MHz, and dual polarization when required. The link budgets upon which these results are based are given in appendix 4A. In addition, the CEV-Earth link design is given for a CEV in transit to and from Mars. These results are then tied to the Mars relay results to determine if there is an efficient way to utilize the same ground array resources to simultaneously support both an in-transit CEV and explorers and instruments at Mars.
Author
Transmission Efficiency; Rates (Per Time); Radio Frequencies; Antenna Design; Bandwidth; Downlinking

20080012565 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Enabling Technologies for Earth-Mars Communications, Part 1, Antenna System

Hodges, Richard E.; Chen, Jackie; Connolly, Joseph; Davis, Gregory; Fang, Houfei; Hodges, Richard; Huang, John; Imbriale, William; Romanofsky, Robert; Sands, O. Scott; High-Capacity Communications from Martian Distances; December 2007, pp. 43-95; In English; See also 20080012561; Original contains color and black and white illustrations; Copyright; Avail.: CASI: A04, Hardcopy

This chapter and the next present the technical challenges and enabling technologies for realization of a high-capacity Gbps-class RF communications system at technology readiness level (TRL) 6 by the year 2020. The overall goal for these technologies is to achieve the required EIRP with a system of sufficiently low mass that can be stowed for launch and transport to Mars. This involves a tradeoff between transmit power and antenna gain. A smaller antenna will reduce mass, simplify stowage, and minimize beam-pointing accuracy requirements. However, smaller antennas require much higher transmit power, which in turn places greater demand on the prime DC power generation system (solar cells and batteries). Since large-aperture antenna technology can substantially reduce the demand for RF power, developing a simple and practical antenna design has potential to provide high reliability and minimize overall system mass at an acceptable mission cost. Referring back to the tables in section 4.2 will confirm that the requirements of communication scenarios for Mars can be met with antennas 6 to 25 m in size and power systems capable of delivering hundreds of watts to the antenna at Ka-band. This chapter addresses enabling technologies for a HGA system. Chapter 6 then discusses the technical challenges associated with generating high-RF transmit power. In these two chapters, we present a brief overview of the current state of the art for each technology, discuss current research directions, and finally indicate the key areas where research and development is needed to enable high-capacity RF communications. As discussed in chapter 4, the goal is to minimize the RF subsystem mass in obtaining a desired EIRP. This includes the power system, the antenna itself, and any other spacecraft systems whose mass varies with the antenna aperture. Figure 5-1 describes the elements of two basic antenna configurations: a steerable antenna system and a body-mounted antenna system. The mass and complexity are lower in a body-mounted configuration for HGAs; thus the focus of this report is on the body-mounted antenna. It comprises a reflector, a fixture that attaches it to the spacecraft body, and an optional fine-pointing subsystem. The total mass is also impacted by the stowage and associated deployment mechanism utilized and the ADCS, whose masses may have to be increased to support the antenna system.

Author

Antennas; Communication Equipment; Radio Communication; Steerable Antennas; Extremely High Frequencies; Beams (Radiation); Antenna Gain; Radio Frequencies

20080012566 NASA, Washington, DC, USA

Conclusions and Recommendations

Williams, W. Dan; Schuchman, Leonard; High-Capacity Communications from Martian Distances; December 2007, pp. 141-142; In English; See also 20080012561; Copyright; Avail.: CASI: A01, Hardcopy

We conclude that high capacity RF communications from large distances is achievable. This report considers methods to increase the capacity of an RF system to achieve very high data rates at Mars distances. The thesis of this report is that significantly higher downlink data rates are achievable by utilizing new RF technology. The technology enables much higher EIRP with small increases in spacecraft mass and reasonable increases in the Earth station effective aperture requirements. The uplink, not considered in this study, is easily enabled because it almost always carries lower data rate traffic than the downlink. There are three major objectives of this report: 1. Demonstrate that 1 Gbps return data rates in 2020 operational systems are possible using technology that is ready, or nearly ready, to fly today. 2. Describe conceptual designs of spacecraft telecommunications transmit subsystems for data rates 1 Gbps and 500 and 100 Mbps for a Mars telecom orbiter at maximum Earth- Mars distance. 3. Recommend strategic investment in technologies that offer design options for RF communications to meet high-data-rate needs. These three objectives were met: The conclusion is that 1-Gbps data rates are achievable from Mars distance by (1) increasing the spacecraft RF power transmitted and size of the spacecraft antenna; (2) using power-efficient, high-order modulation and near-capacity coding, and (3) using larger ground aperture from the Earth-based array. The study also indicates that required technology will be ready well before 2015 and can enable an operational architecture by 2020. The study further indicates that the needed power systems are ready today, but have yet to be flown. Earth sciences today collectively transmit data hundreds of Mbps to Earth. The DSN presently supports deep space science by receiving data in the 10 to 100 kbps range. The DSN has historically increased its capability in step with a steady increase in the quantity of data available from deep space. With the advent of a renewed exploration age and the desire to maximize scientific value by maximizing the amount of data that can be returned to Earth, it is with high probability that orders of magnitude more data will be available in deep space by 2030 and will some day be returned to Earth at transmission rates that match those now transmitted from near Earth via the Space Network (100s of Mbps). This report summarizes technologies

that enable the realization of tomorrow s communication needs. Technologies that can reduce the mass per bit such that 1 Gbps can be transmitted from the maximum Mars distance using reasonable space and ground resources are identified. Based on the report s findings, the following technology investment strategy is recommended.
Author
Design Analysis; Telecommunication; Downlinking; Power Efficiency; Radio Frequencies; Transmission Efficiency; Coding; Spacecraft Antennas

20080012567 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Assumptions for Mars RF Link Design
Vyas, Hemali; Brandel, Dan; Orr, Richard; Sands, O. Scott; High-Capacity Communications from Martian Distances; December 2007, pp. 11-23; In English; See also 20080012561; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy

High-rate communications from Mars has significant but manageable challenges during the timeline 2020 to 2030. MRO sends data on X-band at rates as high as 5.3 Mbps. MRO could have been designed to send data at much higher rates than 5.3 Mbps over most Mars-Earth distances were it not for bandwidth limitations at X-band (ref. 3-1). The bandwidth issue is less severe at Ka-band. The deep space allocation for Ka-band is 500 MHz, compared with 50 MHz at X-band. This section discusses the various assumptions and challenges foreseen for a high rate Ka-band downlink. These assumptions and challenges include spacecraft constraints, ground station configuration, weather and atmospheric implications, solar conjunction, spectrum constraints, and the extreme variation in Earth-Mars distance.
Author
Superhigh Frequencies; Radio Communication; Spacecraft Configurations; Rates (Per Time); Communication Equipment

20080012568 NASA, Washington, DC, USA
Introduction
Williams, W. Dan; Cain, Jeremy; Lieb, Erica; High-Capacity Communications from Martian Distances; December 2007, pp. 1-6; In English; See also 20080012561; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy

High-capacity (or high-data-rate) communications is required for human exploration of Mars and would allow science missions to execute and efficiently complete more data-intensive missions (refs. 1-1 and 1-2). Presently, science missions at Mars operate at very low data rates, such as 120 kbps (kilobits per second) for reporting telemetry from robotic experiments. Not only is this data rate insufficient to meet the expectations of future science missions that are striving to provide the same quality and quantity of return that is achieved on Earth-observing spacecraft, but it also falls short of expectations for activities associated with human exploration. High-capacity communications over large planetary distances, however, is challenging. This occurs since signal strength, whether optical or radiofrequency (RF), decreases in inverse proportion to the square of the distance, so that getting enough power back to Earth from astronomical unit (AU) distances approaches new technological boundaries. The thesis of this work is that significantly higher capacity communication at RF is possible by utilizing new technology, which will allow increasing the spacecraft effective isotropic radiated power (EIRP) for relatively small increases in spacecraft mass and with reasonable increases in the Earth station effective aperture capabilities. By focusing specifically on the communications return link from Mars to Earth, the challenges and the spacecraft RF technologies that will provide the solutions are presented in the context of a critical piece of NASA s vision for exploration. This report will demonstrate that Mars-to-Earth RF communications may achieve data rates as large as 1 Gbps (gigabits per second) with operational systems no later than 2020 using technologies that are at mid-technology readiness level (TRL) 4 to 5 or higher today. These technologies can be developed to TRL 6 or higher by 2020 without excessive monetary expenditures. This is addressed in two segments, the first of which is a discussion of spacecraft telecommunications transmit subsystem designs for a range of data rates (1 Gbps, 500 Mbps, and 100 Mbps) for both a Mars telecom orbiter at maximum Earth-Mars distance and a Crew Exploration Vehicle (CEV) in transit to the Red Planet. Broad recommendations for a CEV communication system will be discussed in the context of investigating how the requirements for an in-transit CEV and those of the transmitting Mars orbiter can simultaneously be met with a prudent allocation of Earth resources. The second segment explores the strategic and high-payoff technology investments that will offer design solutions for RF communications to meet the orbiter and CEV scenarios.
Author
Communication Networks; Telecommunication; Radio Communication; Data Links; Rates (Per Time); Radio Frequencies

20080012569 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Telecom Design for 1 Gbps, 500 Mbps, and 100 Mbps

Vyas, Hemali; Estabrook, Polly; Orr, Richard; Schuchman, Leonard; High-Capacity Communications from Martian Distances; December 2007, pp. 27-36; In English; See also 20080012561; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy

The telecom system for Mars to Earth communication downlink is designed for three data rate capabilities for a Mars relay. The three design points are 1 Gbps, 500 Mbps, and 100 Mbps at the maximum range of 2.67 AU, corresponding to the furthest point from Earth for the relay satellite. This communication link is designed for a Ka-band downlink with 90 percent link availability.

Author

Communication Networks; Spacecraft Communication; Deep Space Network; Extremely High Frequencies; Radio Frequencies; Rates (Per Time); Relay Satellites; Satellite Antennas

20080012684 Graduate Univ. for Advanced Studies, Japan

Analysis of Capture Trajectories to the Vicinity of Libration Points

Nakamiya, M.; Scheeres, D. J.; Yamakawa, H.; Yoshikawa, M.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 12 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

Spacecraft capture trajectories to the periodic orbits of the L1 and L2 points in the restricted Hill three-body problem are studied. The specific focus is on transfer to these vicinities from interplanetary trajectories. This application is motivated by future proposals to place 'Deep Space ports' at the Earth and Mars L1 or L2 points. These spaceports are considered as candidate gateways for interplanetary transfers in the future. We utilize stable manifolds for capture trajectories to periodic orbits around the libration points. As a result, the cost of capture into a periodic orbit is also reduced relative to direct capture into a parabolic orbit. The way of linking between interplanetary transfer trajectories and the stable manifold is also discussed.

Author

Interplanetary Trajectories; Libration; Spacecraft Trajectories; Trajectory Analysis; Mathematical Models; Trajectory Planning; Celestial Mechanics

20080012697 Israel Aerospace Industries Ltd., Israel

Orbit Determination System for Low Earth Orbit Satellites

Elisha, Yossi; Shyldkrot, Haim; Hankin, Maxim; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 8 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The IAI/MBT Precise Orbit Determination system for Low Earth Orbit satellites is presented. The system is based on GPS pesudorange and carrier phase measurements and implements the Reduced Dynamics method. The GPS measurements model, the dynamic model, and the least squares orbit determination are discussed. Results are shown for data from the CHAMP satellite and for simulated data from the ROKAR GPS receiver. In both cases the one sigma 3D position and velocity accuracy is about 0.2 m and 0.5 mm/sec respectively.

Author

Global Positioning System; Low Earth Orbits; Orbit Determination; Satellite Tracking

20080012706 National Commission of Space Activities, Buenos Aires, Argentina

Visual Navigation - SARE Mission

Alonso, Roberto; Kuba, Jose; Caruso, Daniel; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 3 pp.; In English; See also 20080012629; Copyright; Avail.: CASI: A01, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The SARE Earth Observing and Technological Mission is part of the Argentinean Space Agency (CONAE - Comision Nacional de Actividades Espaciales) Small and Technological Payloads Program. The Argentinean National Space Program requires from the SARE program mission to test in a real environment of several units, assemblies and components to reduce the risk of using these equipments in more expensive Space Missions. The objective is to make use those components with an acceptable maturity in design or development, but without any heritage at space. From the application point of view, this mission offers new products in the Earth Observation data market which are listed in the present paper. One of the technological payload on board of the SARE satellite is the sensor Ground Tracker. It computes the satellite attitude and orbit

in real time (goal) and/or by ground processing. For the first operating mode a dedicated computer and mass memory are necessary to be part of the mentioned sensor. For the second operational mode the hardware and software are much simpler. Derived from text

Satellite Orbits; Space Missions; Space Navigation; Visual Control; Spacecraft Control

20080012721 Japan Aerospace Exploration Agency, Kanagawa, Japan

SELENE Translunar Trajectory Reconfiguration Plan Provided for the Case of Main Engine Anomaly

Kawakatsu, Yasuhiro; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 12 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

In this paper, the reconfiguration of translunar trajectory in case of main engine anomaly is investigated. The objectives of the trajectory design are to reduce the excessive velocity at the Lunar encounter as well as to reduce the total required Delta-v to complete the sequence. 3-impulse Hohmann transfer based trajectory is adopted and possible trajectories are categorized under 2-body approximation. The solutions obtained are applied to more sophisticated models (3-body approximation and 4-body) and yields feasible trajectory.

Author

Transfer Orbits; Lunar Trajectories; Flight Mechanics; Spacecraft Trajectories; Trajectory Planning; Spacecraft Control; Spacecraft Guidance; Spacecraft Maneuvers

20080013146 NASA Glenn Research Center, Cleveland, OH, USA

Updates to the NASA Space Telecommunications Radio System (STRS) Architecture

Kacpura, Thomas J.; Handler, Louis M.; Briones, Janette; Hall, Charles S.; January 2008; 13 pp.; In English; Original contains color and black and white illustrations

Contract(s)/Grant(s): WBS 439432.04.07.01

Report No.(s): NASA/TM-2008-215052; E-16262; Copyright; Avail.: CASI: A03, Hardcopy

This paper describes an update of the Space Telecommunications Radio System (STRS) open architecture for NASA space based radios. The STRS architecture has been defined as a framework for the design, development, operation and upgrade of space based software defined radios, where processing resources are constrained. The architecture has been updated based upon reviews by NASA missions, radio providers, and component vendors. The STRS Standard prescribes the architectural relationship between the software elements used in software execution and defines the Application Programmer Interface (API) between the operating environment and the waveform application. Modeling tools have been adopted to present the architecture. The paper will present a description of the updated API, configuration files, and constraints. Minimum compliance is discussed for early implementations. The paper then closes with a summary of the changes made and discussion of the relevant alignment with the Object Management Group (OMG) SWRadio specification, and enhancements to the specialized signal processing abstraction.

Author

Telecommunication; Signal Processing; Radio Equipment; Computer Programming; Architecture (Computers)

20080013190 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Earth-Image Tracking in the IR for Deep Space Optical Communications

Hemmati, Hamid; Chen, Yinging; Lee, Shinhak; Ortiz, Gerard G.; July 25, 2005; 2 pp.; In English; Original contains black and white illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40629

Sub-microradian level laser beam pointing to an Earth-based receiver is required for deep space optical communications. This requires a beacon emanated from Earth towards the spacecraft. The beacon could be a laser or reflected sunlight from Earth. Earth image tracking in the visible is hampered by significant albedo variations and/or crescent Earth image yielding large central errors. Here, we report results of Earth-image tracking in the infrared (8 to 13 micron) region of the spectrum with the aim of substantially alleviating the two challenges mentioned earlier.

Author

Infrared Radiation; Optical Communication; Space Communication; Deep Space; Earth Albedo; Beams (Radiation)

20080013208 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Evaluation of the Telecommunications Protocol Processing Subsystem Using Reconfigurable Interoperable Gate Array

Pang, Jackson; Liddicoat, Albert; Ralston, Jesse; Pingree, Paula; April 19, 2006; 5 pp.; In English; CoolChips IX, 19-21 Apr. 2006, Yokohama, Japan; Original contains color and black and white illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40683

The current implementation of the Telecommunications Protocol Processing Subsystem Using Reconfigurable Interoperable Gate Arrays (TRIGA) is equipped with CFDP protocol and CCSDS Telemetry and Telecommand framing schemes to replace the CPU intensive software counterpart implementation for reliable deep space communication. We present the hardware/software co-design methodology used to accomplish high data rate throughput. The hardware CFDP protocol stack implementation is then compared against the two recent flight implementations. The results from our experiments show that TRIGA offers more than 3 orders of magnitude throughput improvement with less than one-tenth of the power consumption.

Author

Telecommunication; Command and Control; Protocol (Computers); Rates (Per Time); Space Communication; Computer Programs

20080013223 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

UHF Relay Antenna Measurements on Phoenix Mars Lander Mockup

Ilott, Peter; Harrel, Jefferson; Arnold, Bradford; Bliznyuk, Natalia; Nielsen, Rick; Dawson, David; McGee, Jodi; October 22, 2006; 7 pp.; In English; Antenna Measurements and Techniques Association (AMTA), 22-27 Oct. 2006, Austin, TX, USA; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40721

The Phoenix Lander, a NASA Discovery mission which lands on Mars in the spring of 2008, will rely entirely on UHF relay links between it and Mars orbiting assets, (Odyssey and Mars Reconnaissance Orbiter (MRO)), to communicate with the Earth. As with the Mars Exploration Rover (MER) relay system, non directional antennas will be used to provide roughly emispherical coverage of the Martian sky. Phoenix lander deck object pattern interference and obscuration are significant, and needed to be quantified to answer system level design and operations questions. This paper describes the measurement campaign carried out at the SPAWAR (Space and Naval Warfare Research) Systems Center San Diego (SSC-SD) hemispherical antenna range, using a Phoenix deck mockup and engineering model antennas. One goal of the measurements was to evaluate two analysis tools, the time domain CST, and the moment method WIPL-D software packages. These would subsequently be used to provide pattern analysis for configurations that would be difficult and expensive to model and test on Earth.

Author

Ultrahigh Frequencies; Mars Reconnaissance Orbiter; Phoenix Mars Lander; Directional Antennas; Method of Moments

20080013224 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Implementation of a Coded Modulation for Deep Space Optical Communications

Cheng, Michael K.; Moision, Bruce E.; Hamkins, Jon; Nakashima, Michael A.; November 27, 2006; 5 pp.; In English; IEEE Globecom, 27 Nov. - 1 Dec. 2006, San Francisco, CA, USA; Original contains color and black and white illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40719

We present an efficient implementation of a coded modulation for the deep space optical channel. NASA designed this so called serially concatenated pulse position modulation (SCPPM) code to provide an optical link that can operate within one dB signal energy of the Shannon capacity during a nominal mission condition from Mars. Here, we describe some of the challenges in realizing the SCPPM decoder on a field-programmable gate array (FPGA). Through various architectural optimizations, we achieve a 6 Mbps decoder on a single FPGA. Moreover, we demonstrate that it is possible to communicate reliably on an efficient bits-per-photon count in an end-to-end SCPPM coded system.

Author

Optical Communication; Field-Programmable Gate Arrays; Space Communication; Pulse Position Modulation; Channels (Data Transmission); Decoders; End-to-End Data Systems

20080013273 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Simplified Lasercom System Architecture Using a Disturbance-Free Platform

Chen, Chien-Chung; Hemmati, Hamid; Biswas, Abhijit; Ortiz, Gerardo; Farr, William; Pedreiro, Nelson; January 23, 2006; 6 pp.; In English; SPIE Photonics West, 23-25 Jan. 2006, San Jose, CA, USA; Original contains black and white illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40668

A simplified laser communications (lasercom) system architecture, primarily for a deep-space flight transceivers, can be realized by decoupling the lasercom optical components from the host spacecraft using a disturbance-free platform (DFP) developed by Lockheed Martin Space System Company. Unlike conventional lasercom system architectures where a high bandwidth control loop is used to stabilize the optical line-of-sight in the presence of platform disturbance, the DFP package isolates the optical train from the high frequency platform jitter produced by the host. By preventing the vibration from coupling into the optics train, the need for a high bandwidth beam stabilization control loop (including fast steering mirror, detectors, controls and the associated relay optics) is eliminated with possible mass savings.

Author

Optical Communication; Decoupling; Transmitter Receivers; Architecture (Computers); Line of Sight; High Frequencies; Bandwidth

20080013278 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Implementation of a Coded Modulation for Deep Space Optical Communications

Cheng, Michael K.; Moision, Bruce E.; Hamkins, Jon; Nakashima, Michael A.; February 6, 2006; 5 pp.; In English; Information Theory Workshop, 6-10 Feb. 2006, San Diego, CA, USA; Original contains black and white illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40687

We present a field programmable gate array code (FPGA) implementation of a turbo-like decoder for a serially concatenated pulse-position modulation (SCPPM) code. NASA a developed this coded modulation scheme for deep space communications from Mars. Under a nominal mission condition, the decoder complexity by iteratively decoding the modulation and SCPPM coded system can operate within a one dB signal energy gap from capacity. The structure of SCPPM makes direct application of the conventional turbo decoding algorithm very inefficient. Here, we describe techniques to increase the throughput and performance of a hardware SCPPM decoder. using our optimizations, we demonstrate a 6 mega-bits per second (Mbps) decoder realization on a single FPGA. Extension toa higher data rate decoder using multiple FPGAs is readily achievable. Similar codes designed for the optical channel can benefit from our optimization techniques.

Author

Field-Programmable Gate Arrays; Pulse Position Modulation; Rates (Per Time); Space Communication; Channels (Data Transmission); Decoders; Optical Communication; Decoding

20080013282 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

A Gigabit-per-Second Ka-Band Demonstration Using a Reconfigurable FPGA Modulator

Lee, Dennis; Gray, Andrew A.; Kang, Edward C.; Tsou, Haiping; Lay, Norman E.; Fong, Wai; Fisher, Dave; Hoy, Scott; March 5, 2005; 9 pp.; In English; IEEE Aerospace Conference, 5-12 Mar. 2005, Big Sky, MT, USA; Original contains black and white illustrations

Report No.(s): IEEEAC Paper-1403, Version 4; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40626

Gigabit-per-second communications have been a desired target for future NASA Earth science missions, and for potential manned lunar missions. Frequency bandwidth at S-band and X-band is typically insufficient to support missions at these high data rates. In this paper, we present the results of a 1 Gbps 32-QAM end-to-end experiment at Ka-band using a reconfigurable Field Programmable Gate Array (FPGA) baseband modulator board. Bit error rate measurements of the received signal using a software receiver demonstrate the feasibility of using ultra-high data rates at Ka-band, although results indicate that error correcting coding and/or modulator predistortion must be implemented in addition. Also, results of the demonstration validate the low-cost, MOS-based reconfigurable modulator approach taken to development of a high rate modulator, as opposed to more expensive ASIC or pure analog approaches.

Author

Field-Programmable Gate Arrays; Superhigh Frequencies; Bit Error Rate; Extremely High Frequencies; Ultrahigh Frequencies; Rates (Per Time); Quadrature Amplitude Modulation; Application Specific Integrated Circuits

20080013328 NASA Johnson Space Center, Houston, TX, USA

Empirical Accuracies of U.S. Space Surveillance Network Reentry Predictions

Johnson, Nicholas L.; [2008]; 1 pp.; In English; COSPAR, 13-20 Jul. 2008, Montrel, Canada; No Copyright; Avail.: Other Sources; Abstract Only

The U.S. Space Surveillance Network (SSN) issues formal satellite reentry predictions for objects which have the potential for generating debris which could pose a hazard to people or property on Earth. These prognostications, known as Tracking and Impact Prediction (TIP) messages, are nominally distributed at daily intervals beginning four days prior to the anticipated reentry and several times during the final 24 hours in orbit. The accuracy of these messages depends on the nature of the satellite s orbit, the characteristics of the space vehicle, solar activity, and many other factors. Despite the many influences on the time and the location of reentry, a useful assessment of the accuracies of TIP messages can be derived and compared with the official accuracies included with each TIP message. This paper summarizes the results of a study of numerous uncontrolled reentries of spacecraft and rocket bodies from nearly circular orbits over a span of several years. Insights are provided into the empirical accuracies and utility of SSN TIP messages.

Author

Satellite Orbits; Reentry Vehicles; Impact Prediction; Circular Orbits; Position (Location); Space Debris

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SPACECRAFT DESIGN, TESTING AND PERFORMANCE

Includes satellites; space platforms; space stations; spacecraft systems and components such as thermal and environmental controls; and spacecraft control and stability characteristics. For life support systems see *54 Man/System Technology and Life Support*. For related information see also *05 Aircraft Design, Testing and Performance; 39 Structural Mechanics*; and *16 Space Transportation and Safety*.

20080012480 NASA Johnson Space Center, Houston, TX, USA

A Brief History of Meteoroid and Orbital Debris Shielding Technology for US Manned Spacecraft

Bjorkman, Michael D.; Hyde, James L.; [2008]; 1 pp.; In English; AIAA Space 2008 Conference and Exposition, 9-11 Sept. 2008, San Diego, CA, USA; Copyright; Avail.: Other Sources; Abstract Only

Meteoroid and orbital debris shielding has played an important role from the beginning of manned spaceflight. During the early 60 s, meteoroid protection drove requirements for new meteor and micrometeoroid impact science. Meteoroid protection also stimulated advances in the technology of hypervelocity impact launchers and impact damage assessment methodologies. The first phase of meteoroid shielding assessments closed in the early 70 s with the end of the Apollo program. The second phase of meteoroid protection technology began in the early 80 s when it was determined that there is a manmade Earth orbital debris belt that poses a significant risk to LEO manned spacecraft. The severity of the Earth orbital debris environment has dictated changes in Space Shuttle and ISS operations as well as driven advances in shielding technology and assessment methodologies. A timeline of shielding technology and assessment methodology advances is presented along with a summary of risk assessment results.

Author

Meteoroid Protection; Hypervelocity Impact; Spacecraft Shielding; Space Debris; Micrometeoroids; Meteorite Collisions; Low Earth Orbits; Impact Damage; Damage Assessment

20080012530 NASA Johnson Space Center, Houston, TX, USA

Early Impacts of a Human-in-the-Loop Evaluation in a Space Vehicle Mock-up Facility

Byrne, Vicky; Vos, Gordon; Whitmore, Mihriban; [2008]; 6 pp.; In English; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy

The development of a new space vehicle, the Orion Crew Exploration Vehicle (CEV), provides Human Factors engineers an excellent opportunity to have an impact early in the design process. This case study highlights a Human-in-the-Loop (HITL) evaluation conducted in a Space Vehicle Mock-Up Facility and will describe the human-centered approach and how the findings are impacting design and operational concepts early in space vehicle design. The focus of this HITL evaluation centered on the activities that astronaut crewmembers would be expected to perform within the functional internal volume of the Crew Module (CM) of the space vehicle. The primary objective was to determine if there are aspects of a baseline vehicle configuration that would limit or prevent the performance of dynamically volume-driving activities (e.g. six crewmembers donning their suits in an evacuation scenario). A second objective was to step through concepts of operations for known systems and evaluate them in integrated scenarios. The functional volume for crewmember activities is closely tied to every

aspect of system design (e.g. avionics, safety, stowage, seats, suits, and structural support placement). As this evaluation took place before the Preliminary Design Review of the space vehicle with some designs very early in the development, it was not meant to determine definitely that the crewmembers could complete every activity, but rather to provide inputs that could improve developing designs and concepts of operations definition refinement.
Derived from text
Crew Exploration Vehicle; Design Analysis; Human Factors Engineering; Spacecraft Modules; Spacecrews; Space Capsules

20080012573 NASA Glenn Research Center, Cleveland, OH, USA
Probabilistic Analysis of Space Shuttle Body Flap Actuator Ball Bearings
Oswald, Fred B.; Jett, Timothy R.; Predmore, Roamer E.; Zaretsky, Erwin V.; January 2008; 25 pp.; In English; STLE's 62nd Annual Meeting and Exhibition, 6-10 May 2007, Philadelphia, PA, USA; Original contains black and white illustrations
Contract(s)/Grant(s): WBS 049788.04.06.03.06
Report No.(s): NASA/TM-2008-215057; E-15843-1; Copyright; Avail.: CASI: A03, Hardcopy

A probabilistic analysis, using the 2-parameter Weibull-Johnson method, was performed on experimental life test data from space shuttle actuator bearings. Experiments were performed on a test rig under simulated conditions to determine the life and failure mechanism of the grease lubricated bearings that support the input shaft of the space shuttle body flap actuators. The failure mechanism was wear that can cause loss of bearing preload. These tests established life and reliability data for both shuttle flight and ground operation. Test data were used to estimate the failure rate and reliability as a function of the number of shuttle missions flown. The Weibull analysis of the test data for the four actuators on one shuttle, each with a 2-bearing shaft assembly, established a reliability level of 96.9 percent for a life of 12 missions. A probabilistic system analysis for four shuttles, each of which has four actuators, predicts a single bearing failure in one actuator of one shuttle after 22 missions (a total of 88 missions for a 4-shuttle fleet). This prediction is comparable with actual shuttle flight history in which a single actuator bearing was found to have failed by wear at 20 missions.
Author
Actuators; Ball Bearings; Space Shuttles; Shafts (Machine Elements); Wear; Component Reliability; Weibull Density Functions

20080012604 NASA Glenn Research Center, Cleveland, OH, USA
Development and Buildup of a Stirling Radioisotope Generator Electrical Simulator
Prokop, Norman F.; Krasowski, Michael J.; Greer, Lawrence C.; Flatico, Joseph M.; Spina, Dan C.; January 2008; 13 pp.; In English; Original contains color and black and white illustrations
Contract(s)/Grant(s): WBS 387498.04.01.03.01.03
Report No.(s): NASA/TM-2008-215063; E-16291; Copyright; Avail.: CASI: A03, Hardcopy

This paper describes the development of a Stirling Radioisotope Generator (SRG) Simulator for use in a prototype lunar robotic rover. The SRG developed at NASA Glenn Research Center (GRC) is a promising power source for the robotic exploration of the sunless areas of the moon. The simulator designed provides a power output similar to the SRG output of 5.7 A at 28 Vdc, while using ac wall power as the input power source. The designed electrical simulator provides rover developers the physical and electrical constraints of the SRG supporting parallel development of the SRG and rover. Parallel development allows the rover design team to embrace the SRG s unique constraints while development of the SRG is continued to a flight qualified version.
Author
Stirling Cycle; Simulators; Robotics; Alternating Current

20080012629 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Proceedings of the 20th International Symposium on Space Flight Dynamics
Woodard, Mark, Editor; Stengle, Tom, Editor; September 24, 2007; In English; 20th International Symposium on Space Flight Dynamics, 24-28 Sep. 2007, Annapolis, MD, USA; See also 20080012630 - 20080012730; Original contains color and black and white illustrations
Report No.(s): NASA/CP-2007-214158; Copyright; Avail.: CASI: C01, CD-ROM

Topics include: Measuring Image Navigation and Registration Performance at the 3-Sigma Level Using Platinum Quality Landmarks; Flight Dynamics Performances of the MetOp A Satellite during the First Months of Operations; Visual Navigation - SARE Mission; Determining a Method of Enabling and Disabling the Integral Torque in the SDO Science and Inertial Mode Controllers; Guaranteeing Pointing Performance of the SDO Sun-Pointing Controllers in Light of Nonlinear Effects; SDO

Delta H Mode Design and Analysis; Observing Mode Attitude Controller for the Lunar Reconnaissance Orbiter; Broken-Plane Maneuver Applications for Earth to Mars Trajectories; ExoMars Mission Analysis and Design - Launch, Cruise and Arrival Analyses; Mars Reconnaissance Orbiter Aerobraking Daily Operations and Collision Avoidance; Mars Reconnaissance Orbiter Interplanetary Cruise Navigation; Motion Parameters Determination of the SC and Phobos in the Project Phobos-Grunt; GRAS NRT Precise Orbit Determination: Operational Experience; Orbit Determination of LEO Satellites for a Single Pass through a Radar: Comparison of Methods; Orbit Determination System for Low Earth Orbit Satellites; Precise Orbit Determination for ALOS; Anti-Collision Function Design and Performances of the CNES Formation Flying Experiment on the PRISMA Mission; CNES Approaching Guidance Experiment within FFIORD; Maneuver Recovery Analysis for the Magnetospheric Multiscale Mission; SIMBOL-X: A Formation Flying Mission on HEO for Exploring the Universe; Spaceborne Autonomous and Ground Based Relative Orbit Control for the TerraSAR-X/TanDEM-X Formation; First In-Orbit Experience of TerraSAR-X Flight Dynamics Operations; Automated Target Planning for FUSE Using the SOVA Algorithm; Space Technology 5 Post-Launch Ground Attitude Estimation Experience; Standardizing Navigation Data: A Status Update; and A Study into the Method of Precise Orbit Determination of a HEO Orbiter by GPS and Accelerometer.
Derived from text
Space Flight; Global Positioning System; Collision Avoidance; Aerodynamics; Aerospace Engineering; Low Earth Orbits; Mars Reconnaissance Orbiter; Orbit Determination

20080012630 European Space Agency. European Space Operations Center, Darmstadt, Germany
Rosetta Navigation at its Mars Swing-By
Budnik, Frank; Morley, Trevor; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 10 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

This paper reports on the navigation activities during Rosetta s Mars swing-by. It covers the Mars approach phase starting after a deterministic deep-space maneuver in September 2006, the swing-by proper on 25 February 2007, and ends with another deterministic deep-space maneuver in April 2007 which was also foreseen to compensate any navigation error. Emphasis is put on the orbit determination and prediction set-up and the evolution of the targeting estimates in the B-plane and their adjustments by trajectory correction maneuvers.
Author
Rosetta Mission; Navigation; Spacecraft Maneuvers; Trajectories; Orbit Determination

20080012631 DEIMOS Engenharia, Lisbon, Portugal
Guidance Algorithms for Non-Drifting Trajectory Generation and Control in RendezVous Missions into Elliptical Orbits
DiSotto, Emanuele; Bastante, Juan Carlos; Drai, Remi; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 13 pp.; In English; See also 20080012629; Original contains color illustrations
Contract(s)/Grant(s): ESTE-19495/05/NL/JA/pg; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

Safety requirement represents one of the most critical aspect when defining the operational profile for a RendezVous mission. This requirement specially affects the design of the guidance algorithms that need to be tailored to guarantee what is normally referred to as Passive Trajectory Protection . The basic idea of passive trajectory protection is to design all the trajectory elements in an approach sequence such that if, at any point of the trajectory, thrust control ceases, the resulting free drift motion will remain collision free during a certain amount of time. This paper deals with the design and performances assessment of specific guidance algorithm addressing this issue. Firstly the problem is addressed for circular orbit using the Traveling Ellipse formulation for the relative motion. Secondly a solution for the RendezVous into a generic elliptical orbit is presented. This is based on a reduced transition matrix obtained through a description of the relative motion based on the first order variation of the orbital elements.
Author
Algorithms; Elliptical Orbits; Trajectory Control; Rendezvous Guidance

20080012632 Japan Aerospace Exploration Agency, Kanagawa, Japan
Formation Design Strategy for SCOPE High-Elliptic Formation Flying Mission
Tsuda, Yuichi; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 9 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The new formation design strategy using simulated annealing (SA) optimization is presented. The SA algorithm is useful

to survey a whole solution space of optimum formation, taking into account realistic constraints composed of continuous and discrete functions. It is revealed that this method is not only applicable for circular orbit, but also for high-elliptic orbit formation flying. The developed algorithm is first tested with a simple cart-wheel motion example, and then applied to the formation design for SCOPE. SCOPE is the next generation geomagnetotail observation mission planned in JAXA, utilizing a formation flying techonology in a high elliptic orbit. A distinctive and useful heuristics is found by investigating SA results, showing the effectiveness of the proposed design process.
Author
Formation Flying; Mission Planning; Simulated Annealing; Optimization; Algorithms

20080012633 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Expanding Hardware-in-the-Loop Formation Navigation and Control with Radio Frequency Crosslink Ranging
Mitchell, Jason W.; Barbee, Brent W.; Baldwin, Philip J.; Luquette, Richard J.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 14 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The Formation Flying Testbed (FFTB) at the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center (GSFC) provides a hardware-in-the-loop test environment for formation navigation and control. The facility continues to evolve as a modular, hybrid, dynamic simulation facility for end-to-end guidance, navigation, and control (GN&C) design and analysis of formation flying spacecraft. The core capabilities of the FFTB, as a platform for testing critical hardware and software algorithms in-the-loop, are reviewed with a focus on recent improvements. With the most recent improvement, in support of Technology Readiness Level (TRL) 6 testing of the Inter-spacecraft Ranging and Alarm System (IRAS) for the Magnetospheric Multiscale (MMS) mission, the FFTB has significantly expanded its ability to perform realistic simulations that require Radio Frequency (RF) ranging sensors for relative navigation with the Path Emulator for RF Signals (PERFS). The PERFS, currently under development at NASA GSFC, modulates RF signals exchanged between spacecraft. The RF signals are modified to accurately reflect the dynamic environment through which they travel, including the effects of medium, moving platforms, and radiated power.
Author
Formation Flying; Radio Frequencies; Hardware-in-the-Loop Simulation; Navigation; Crosslinking; Rangefinding

20080012634 Massachusetts Inst. of Tech., Cambridge, MA, USA
Implementation of Satellite Formation Flight Algorithms Using SPHERES Aboard the International Space Station
Mandy, Christophe P.; Sakamoto, Hiraku; Saenz-Otero, Alvar; Miller, David W.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The MIT's Space Systems Laboratory developed the Synchronized Position Hold Engage and Reorient Experimental Satellites (SPHERES) as a risk-tolerant spaceborne facility to develop and mature control, estimation, and autonomy algorithms for distributed satellite systems for applications such as satellite formation flight. Tests performed study interferometric mission-type formation flight maneuvers in deep space. These tests consist of having the satellites trace a coordinated trajectory under tight control that would allow simulated apertures to constructively interfere observed light and measure the resulting increase in angular resolution. This paper focuses on formation initialization (establishment of a formation using limited field of view relative sensors), formation coordination (synchronization of the different satellite s motion) and fuel-balancing among the different satellites.
Author
International Space Station; Spheres; Formation Flying; Natural Satellites; Trajectory Control; Algorithms; Aerospace Systems; Angular Resolution

20080012635 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Solar Cycle #24 and the Solar Dynamo
Schatten, Kenneth; Pesnell, W. Dean; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 14 pp.; In English; See also 20080012629; Original contains black and white illustrations
Contract(s)/Grant(s): NNG04DA01C; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

We focus on two solar aspects related to flight dynamics. These are the solar dynamo and long-term solar activity

predictions. The nature of the solar dynamo is central to solar activity predictions, and these predictions are important for orbital planning of satellites in low earth orbit (LEO). The reason is that the solar ultraviolet (UV) and extreme ultraviolet (EUV) spectral irradiances inflate the upper atmospheric layers of the Earth, forming the thermosphere and exosphere through which these satellites orbit. Concerning the dynamo, we discuss some recent novel approaches towards its understanding. For solar predictions we concentrate on a solar precursor method, in which the Sun's polar field plays a major role in forecasting the next cycle s activity based upon the Babcock-Leighton dynamo. With a current low value for the Sun s polar field, this method predicts that solar cycle #24 will be one of the lowest in recent times, with smoothed F10.7 radio flux values peaking near 130 plus or minus 30 (2 sigma), in the 2013 timeframe. One may have to consider solar activity as far back as the early 20th century to find a cycle of comparable magnitude. Concomitant effects of low solar activity upon satellites in LEO will need to be considered, such as enhancements in orbital debris. Support for our prediction of a low solar cycle #24 is borne out by the lack of new cycle sunspots at least through the first half of 2007. Usually at the present epoch in the solar cycle (approx. 7+ years after the last solar maximum), for a normal size following cycle, new cycle sunspots would be seen. The lack of their appearance at this time is only consistent with a low cycle #24. Polar field observations of a weak magnitude are consistent with unusual structures seen in the Sun s corona. Polar coronal holes are the hallmarks of the Sun's open field structures. At present, it appears that the polar coronal holes are relatively weak, and there have been many equatorial coronal holes. This appears consistent with a weakening polar field, but coronal hole data must be scrutinized carefully as observing techniques have changed. We also discuss new solar dynamo ideas, and the SODA (SOlar Dynamo Amplitude) index, which provides the user with the ability to track the Sun's hidden, dynamo magnetic fields throughout the various stages of the Sun's cycle. Our solar dynamo ideas are a modernization and rejuvenation of the Babcock-Leighton original idea of a shallow solar dynamo, using modern observations that appear to support their shallow dynamo viewpoint. We are in awe of being able to see an object the size of the Sun undergoing as dramatic a change as our model provides in a few short years. The Sun, however, has undergone changes as rapid as this before! The weather on the Sun is at least as fickle as the weather on the Earth. Author

Dynamo Theory; Solar Activity Effects; Solar Cycles; Sun

20080012636 Centre National d'Etudes Spatiales, Toulouse, France

Four-Formation In-Track Configuration Maintenance Strategy

Lamy, Alain; Costes, Thierry; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007, pp. 1-15; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The aim of this paper is to present the analysis conducted by CNES for the maintenance of a formation made of several LEO satellites (typically 4) in several planes (typically 2), 100 km or so apart from each other. The along-track separations between the satellites have to be controlled to within 15 km thanks to orbit correction maneuvers supposed to be performed every 2 weeks. The main difficulty is related to solar activity which is expected to be close to its maximum for the entire mission s lifespan. As a matter of fact, a high solar activity makes orbit prediction harder, and makes it impossible to keep the altitude of the formation constant. Thus, a specific relative maintenance strategy had to be devised in order to meet the mission's requirements. The first part provides a few elements on the mission analysis process that has taken place. The method used for the evaluation of the maneuver frequency is detailed, based on the evaluation of the effects of atmospheric drag on the orbit. The second part is dedicated to the maintenance strategy that has been designed, and particularly to the computation of the reference orbits and of the velocity increments that enable the in-track inter-satellite distances to be maintained within the desired bounds. Finally a few simulation results are presented; they enable the performance of the maintenance strategy to be checked in a more realistic context.
Author

Low Earth Orbits; Satellite Control; Algorithms; Satellite Design; Spacecraft Maneuvers

20080012637 GMV Aerospace and Defense S.A., Madrid, Spain

Galileo Station Keeping Strategy

Perez-Cambriles, Antonio; Bejar-Romero, Juan Antonio; Aguilar-Taboada, Daniel; Perez-Lopez, Fernando; Navarro, Daniel; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 7 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

This paper presents analyses done for the design and implementation of the Maneuver Planning software of the Galileo

Flight Dynamics Facility. The station keeping requirements of the constellation have been analyzed in order to identify the key parameters to be taken into account in the design and implementation of the software.
Author
Galileo Spacecraft; Stationkeeping; Computer Programs

20080012638 DEIMOS Space S.L., Madrid, Spain
Mission Analysis for the Don Quijote Phase-A Study
Cano, Juan L.; Sanchez, Mariano; Cornara, Stefania; Carnelli, Ian; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 14 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The Don Quijote Phase-A study is a definition study funded by ESA and devoted to the analysis of the possibilities to deflect a Near Earth Object (NEO) in the range of 300-800 m diameter. DEIMOS Space S.L. and EADS Astrium have teamed up within this study to form one of the three consortia that have analyzed these aspects for ESA. Target asteroids for the mission are 1989 ML, 2002 AT4 and Apophis. This paper presents the mission analysis activities within the consortium providing: low-thrust interplanetary rendezvous Orbiter trajectories to the target asteroids, ballistic interplanetary trajectories for the Impactor, Orbiter arrival description at the asteroids, Orbiter stable orbits characterization at the asteroid, deflection determination by means of a Radio Science Experiment (RSE) as well as the mission timelines and overall mission scenarios.
Author
Mission Planning; Astrodynamics; Spacecraft Propulsion; Asteroids; Near Earth Objects

20080012640 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Topology of the Relative Motion: Circular and Eccentric Reference Orbit Cases
FontdecabaiBaig, Jordi; Metris, Gilles; Exertier, Pierre; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 12 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

This paper deals with the topology of the relative trajectories in flight formations. The purpose is to study the different types of relative trajectories, their degrees of freedom, and to give an adapted parameterization. The paper also deals with the research of local circular motions. Even if they exist only when the reference orbit is circular, we extrapolate initial conditions to the eccentric reference orbit case.This alternative approach is complementary with traditional approaches in terms of cartesian coordinates or differences of orbital elements.
Author
Orbital Elements; Circular Orbits; Formation Flying; Trajectories; Cartesian Coordinates; Degrees of Freedom

20080012641 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Establishing a Near Term Lunar Farside Gravity Model via Inexpensive Add-on Navigation Payload
Folta, David; Mesarch, Michael; Miller, Ronald; Bell, David; Jedrey, Tom; Butman, Stanley; Asmar, Sami; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 13 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The Space Communications and Navigation, Constellation Integration Project (SCIP) is tasked with defining, developing, deploying and operating an evolving multi-decade communications and navigation (C/N) infrastructure including services and subsystems that will support both robotic and human exploration activities at the Moon. This paper discusses an early far side gravitational mapping service and related telecom subsystem that uses an existing spacecraft (WIND) and the Lunar Reconnaissance Orbiter (LRO) to collect data that would address several needs of the SCIP. An important aspect of such an endeavor is to vastly improve the current lunar gravity model while demonstrating the navigation and stationkeeping of a relay spacecraft. We describe a gravity data acquisition activity and the trajectory design of the relay orbit in an Earth-Moon L2 co-linear libration orbit. Several phases of the transfer from an Earth-Sun to the Earth-Moon region are discussed along with transfers within the Earth-Moon system. We describe a proposed, but not integrated, add-on to LRO scheduled to be launched in October of 2008. LRO provided a real host spacecraft against which we designed the science payload and mission activities. From a strategic standpoint, LRO was a very exciting first flight opportunity for gravity science data collection. Gravity Science data collection requires the use of one or more low altitude lunar polar orbiters. Variations in the lunar gravity field will cause measurable variations in the orbit of a low altitude lunar orbiter. The primary means to capture these induced motions is to monitor the Doppler shift of a radio signal to or from the low altitude spacecraft, given that the signal is

referenced to a stable frequency reference. For the lunar far side, a secondary orbiting radio signal platform is required. We provide an in-depth look at link margins, trajectory design, and hardware implications. Our approach posed minimum risk to a host mission while maintaining a very low implementation and operations cost.
Author
Space Communication; Navigation; Constellations; Lunar Orbiter; Reconnaissance; Earth-Moon System; Gravitational Fields; Lunar Gravitation; Radio Signals; Robotics

20080012642 DEIMOS Space S.L., Madrid, Spain
Flight Mechanics of the Entry, Descent and Landing of the ExoMars Mission
HayaRamos, Rodrigo; Boneti, Davide; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 10 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

ExoMars is ESA's current mission to planet Mars. A high mobility rover and a fixed station will be deployed on the surface of Mars. This paper regards the flight mechanics of the Entry, Descent and Landing (EDL) phases used for the mission analysis and design of the Baseline and back-up scenarios of the mission. The EDL concept is based on a ballistic entry, followed by a descent under parachutes and inflatable devices (airbags) for landing. The mission analysis and design is driven by the flexibility in terms of landing site, arrival dates and the very stringent requirement in terms of landing accuracy. The challenging requirements currently imposed to the mission need innovative analysis and design techniques to support system design trade-offs to cope with the variability in entry conditions. The concept of the Global Entry Corridor has been conceived, designed, implemented and successfully validated as a key tool to provide a global picture of the mission capabilities in terms of landing site reachability.
Author
Mars Missions; Descent; Landing Sites; Deployment; Mars Surface; Flight Mechanics

20080012643 SES Astra S.A., Luxembourg, France
A General Approach to the Geostationary Transfer Orbit Mission Recovery
Faber, Nicolas; Aresini, Andrea; Wauthier, Pascal; Francken, Philippe; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 16 pp.; In English; See also 20080012629; Original contains color illustrations Contract(s)/Grant(s): BFR 04/55; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

This paper discusses recovery scenarios for geosynchronous satellites injected in a non-nominal orbit due to a launcher underperformance. The theory on minimum-fuel orbital transfers is applied to develop an operational tool capable to design a recovery mission. To obtain promising initial guesses for the recovery three complementary techniques are used: p-optimized impulse function contouring, a numerical impulse function minimization and the solutions to the switching equations. The tool evaluates the feasibility of a recovery with the on-board propellant of the spacecraft and performs the complete mission design. This design takes into account for various mission operational constraints such as e.g., the requirement of multiple finite-duration burns, third-body orbital perturbations, spacecraft attitude constraints and ground station visibility. In a final case study, we analyze the consequences of a premature breakdown of an upper rocket stage engine during injection on a geostationary transfer orbit, as well as the possible recovery solution with the satellite on-board propellant.
Author
Geosynchronous Orbits; Optimization; Transfer Orbits; Spacecraft Recovery; Mission Planning; Upper Stage Rocket Engines

20080012644 European Space Agency. European Space Operations Center, Darmstadt, Germany
Contingency Operations during Failure of Inertial Attitude Acquisition Due to Star Tracker Blinding for Three-Axes-Stabilized Interplanetary Spacecraft
Keil, Joachim; Herfort, Ulrich; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 8 pp.; In English; See also 20080012629; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The three interplanetary ESA missions Mars-Express, Rosetta and Venus-Express (launched 2003, 2004 and 2005 resp.) are three-axes stabilized spacecraft (s/c) that estimate their inertial attitude (i.e. the attitude of the s/c w.r.t. the inertial frame) using measurements from a redundant set of star trackers (STR). Each s/c is equipped with four reaction wheels, a reaction control system based on thrusters and a redundant set of ring laser gyroscopes (gyros). The STR h/w layout of the three s/c is identical whereas there is a difference in the star pattern recognition algorithm of Rosetta which uses five neighbouring stars

around a central star instead of star triads. The Rosetta algorithm has been implemented to cope with the presence of false stars which are expected to be seen during operations around the comet. The attitude acquisition capability from lost in space is different also in terms of AOCMS: The survival mode of Rosetta which is entered upon STR failure is presented. The AOCMS of Mars- and Venus-Express manages temporary STR outages during sky occultation by the planet not even by using redundancy. Though, a blinding of both STR during cruise lasting for the order of days confronts the ground operators with the limits of the AOCMS design. The operations and analyses that have been planned and partially been performed to compensate for the outage of the STR are demonstrated for Mars-Express. The caution measures taken before Venus orbit insertion of Venus-Express are detailed.
Author
Star Trackers; Rosetta Mission; Interplanetary Spacecraft; Mars Express; Laser Gyroscopes; Attitude (Inclination)

20080012645 Centre National d'Etudes Spatiales, Toulouse, France
CNES Approaching Guidance Experiment within FFIORD
Berges, Jean-Claude; Cayeux, Philippe; Gaudel-Vacaresse, Angelique; Meyssignac, Benoit; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

This article outlines the relative orbit control (guidance algorithm and its preliminary performance tests evaluation) that will be tested by the CNES Team on FFIORD (Formation Flying In Orbit Ranging Demonstration) onboard PRISMA mission. After a brief summary of the PRISMA mission context, the paper provides a full description of the rendezvous function involved in the approaching guidance experiment. This FFIORD onboard function is detailed in terms of on-board algorithmic method (basic algorithm and enhanced alternative), sensibility analysis used to construct maneuver plans and preliminary tests results.
Author
Formation Flying; Performance Tests; Rangefinding

20080012646 European Space Agency. European Space Operations Center, Darmstadt, Germany
Cluster: Mission Overview and End-of-Life Analysis
Pallaschke, S.; Munoz, I.; Rodriquez-Canabal, J.; Sieg, D.; Yde, J. J.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 9 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The Cluster mission is part of the scientific programme of the European Space Agency (ESA) and its purpose is the analysis of the Earth's magnetosphere. The Cluster project consists of four satellites. The selected polar orbit has a shape of 4.0 and 19.2 Re which is required for performing measurements near the cusp and the tail of the magnetosphere. When crossing these regions the satellites form a constellation which in most of the cases so far has been a regular tetrahedron. The satellite operations are carried out by the European Space Operations Centre (ESOC) at Darmstadt, Germany. The paper outlines the future orbit evolution and the envisaged operations from a Flight Dynamics point of view. In addition a brief summary of the LEOP and routine operations is included beforehand.
Author
Cluster Mission; Earth Magnetosphere; Polar Orbits; Shapes

20080012647 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Control of Formation-Flying Multi-Element Space Interferometers with Direct Interferometer-Output Feedback
Lu, Hui-Ling; Cheng, H. L.; Lyon, Richard G.; Carpenter, Kenneth G.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The long-baseline space interferometer concept involving formation flying of multiple spacecraft holds great promise as future space missions for high-resolution imagery. A major challenge of obtaining high-quality interferometric synthesized images from long-baseline space interferometers is to accurately control these spacecraft and their optics payloads in the specified configuration. Our research focuses on the determination of the optical errors to achieve fine control of long-baseline space interferometers without resorting to additional sensing equipment. We present a suite of estimation tools that can effectively extract from the raw interferometric image relative x/y, piston translational and tip/tilt deviations at the exit pupil

aperture. The use of these error estimates in achieving control of the interferometer elements is demonstrated using simulated as well as laboratory-collected interferometric stellar images.
Author
Feedback; Formation Flying; Interferometers; Spacecraft Control; Mathematical Models; Optics

20080012648 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Jitter Test Program and On-Orbit Mitigation Strategies for Solar Dynamic Observatory
Liu, Kuo-Chia; Kenney, Thomas; Maghami, Peiman; Mule, Pete; Blaurock, Carl; Haile, William B.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 16 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The Solar Dynamic Observatory (SDO) aims to study the Sun's influence on the Earth, the source, storage, and release of the solar energy, and the interior structure of the Sun. During science observations, the jitter stability at the instrument focal plane must be maintained to less than a fraction of an arcsecond for two of the SDO instruments. To meet these stringent requirements, a significant amount of analysis and test effort has been devoted to predicting the jitter induced from various disturbance sources. This paper presents an overview of the SDO jitter analysis approach and test effort performed to date. It emphasizes the disturbance modeling, verification, calibration, and validation of the high gain antenna stepping mechanism and the reaction wheels, which are the two largest jitter contributors. This paper also describes on-orbit mitigation strategies to protect the system from analysis model uncertainties. Lessons learned from the SDO jitter analyses and test programs are included in the paper to share the knowledge gained with the community.
Author
Solar Observatories; Systems Analysis; Solar Energy; Reaction Wheels; Calibrating; High Gain

20080012649 Japan Aerospace Exploration Agency, Tsukuba, Japan
Modeling and Flight Data Analysis of Spacecraft Dynamics with a Large Solar Array Paddle
Iwata, Takanori; Maeda, Ken; Hoshino, Hiroki; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 14 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The Advanced Land Observing Satellite (ALOS) was launched on January 24 2006 and has been operated successfully since then. This satellite has the attitude dynamics characterized by three large flexible structures, four large moving components, and stringent attitude/pointing stability requirements. In particular, it has one of the largest solar array paddles. Presented in this paper are flight data analyses and modeling of spacecraft attitude motion induced by the large solar array paddle. On orbit attitude dynamics was first characterized and summarized. These characteristic motions associated with the solar array paddle were identified and assessed. These motions are thermally induced motion, the pitch excitation by the paddle drive, and the role excitation. The thermally induced motion and the pitch excitation by the paddle drive were modeled and simulated to verify the mechanics of the motions. The control law updates implemented to mitigate the attitude vibrations are also reported.
Author
Attitude (Inclination); Attitude Stability; Excitation; Paddles; Spacecraft Motion; Spacecraft Guidance; Spacecraft Orbits; Mathematical Models

20080012650 European Space Agency. European Space Operations Center, Darmstadt, Germany
Operational Experience with Autonomous Star Trackers on ESA Interplanetary Spacecraft
Lauer, Mathias; Jauregui, Libe; Kielbassa, Sabine; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 6 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

Mars Express (MEX), Rosetta and Venus Express (VEX) are ESA interplanetary spacecrafts (S/C) launched in June 2003, March 2004 and November 2005, respectively. Mars Express was injected into Mars orbit end of 2003 with routine operations starting in spring 2004. Rosetta is since launch on its way to rendezvous comet Churyumov-Gerasimenko in 2014. It has completed several test and commissioning activities and is performing several planetary swingbys (Earth in spring 2005, Mars in spring 2007, Earth in autumn 2007 and again two years later). Venus Express has also started routine operations since the completion of the Venus orbit insertion maneuver sequence beginning of May 2006. All three S/C are three axes stabilized with a similar attitude and orbit control system (AOCS). The attitude is estimated on board using star and rate sensors and

controlled using four reaction wheels. A bipropellant reaction control system with 10N thrusters serves for wheel off loadings and attitude control in safe mode. Mars Express and Venus Express have an additional 400N engine for the planetary orbit insertion. Nominal Earth communication is accomplished through a high gain antenna. All three S/C are equipped with a redundant set of autonomous star trackers (STR) which are based on almost the same hardware. The STR software is especially adapted for the respective mission. This paper addresses several topics related to the experience gained with the STR operations on board the three S/C so far.
Author
Interplanetary Spacecraft; Mars Express; Attitude Control; Autonomy; Star Trackers; Rosetta Mission; ESA Spacecraft

20080012651 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
The Determination of Titan Gravity Field from Doppler Tracking of the Cassini Spacecraft
Iess, L.; Armstrong, J. W.; Aamar, S. W.; DiBenedetto, M.; Graziani, A.; Mackenzie, R.; Racioppa, P.; Rappaport, N.; Tortora, P.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 9 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

In its tour of the Saturnian system, the spacecraft Cassini is carrying out measurements of the gravity field of Titan, whose knowledge is crucial for constraining the internal structure of the satellite. In the five flybys devoted to gravity science, the spacecraft is tracked in X (8.4 GHz) and Ka band (32.5 GHz) from the antennas of NASA's Deep Space Network. The use of a dual frequency downlink is used to mitigate the effects of interplanetary plasma, the largest noise source affecting Doppler measurements. Variations in the wet path delay are effectively compensated by means of advanced water vapor radiometers placed close to the ground antennas. The first three flybys occurred on February 27, 2006, December 28, 2006, and June 29, 2007. Two additional flybys are planned in July 2008 and May 2010. This paper presents the estimation of the mass and quadrupole field of Titan from the first two flybys, carried out by the Cassini Radio Science Team using a short arc orbit determination. The data from the two flybys are first independently fit using a dynamical model of the spacecraft and the bodies of the Saturnian system, and then combined in a multi-arc solution. Under the assumption that the higher degree harmonics are negligible, the estimated values of the gravity parameters from the combined, multi-arc solution are GM = 8978.1337 +/- 0.0025 km(exp 3) / s(exp 2), J (sub 2) = (2.7221 +/- 0.0185) 10 (exp -5) and C (sub 22) = (1.1159 +/- 0.0040) 10 (exp -5) The excellent agreement (within 1.7 sigma) of the results from the two flybys further increases the confidence in the solution and provides an a posteriori validation of the dynamical model.
Author
Cassini Mission; Gravitation; Gravitational Fields; Orbit Determination; Titan

20080012652 NASA Wallops Flight Center, Wallops Island, VA, USA
Automated Target Planning for FUSE Using the SOVA Algorithm
Heatwole, Scott; Lanzi, R. James; Civeit, Thomas; Calvani, Humberto; Kruk, Jeffrey W.; Suchkov, Anatoly; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The SOVA algorithm was originally developed under the Resilient Systems and Operations Project of the Engineering for Complex Systems Program from NASA s Aerospace Technology Enterprise as a conceptual framework to support real-time autonomous system mission and contingency management. The algorithm and its software implementation were formulated for generic application to autonomous flight vehicle systems, and its efficacy was demonstrated by simulation within the problem domain of Unmanned Aerial Vehicle autonomous flight management. The approach itself is based upon the precept that autonomous decision making for a very complex system can be made tractable by distillation of the system state to a manageable set of strategic objectives (e.g. maintain power margin, maintain mission timeline, and et cetera), which if attended to, will result in a favorable outcome. From any given starting point, the attainability of the end-states resulting from a set of candidate decisions is assessed by propagating a system model forward in time while qualitatively mapping simulated states into margins on strategic objectives using fuzzy inference systems. The expected return value of each candidate decision is evaluated as the product of the assigned value of the end-state with the assessed attainability of the end-state. The candidate decision yielding the highest expected return value is selected for implementation; thus, the approach provides a software framework for intelligent autonomous risk management. The name adopted for the technique incorporates its essential elements: Strategic Objective Valuation and Attainability (SOVA). Maximum value of the approach is realized for systems where human intervention is unavailable in the timeframe within which critical control decisions must be made. The Far Ultraviolet Spectroscopic Explorer (FUSE) satellite, launched in 1999, has been collecting science data for eight years.[1] At

its beginning of life, FUSE had six gyros in two IRUs and four reaction wheels. Over time through various failures, the satellite has been left with one reaction wheel on the vehicle skew axis and two gyros. To remain operational, a control scheme has been implemented using the magnetic torque rods and the remaining momentum wheel.[2] As a consequence, there are attitude regions where there is insufficient torque authority to overcome environmental disturbances (e.g. gravity gradient torques). The situation is further complicated by the fact that these attitude regions shift inertially with time as the spacecraft moves through earth s magnetic field during the course of its orbit. Under these conditions, the burden of planning targets and target-to-target slew maneuvers has increased significantly since the beginning of the mission.[3] Individual targets must be selected so that the magnetic field remains roughly aligned with the skew wheel axis to provide enough control authority to the other two orthogonal axes. If the field moves too far away from the skew axis, the lack of control authority allows environmental torques to pull the satellite away from the target and can potentially cause it to tumble. Slew maneuver planning must factor the stability of targets at the beginning and end, and the torque authority at all points along the slew. Due to the time varying magnetic field geometry relative to any two inertial targets, small modifications in slew maneuver timing can make large differences in the achievability of a maneuver.
Author
Algorithms; Autonomy; Systems Engineering; Support Systems; Flight Management Systems; Pilotless Aircraft; Far UV Spectroscopic Explorer; Magnetic Field Configurations

20080012653 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Space Technology 5 Post-Launch Ground Attitude Estimation Experience
Harman, Richard R.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 12 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The Space Technology (ST)-5 satellites were launched March 22, 2006 on a Pegasus XL launch vehicle into a Sun-synchronous orbit. The three micro-satellites which constituted the ST-5 mission were kept in a formation which allowed three successive measurements taken of the Earth s magnetic field in order to study short term fluctuations of the field. The attitude of each satellite was computed on the ground using data from the science grade magnetometer as well as the miniature spinning Sun sensor (MSSS) which was the primary attitude sensor. Attitude and orbit maneuvers were performed using a single axial cold gas thruster. This paper describes the ground attitude estimation process and performance as well as anomaly resolutions.
Author
Solar Sensors; Aerospace Engineering; Geomagnetism; Formation Flying; Launch Vehicles; Synchronous Satellites

20080012654 Johns Hopkins Univ., Laurel, MD, USA
STEREO Mission Design Implementation
Guzman, Jose J.; Dunham, David W.; Sharer, Peter J.; Hunt, Jack W.; Ray, J. Courtney; Shapiro, Hongxing S.; Ossing, Daniel A.; Eichstedt, John E.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 14 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

STEREO (Solar-TErrestrial RElations Observatory) is the third mission in the Solar Terrestrial Probes program (STP) of the National Aeronautics and Space Administration (NASA) Science Mission Directorate Sun-Earth Connection theme. This paper describes the successful implementation (lunar swingby targeting) of the mission following the first phasing orbit to deployment into the heliocentric mission orbits following the two lunar swingbys. The STEREO Project had to make some interesting trajectory decisions in order to exploit opportunities to image a bright comet and an unusual lunar transit across the Sun.
Author
Solar Terrestrial Interactions; STEREO (Observatory); Mission Planning; NASA Programs; Solar Orbits; Trajectories; Space Missions

20080012655 Carr Astronautics Corp., Washington, DC, USA
Measuring Image Navigation and Registration Performance at the 3-Sigma Level Using Platinum Quality Landmarks
Carr, James L.; Madai, Houria; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 14 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

Geostationary Operational Environmental Satellite (GOES) Image Navigation and Registration (INR) performance is

specified at the 3- level, meaning that 99.7% of a collection of individual measurements must comply with specification thresholds. Landmarks are measured by the Replacement Product Monitor (RPM), part of the operational GOES ground system, to assess INR performance and to close the INR loop. The RPM automatically discriminates between valid and invalid measurements enabling it to run without human supervision. In general, this screening is reliable, but a small population of invalid measurements will be falsely identified as valid. Even a small population of invalid measurements can create problems when assessing performance at the 3-sigma level. This paper describes an additional layer of quality control whereby landmarks of the highest quality ('platinum') are identified by their self-consistency. The platinum screening criteria are not simple statistical outlier tests against sigma values in populations of INR errors. In-orbit INR performance metrics for GOES-12 and GOES-13 are presented using the platinum landmark methodology.
Author
GOES Satellites; Pattern Registration; Image Processing; Navigation; Satellite Imagery

20080012656 European Organization for the Exploitation of Meteorological Satellites, Darmstadt, Germany
Flight Dynamics Performances of the MetOp A Satellite during the First Months of Operations
Righetti, Pier Luigi; Meixner, Hilda; Sancho, Francisco; Damiano, Antimo; Lazaro, David; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The 19th of October 2006 at 16:28 UTC the first MetOp satellite (MetOp A) was successfully launched from the Baykonur cosmodrome by a Soyuz/Fregat launcher. After only three days of LEOP operations, performed by ESOC, the satellite was handed over to EUMETSAT, who is since then taking care of all satellite operations. MetOp A is the first European operational satellite for meteorology flying in a Low Earth Orbit (LEO), all previous satellites operated by EUMETSAT, belonging to the METEOSAT family, being located in the Geo-stationary orbit. To ensure safe operations for a LEO satellite accurate and continuous commanding from ground of the on-board AOCS is required. That makes the operational transition at the end of the LEOP quite challenging, as the continuity of the Flight Dynamics operations is to be maintained. That means that the main functions of the Flight Dynamics have to be fully validated on-flight during the LEOP, before taking over the operational responsibility on the spacecraft, and continuously monitored during the entire mission. Due to the nature of a meteorological operational mission, very stringent requirements in terms of overall service availability (99 % of the collected data), timeliness of processing of the observation data (3 hours after sensing) and accuracy of the geo-location of the meteorological products (1 km) are to be fulfilled. That translates in tight requirements imposed to the Flight Dynamics facility (FDF) in terms of accuracy, timeliness and availability of the generated orbit and clock solutions; a detailed monitoring of the quality of these products is thus mandatory. Besides, being the accuracy of the image geo-location strongly related with the pointing performance of the platform and with the on-board timing stability, monitoring from ground of the behaviour of the on-board sensors and clock is needed. This paper presents an overview of the Flight Dynamics operations performed during the different phases of the MetOp A mission up to routine. The activities performed to validate all the Flight Dynamics functions, characterize the behaviour of the satellite and monitor the performances of the Flight Dynamics facility will be highlighted. The MetOp Flight Dynamics Operations team is led by Anders Meier Soerensen and composed by Pier Luigi Righetti, Francisco Sancho, Antimo Damiano and David Lazaro. The team is supported by Hilda Meixner, responsible for all Flight Dynamics validation activities.
Author
Meteorological Satellites; Meteosat Satellite; Soyuz Spacecraft; Low Earth Orbits; Launching Bases; Aerodynamics; Flight Characteristics

20080012657 Mission Control Center, Moscow, Russia
Coronas-F Orbit Monitoring and Re-Entry Prediction
Ivanov, N. M.; Kolyuka, Yu. F.; Afanasieva, T. I.; Gridchina, T. A.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 14 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

Russian scientific satellite CORONAS-F was launched on July, 31, 2001. The object was inserted in near-circular orbit with the inclination 82.5deg and a mean altitude approx. 520 km. Due to the upper atmosphere drag CORONAS-F was permanently descended and as a result on December, 6, 2005 it has finished the earth-orbital flight, having lifetime in space approx. 4.5 years. The satellite structural features and its flight attitude control led to the significant variations of its ballistic coefficient during the flight. It was a cause of some specific difficulties in the fulfillment of the ballistic and navigation support of this space vehicle flight. Besides the main mission objective CORONAS-F also has been selected by the Inter-Agency

Space Debris Coordination Committee (IADC) as a target object for the next regular international re-entry test campaign on a program of surveillance and re-entry prediction for the hazard space objects within their de-orbiting phases. Spacecraft (S/C) CORONAS-F kept its working state right up to the end of the flight - down to the atmosphere entry. This fact enabled to realization of the additional research experiments, concerning with an estimation of the atmospheric density within the low earth orbits (LEO) of the artificial satellites, and made possible to continue track the S/C during final phase of its flight by means of Russian regular command & tracking system, used for it control. Thus there appeared a unique possibility of using for tracking S/C at its de-orbiting phase not only passive radar facilities, belonging to the space surveillance systems and traditionally used for support of the IADC re-entry test campaigns, but also more precise active trajectory radio-tracking facilities from the ground control complex (GCC) applied for this object. Under the corresponding decision of the Russian side such capability of additional high-precise tracking control of the CORONAS-F flight in this period of time has been implemented. The organizing of the CORONAS-F ballistic and navigational support (BNS) and solving its main tasks (such as S/C orbit determination (OD) and its motion prediction and connected with them) both for regular mission stage and for additional flight program were realized by the group of specialists from the Mission Control Center (MCC). MCC was also assigned as a principal organization from the Russian side for participation in the 7th IADC re-entry test campaign on CORONAS-F. The CORONAS-F flight features and space environments circumstances during its flight as well as a methodology and technology of spacecraft ballistic and navigational support are given below. The BNS results for different phases of S/C flight, including the results of its re-entry predictions, obtained during the realization of the 7th IADC test campaign are submitted. The accuracy of space vehicle re-entry prediction and its dependence on various factors are analyzed in more details.

Author

Coronas; Orbit Determination; Reentry; Predictions; Aerospace Environments; Artificial Satellites; Atmospheric Entry; Circular Orbits; Ground Based Control; Low Earth Orbits

20080012658 Johns Hopkins Univ., Laurel, MD, USA

STEREO Mission Design

Dunham, David W.; Guzman, Jose J.; Sharer, Peter J.; Friessen, Henry D.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

STEREO (Solar-TErestrial RElations Observatory) is the third mission in the Solar Terrestrial Probes program (STP) of the National Aeronautics and Space Administration (NASA). STEREO is the first mission to utilize phasing loops and multiple lunar flybys to alter the trajectories of more than one satellite. This paper describes the launch computation methodology, the launch constraints, and the resulting nine launch windows that were prepared for STEREO. More details are provided for the window in late October 2006 that was actually used.

Author

Solar Observatories; Mission Planning; NASA Programs; Launch Windows; Trajectories; Solar Probes

20080012659 Virginia Polytechnic Inst. and State Univ., Blacksburg, VA, USA

Optimal Electrodynamic Tether Phasing Maneuvers

Bitzer, Matthew S.; Hall, Christopher D.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 11 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

We study the minimum-time orbit phasing maneuver problem for a constant-current electrodynamic tether (EDT). The EDT is assumed to be a point mass and the electromagnetic forces acting on the tether are always perpendicular to the local magnetic field. After deriving and non-dimensionalizing the equations of motion, the only input parameters become current and the phase angle. Solution examples, including initial Lagrange costates, time of flight, thrust plots, and thrust angle profiles, are given for a wide range of current magnitudes and phase angles. The two-dimensional cases presented use a non-tilted magnetic dipole model, and the solutions are compared to existing literature. We are able to compare similar trajectories for a constant thrust phasing maneuver and we find that the time of flight is longer for the constant thrust case with similar initial thrust values and phase angles. Full three-dimensional solutions, which use a titled magnetic dipole model, are also analyzed for orbits with small inclinations.

Author

Tethering; Thrust; Spacecraft Maneuvers; Electrodynamics; Planetary Magnetic Fields; Mathematical Models; Tetherlines

20080012660 Japan Aerospace Exploration Agency, Sagamihara, Japan

Time-Varying Expression of the Formation Flying along Circular Trajectories

Kawaguchi, Jun'ichiro; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 9 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

Usually, the formation flying associated with circular orbits is discussed through the well-known Hill s or C-W equations of motion. This paper dares to present and discuss the coordinates that may contain time-varying coefficients. The discussion presents how the controller s performance is affected by the selection of coordinates, and also looks at the special coordinate suitable for designating a target bin to which each spacecraft in the formation has only to be guided. It is revealed that the latter strategy may incorporate the J2 disturbance automatically.

Author

Formation Flying; Trajectories; Circular Orbits; Coordinates; Equations of Motion; Coefficients

20080012662 NASA Goddard Space Flight Center, Greenbelt, MD, USA

SDO Delta H Mode Design and Analysis

Mason, Paul A.; Starin, Scott R.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 14 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

While on orbit, disturbance torques on a three axis stabilized spacecraft tend to increase the system momentum, which is stored in the reaction wheels. Upon reaching the predefined momentum capacity (or maximum wheel speed) of the reaction wheel, an external torque must be used to unload the momentum. The purpose of the Delta H mode is to manage the system momentum. This is accomplished by driving the reaction wheels to a target momentum state while the attitude thrusters, which provide an external torque, are used to maintain the attitude. The Delta H mode is designed to meet the mission requirements and implement the momentum management plan. Changes in the requirements or the momentum management plan can lead to design changes in the mode. The momentum management plan defines the expected momentum buildup trend, the desired momentum state and how often the system is driven to the desired momentum state (unloaded). The desired momentum state is chosen based on wheel capacity, wheel configuration, thruster layout and thruster sizing. For the Solar Dynamics Observatory mission, the predefined wheel momentum capacity is a function of the jitter requirements, power, and maximum momentum capacity. Changes in jitter requirements or power limits can lead to changes in the desired momentum state. These changes propagate into the changes in the momentum management plan and therefore the Delta H mode design. This paper presents the analysis and design performed for the Solar Dynamics Observatory Delta H mode. In particular, the mode logic and processing needed to meet requirements is described along with the momentum distribution formulation. The Delta H mode design is validated using the Solar Dynamics Observatory High Fidelity simulator. Finally, a summary of the design is provided along with concluding remarks.

Author

Momentum; Mission Planning; Management Planning; Helioseismology; Design Analysis; Attitude (Inclination)

20080012663 GMV Aerospace and Defense S.A., Madrid, Spain

GRAS NRT Precise Orbit Determination: Operational Experience

MartinezFadrique, Francisco M.; Mate, Alberto Agueda; Rodriquez-Portugal, Francisco Sancho; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 10 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

EUMETSAT launched the meteorological satellite MetOp-A in October 2006; it is the first of the three satellites that constitute the EUMETSAT Polar System (EPS) space segment. This satellite carries a challenging and innovative instrument, the GNSS Receiver for Atmospheric Sounding (GRAS). The goal of the GRAS instrument is to support the production of atmospheric profiles of temperature and humidity with high accuracy, in an operational context, based on the bending of the GPS signals traversing the atmosphere during the so-called occultation periods. One of the key aspects associated to the data processing of the GRAS instrument is the necessity to describe the satellite motion and GPS receiver clock behaviour with high accuracy and within very strict timeliness limitations. In addition to these severe requirements, the GRAS Product Processing Facility (PPF) must be integrated in the EPS core ground segment, which introduces additional complexity from the data integration and operational procedure points of view. This paper sets out the rationale for algorithm selection and the conclusions from operational experience. It describes in detail the rationale and conclusions derived from the selection and implementation of the algorithms leading to the final orbit determination requirements (0.1 mm/s in velocity and 1 ns in

receiver clock error at 1 Hz). Then it describes the operational approach and extracts the ideas and conclusions derived from the operational experience.
Author
Meteorological Satellites; Orbit Determination; Atmospheric Sounding; Global Positioning System; Data Integration; Instrument Receivers; Satellite Instruments; Atmospheric Temperature

20080012664 NASA Johnson Space Center, Houston, TX, USA
Zero-Propellant Maneuver[TM] Flight Results for 180 deg ISS Rotation
Bedrossian, Nazareth; Bhatt, Sagar; Lammers, Mike; Nguyen, Louis; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 10 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

This paper presents results for the Zero Propellant Maneuver (ZPM) TradeMark attitude control concept flight demonstration. On March 3, 2007, a ZPM was used to reorient the International Space Station 180 degrees without using any propellant. The identical reorientation performed with thrusters would have burned 110lbs of propellant. The ZPM was a pre-planned trajectory used to command the CMG attitude hold controller to perform the maneuver between specified initial and final states while maintaining the CMGs within their operational limits. The trajectory was obtained from a PseudoSpectral solution to a new optimal attitude control problem. The flight test established the breakthrough capability to simultaneously perform a large angle attitude maneuver and momentum desaturation without the need to use thrusters. The flight implementation did not require any modifications to flight software. This approach is applicable to any spacecraft that are controlled by momentum storage devices.
Author
Attitude Control; Flight Control; Optimal Control; Trajectories; Momentum; Flight Tests; Controllers; Attitude (Inclination)

20080012665 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Maneuver Recovery Analysis for the Magnetospheric Multiscale Mission
Volle, Michael; Lee, Taesul; Long, Anne; Gramling, Cheryl; Carpenter, Russell; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 13 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The use of spacecraft formations creates new and more demanding requirements for orbit determination accuracy. In addition to absolute navigation requirements, there are typically relative navigation requirements that are based on the size or shape of the formation. The difficulty in meeting these requirements is related to the relative dynamics of the spacecraft orbits and the frequency of the formation maintenance maneuvers. This paper examines the effects of bi-weekly formation maintenance maneuvers on the absolute and relative orbit determination accuracy for the four-spacecraft Magnetospheric Multiscale (MMS) formation. Results are presented from high fidelity simulations that include the effects of realistic orbit determination errors in the maneuver planning process. Solutions are determined using a high accuracy extended Kalman filter designed for onboard navigation. Three different solutions are examined, considering the effects of process noise and measurement rate on the solutions.
Author
Spacecraft Maneuvers; Multimission Modular Spacecraft; Orbit Determination; Accuracy; Spacecraft Orbits; Magnetospheres

20080012666 Japan Aerospace Exploration Agency, Ibaraki, Japan
Precise Orbit Determination for ALOS
Nakamura, Ryo; Nakamura, Shinichi; Kudo, Nobuo; Katagiri, Seiji; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 7 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The Advanced Land Observing Satellite (ALOS) has been developed to contribute to the fields of mapping, precise regional land coverage observation, disaster monitoring, and resource surveying. Because the mounted sensors need high geometrical accuracy, precise orbit determination for ALOS is essential for satisfying the mission objectives. So ALOS mounts a GPS receiver and a Laser Reflector (LR) for Satellite Laser Ranging (SLR). This paper deals with the precise orbit determination experiments for ALOS using Global and High Accuracy Trajectory determination System (GUTS) and the

evaluation of the orbit determination accuracy by SLR data. The results show that, even though the GPS receiver loses lock of GPS signals more frequently than expected, GPS-based orbit is consistent with SLR-based orbit. And considering the 1 sigma error, orbit determination accuracy of a few decimeters (peak-to-peak) was achieved.
Author
Orbit Determination; Satellite Laser Ranging; Global Positioning System; Passive Satellites; Earth Resources; Accuracy; Trajectories

20080012667 AI Solutions, Inc., Lanham, MD, USA
Long Term Mean Local Time of the Ascending Node Prediction
McKinley, David P.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 13 pp.; In English; See also 20080012629; Original contains color illustrations
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Significant error has been observed in the long term prediction of the Mean Local Time of the Ascending Node on the Aqua spacecraft. This error of approximately 90 seconds over a two year prediction is a complication in planning and timing of maneuvers for all members of the Earth Observing System Afternoon Constellation, which use Aqua's MLTAN as the reference for their inclination maneuvers. It was determined that the source of the prediction error was the lack of a solid Earth tide model in the operational force models. The Love Model of the solid Earth tide potential was used to derive analytic corrections to the inclination and right ascension of the ascending node of Aqua's Sun-synchronous orbit. Additionally, it was determined that the resonance between the Sun and orbit plane of the Sun-synchronous orbit is the primary driver of this error. The analytic corrections have been added to the operational force models for the Aqua spacecraft reducing the two-year 90-second error to less than 7 seconds.
Author
Earth Observing System (EOS); Aqua Spacecraft; Errors; Predictions; Constellations

20080012668 Massachusetts Inst. of Tech., Cambridge, MA, USA
Two-Stage Path Planning Approach for Designing Multiple Spacecraft Reconfiguration Maneuvers
Aoude, Georges S.; How, Jonathan P.; Garcia, Ian M.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 16 pp.; In English; See also 20080012629; Original contains color illustrations
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The paper presents a two-stage approach for designing optimal reconfiguration maneuvers for multiple spacecraft. These maneuvers involve well-coordinated and highly-coupled motions of the entire fleet of spacecraft while satisfying an arbitrary number of constraints. This problem is particularly difficult because of the nonlinearity of the attitude dynamics, the non-convexity of some of the constraints, and the coupling between the positions and attitudes of all spacecraft. As a result, the trajectory design must be solved as a single 6N DOF problem instead of N separate 6 DOF problems. The first stage of the solution approach quickly provides a feasible initial solution by solving a simplified version without differential constraints using a bi-directional Rapidly-exploring Random Tree (RRT) planner. A transition algorithm then augments this guess with feasible dynamics that are propagated from the beginning to the end of the trajectory. The resulting output is a feasible initial guess to the complete optimal control problem that is discretized in the second stage using a Gauss pseudospectral method (GPM) and solved using an off-the-shelf nonlinear solver. This paper also places emphasis on the importance of the initialization step in pseudospectral methods in order to decrease their computation times and enable the solution of a more complex class of problems. Several examples are presented and discussed.
Author
Spacecraft Maneuvers; Trajectory Planning; Attitude (Inclination); Optimal Control; Trajectories; Algorithms

20080012669 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Mission Design for NASA's Inner Heliospheric Sentinels and ESA's Solar Orbiter Missions
Downing, John; Folta, David; Marr, Greg; Rodriquez-Canabal, Jose; Conde, Rich; Guo, Yanping; Kelley, Jeff; Kirby, Karen; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

This paper will document the mission design and mission analysis performed for NASA's Inner Heliospheric Sentinels

(IHS) and ESA's Solar Orbiter (SolO) missions, which were conceived to be launched on separate expendable launch vehicles. This paper will also document recent efforts to analyze the possibility of launching the Inner Heliospheric Sentinels and Solar Orbiter missions using a single expendable launch vehicle, nominally an Atlas V 551.
Author
Design Analysis; Launch Vehicles; Mission Planning; Spacecraft Launching; Solar Observatories; Space Missions

20080012670 Washington Univ., Saint Louis, MO, USA
Proximity Navigation of Highly Constrained Spacecraft
Scarritt, S.; Swartwout, M.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 14 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

Bandit is a 3-kg automated spacecraft in development at Washington University in St. Louis. Bandit's primary mission is to demonstrate proximity navigation, including docking, around a 25-kg student-built host spacecraft. However, because of extreme constraints in mass, power and volume, traditional sensing and actuation methods are not available. In particular, Bandit carries only 8 fixed-magnitude cold-gas thrusters to control its 6 DOF motion. Bandit lacks true inertial sensing, and the ability to sense position relative to the host has error bounds that approach the size of the Bandit itself. Some of the navigation problems are addressed through an extremely robust, error-tolerant soft dock. In addition, we have identified a control methodology that performs well in this constrained environment: behavior-based velocity potential functions, which use a minimum-seeking method similar to Lyapunov functions. We have also adapted the discrete Kalman filter for use on Bandit for position estimation and have developed a similar measurement vs. propagation weighting algorithm for attitude estimation. This paper provides an overview of Bandit and describes the control and estimation approach. Results using our 6DOF flight simulator are provided, demonstrating that these methods show promise for flight use.
Author
Attitude (Inclination); Spacecraft Design; Navigation; Automatic Control; Docking; Flight Simulators; Liapunov Functions; Kalman Filters

20080012671 Instituto de Pesquisas Espaciais, Brazil
Autonomous Fault Detection on a Low Cost GPS-Aided Attitude Determination System
Louro, Arcelio C.; Lopes, Roberto V. F.; Kuga, Helio K.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 11 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

This paper presents a three-axis attitude determination procedure based on the Global Positioning System (GPS) with special emphasis to the autonomous integrity monitoring issue. One envisages a class of low cost navigation applications requiring low accurate (around 0.5 degrees) but continuous attitude knowledge. A snapshot algorithm first estimate the three-axis attitude from interferometry on double differences of GPS carrier phase L1. Then, the attitude estimate is improved by fusing it with angular rate measurements from low cost, MEMS gyros. The procedure is especially designed to detect single faults on either the GPS or the gyros autonomously from residuals monitoring. Both GPS and gyro measurements are taken as corrupted by colored Gaussian noises whose effects are mitigated by a stochastic dynamic compensation model. The state vector, which includes the attitude quaternion and parameters of the error model, is estimated from a bank of extended Kalman filters with different time delays. Attitude propagation model between GPS sampling times is based on the gyro output after drift calibration. One defines the fault modes of each sensor and some control parameters to the fault detection procedure.The algorithm is tested with numerical simulation and real data. The simulation scenarios include LEO micro-satellites with different orbit inclinations and three different failure modes: complete out track from the whole GPS constellation; temporary abnormal interference on a single GPS satellite; and gyro drift higher than its specified level. The results show that the algorithm is suitable to cope with different fault types and intensity levels.
Author
Autonomy; Global Positioning System; Navigation Satellites; Microelectromechanical Systems; Gyroscopic Stability; Angular Velocity; Attitude Control; Fault Detection

20080012672 Japan Aerospace Exploration Agency, Japan

A Study into the Method of Precise Orbit Determination of a HEO Orbiter by GPS and Accelerometer

Ikenaga, Toshinori; Hashida, Yoshi; Unwin, Martin; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

In the present day, orbit determination by Global Positioning System (GPS) is not unusual. Especially for low-cost small satellites, position determination by an on-board GPS receiver provides a cheap, reliable and precise method. However, the original purpose of GPS is for ground users, so the transmissions from all of the GPS satellites are directed toward the Earth s surface. Hence there are some restrictions for users above the GPS constellation to detect those signals. On the other hand, a desire for precise orbit determination for users in orbits higher than GPS constellation exists. For example, the next Japanese Very Long Baseline Interferometry (VLBI) mission 'ASTRO-G' is trying to determine its orbit in an accuracy of a few centimeters at apogee. The use of GPS is essential for such ultra accurate orbit determination. This study aims to construct a method for precise orbit determination for such high orbit users, especially in High Elliptical Orbits (HEOs). There are several approaches for this objective. In this study, a hybrid method with GPS and an accelerometer is chosen. Basically, while the position cannot be determined by an on-board GPS receiver or other Range and Range Rate (RARR) method, all we can do to estimate the user satellite s position is to propagate the orbit along with the force model, which is not perfectly correct. However if it has an accelerometer (ACC), the coefficients of the air drag and the solar radiation pressure applied to the user satellite can be updated and then the propagation along with the 'updated' force model can improve the fitting accuracy of the user satellite s orbit. In this study, it is assumed to use an accelerometer available in the present market. The effects by a bias error of an accelerometer will also be discussed in this paper.

Author

Navigation Satellites; Orbit Determination; Satellite Orbits; Aerodynamic Drag; Elliptical Orbits; Global Positioning System; Very Long Base Interferometry

20080012673 Japan Aerospace Exploration Agency, Sagamihara, Japan

Attitude Control Flight Experience: Coping with Solar Radiation and Ion Engines Leak Thrust in Hayabusa (MUSES-C)

Kawaguchi, Jun'ichiro; Kominato, Takashi; Shirakawa, Ken'ichi; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 11 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The paper presents the attitude reorientation taking the advantage of solar radiation pressure without use of any fuel aboard. The strategy had been adopted to make Hayabusa spacecraft keep pointed toward the Sun for several months, while spinning. The paper adds the above mentioned results reported in Sedona this February showing another challenge of combining ion engines propulsion tactically balanced with the solar radiation torque with no spin motion. The operation has been performed since this March for a half year successfully. The flight results are presented with the estimated solar array panel diffusion coefficient and the ion engine's swirl torque.

Author

Attitude Control; Fuels; Spacecraft; Drift; Solar Radiation; Ion Engines

20080012674 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Semianalytical Propagation of Satellite Orbits about an Arbitrary Central Body

Cefola, Paul J.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 4 pp.; In English; See also 20080012629; Copyright; Avail.: CASI: A01, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

Precision mean element (PME) satellite theories play a key role in orbit dynamics analyses. These theories employ: nonsingular orbital elements comprehensive force models Generalized Method of Averaging Numerical interpolation concepts The Draper Semianalytical Satellite Theory (DSST) (Refs. 1 - 6), whose development was led by the author, and the independently-developed Universal Semianalytical Method (USM) (Ref. 7) are examples of such theories. These theories provide the capability to tailor the force modeling to meet the desired computational speed vs. accuracy trade-off. The flexibility of such theories is demonstrated by their ability to include complicated atmosphere density models and spacecraft models in the perturbation theory context. The value of high speed satellite theories, in this era of computational plenty, is that they allow new ways of looking at astrodynamical problems such as orbit design (Refs. 8, 9) and atmosphere density updating (Refs. 10, 11). In the mid to late-1980 s, the geodynamics community led the development of very precise geopotential models such as GEM T2 and GEM T3 (Ref. 12), and with the subsequent analysis of the TOPEX flight data, JGM-2 and JGM-3 (Ref.

13). These were high degree and order geopotentials, at least 50 x 50. In 1993, the DSST implementation in the GTDS program was extended to include the 50 x 50 geopotential models (Ref. 14). The 50 x 50 geopotential, J2000 integration coordinate system, and solid Earth tide capabilities were integrated in GTDS by Scott Carter (Ref. 15). This capability demonstrated 1 m accuracy versus the TOPEX Precise Orbit Ephemerides. Subsequently the DSST Standalone program was also extended to include high degree and order geopotential models (Ref. 5). More recently GTDS has been hosted in the Linux PC environment. However, all of these efforts have been limited to modeling the motion of an artificial Earth satellite. They did not consider the additional complexities associated with lunar, planetary, or other natural satellite orbiters. Such complexities include: additional coordinate systems (associated with the direction of the north pole of rotation and the prime meridian of the new central bodies) (Ref. 16) normalized gravity model coefficients (desirable for high degree and order fields) (Ref. 17) indirect oblateness
Author
Satellite Orbits; Geodynamics; Natural Satellites; Orbital Elements; Spacecraft Models; Gravitation; Goddard Trajectory Determination System; Geopotential

20080012675 EADS Astrium Ltd., Toulouse, France
Anti-Collision Function Design and Performances of the CNES Formation Flying Experiment on the PRISMA Mission
Cayeux, P.; Raballand, F.; Borde, J.; Berges, J.-C.; Meyssignac, B.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 14 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

Within the framework of a partnership agreement, EADS ASTRIUM has worked since June 2006 for the CNES formation flying experiment on the PRISMA mission. EADS ASTRIUM is responsible for the anti-collision function. This responsibility covers the design and the development of the function as a Matlab/Simulink library, as well as its functional validation and performance assessment. PRISMA is a technology in-orbit testbed mission from the Swedish National Space Board, mainly devoted to formation flying demonstration. PRISMA is made of two micro-satellites that will be launched in 2009 on a quasi-circular SSO at about 700 km of altitude. The CNES FFIORD experiment embedded on PRISMA aims at flight validating an FFRF sensor designed for formation control, and assessing its performances, in preparation to future formation flying missions such as Simbol X; FFIORD aims as well at validating various typical autonomous rendezvous and formation guidance and control algorithms. This paper presents the principles of the collision avoidance function developed by EADS ASTRIUM for FFIORD; three kinds of maneuvers were implemented and are presented in this paper with their performances.
Author
Rendezvous Guidance; Formation Flying; Collision Avoidance; Collisions; Autonomy

20080012676 Vympel Corp., Russian Federation
Orbit Determination of LEO Satellites for a Single Pass through a Radar: Comparison of Methods
Khutorovsky, Z.; Kamensky, S.; Sbytov, N.; Alfriend, K. T.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 13 pp.; In English; See also 20080012629; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The problem of determining the orbit of a space object from measurements based on one pass through the field of view of a radar is not a new one. Extensive research in this area has been carried out in the USA and Russia since the late 50s when these countries started the development of ballistic missile defense (BMD) and Early Warning systems. In Russia these investigations got additional stimulation in the early 60s after the decision to create a Space Surveillance System, whose primary task would be the maintenance of the satellite catalog. These problems were the focus of research interest until the middle 70s when the appropriate techniques and software were implemented for all radars. Then for more than 20 years no new research papers appeared on this subject. This produced an impression that all the problems of track determination based on one pass had been solved and there was no need for further research. In the late 90s interest in this problem arose again in relation to the following. It was estimated that there would be greater than 100,000 objects with size greater than 1-2 cm and collision of an operational spacecraft with any of these objects could have catastrophic results. Thus, for prevention of hazardous approaches and collisions with valuable spacecraft the existing satellite catalog should be extended by at least an order of magnitude This is a very difficult scientific and engineering task. One of the issues is the development of data fusion procedures and the software capable of maintaining such a huge catalog in near real time. The number of daily processed measurements (of all types, radar and optical) for such a system may constitute millions, thus increasing the number of measurements by at least an order of magnitude. Since we will have ten times more satellites and measurements the computer effort required for the correlation of measurements will be two orders of magnitude greater. This could create significant problems for processing data close to real time even for modern computers. Preliminary ‘compression’ of data for one pass

through the field of view of a sensor can significantly reduce the requirements to computers and data communication. This compression will occur when all the single measurements of the sensor are replaced by the orbit determined on their basis. The single measurement here means the radar parameters (range, azimuth, elevation, and in some cases range rate) measured by a single pulse.
Author
Orbit Determination; Field of View; Early Warning Systems; Low Earth Orbits; Data Transmission; Real Time Operation; Radar Range

20080012678 DEIMOS Space S.L., Madrid, Spain
ExoMars Mission Analysis and Design - Launch, Cruise and Arrival Analyses
Cano, Juan L.; Cacciatore, Francesco; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 12 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

ExoMars is ESA s next mission to planet Mars. The probe is aimed for launch either in 2013 or in 2016. The project is currently undergoing Phase B1 studies under ESA management and Thales Alenia Space Italia project leadership. In that context, DEIMOS Space is responsible for the Mission Analysis and Design for the interplanetary and the entry, descent and landing (EDL) activities. The present mission baseline is based on an Ariane 5 or Proton M launch in 2013 of a spacecraft Composite bearing a Carrier Module (CM) and a Descent Module (DM). A back-up option is proposed in 2016. This paper presents the current status of the interplanetary mission design from launch up to the start of the EDL phase.
Author
Ariane 5 Launch Vehicle; Mars Missions; Mission Planning; Launching; Design Analysis

20080012679 Centre National d'Etudes Spatiales, Toulouse, France
SIMBOL-X: A Formation Flying Mission on HEO for Exploring the Universe
Gamet, Philippe; Epenoy, R.; Salcedo, C.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 13 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

SIMBOL-X is a high energy new generation telescope covering by a single instrument a continuous energy range starting at classical X-rays and extending to hard X-rays, i.e. from 0.5 to 80 keV. It is using in this field a focalizing payload which until now was used for energy below 10 keV only, via the construction of a telescope distributed on two satellites flying in formation. SIMBOL-X permits a gain of two orders of magnitude in sensibility and spatial resolution in comparison to state of the art hard X-rays instruments. The mirror satellite will be in free flight on a high elliptical orbit and will target the object to observe very precisely, thus focusing the hard X-ray emission thanks to this mirror module. At the focal point area which is situated 20 meters behind the mirror satellite, the detector satellite maintains its position on a forced orbit thanks to a radio link with the mirror satellite and a lateral displacement sensor using a beam emitted onboard the mirror satellite. This configuration is said 'formation flying'. The location of the detector satellite shall be very finely tuned as it carries the focal plane of this distributed telescope. To provide science measurements, the Simbol-X orbit has been chosen High elliptic (HEO), which means elliptical orbit with a high perigee altitude. Preliminary studies where made with an orbit with an altitude of the perigee of 44000km and altitude of the apogee of 253000km. The orbit was seven days ground track repeated in order to maintain a perigee pass over the Malindi ground station to download scientific telemetry. But as studies went on, difficulties in mass budget, link budget, perigee maintenance and formation flying maintenance were raised. This was mainly due to the vicinity of the Moon and its disturbing effect on the satellites orbits. Alternative orbits have been proposed in order to demonstrate the feasibility of the mission. The problematic of bringing the two satellites from their injection orbit to their operational orbit 20 m apart from each other and then maintain this configuration is very challenging. It requires theoretical development of the relative motion between two satellites in high eccentric orbit with large differential disturbance on the two bodies. This paper will present the mission analysis for the Simbol-X satellites with the complex problematic of doing formation flying in high elliptic orbit.
Author
Formation Flying; X Ray Telescopes; Elliptical Orbits; High Altitude

20080012680 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Broken-Plane Maneuver Applications for Earth to Mars Trajectories

Abilleira, Fernando; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 8 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

Optimization techniques are critical when investigating Earth to Mars trajectories since they have the potential of reducing the total (delta)V of a mission. A deep space maneuver (DSM) executed during the cruise may improve a trajectory by reducing the total mission V. Nonetheless, DSMs not only may improve trajectory performance (from an energetic point of view) but also open up new families of trajectories that would satisfy very specific mission requirements not achievable with ballistic trajectories. In the following pages, various specific examples showing the potential advantages of the usage of broken plane maneuvers will be introduced. These examples correspond to possible scenarios for Earth to Mars trajectories during the next decade (2010-2020).

Author

Ballistic Trajectories; Mission Planning; Trajectory Optimization

20080012681 Boeing Satellite Development Center, El Segundo, CA, USA

Boeing Low-Thrust Geosynchronous Transfer Mission Experience

Poole, Mark; Ho, Monte; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 6 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

Since 2000, Boeing 702 satellites have used electric propulsion for transfer to geostationary orbits. The use of the 25cm Xenon Ion Propulsion System (25cm XIPS) results in more than a tenfold increase in specific impulse with the corresponding decrease in propellant mass needed to complete the mission when compared to chemical propulsion[1]. In addition to more favorable mass properties, with the use of XIPS, the 702 has been able to achieve orbit insertions with higher accuracy than it would have been possible with the use of chemical thrusters. This paper describes the experience attained by using the 702 XIPS ascent strategy to transfer satellite to geosynchronous orbits.

Author

Electric Propulsion; Geosynchronous Orbits; Satellite Orbits; Transfer Orbits; Ion Propulsion; Specific Impulse

20080012682 Missouri Univ., Rolla, MO, USA

Low-Thrust Control of a Lunar Mapping Orbit

Harl, Nathan; Pernicka, Henry J.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

A method is presented for generating and maintaining a lunar mapping orbit using continuous low-thrust hardware. Optimal control theory is used to maintain a lunar orbit that is low-altitude, near-polar, and Sun-synchronous; three typical requirements for a successful lunar mapping mission. The analysis of the optimal control problem leads to the commonly seen two-point boundary value problem, which is solved using a simple indirect shooting algorithm. Simulations are presented for a 50-day mapping duration, in which it is shown that a very tight control is achieved with thrust levels below 1 N for a 1000 kg spacecraft. A straightforward approach for using the method presented to compute missions of any duration is also discussed.

Author

Thrust; Lunar Orbits; Optimal Control; Low Altitude; Lunar Maps; Lunar Surface; Mapping; Control Theory

20080012683 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Stationkeeping for the Lunar Reconnaissance Orbiter (LRO)

Beckman, Mark; Lamb, Rivers; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629; Original contains color and black and white illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The Lunar Reconnaissance Orbiter (LRO) is scheduled to launch in 2008 as the first mission under NASA's Vision for Space Exploration. Following several weeks in a quasi-frozen commissioning orbit, LRO will fly in a 50 km mean altitude lunar polar orbit. During the one year mission duration, the orbital dynamics of a low lunar orbit force LRO to perform periodic sets of stationkeeping maneuvers. This paper explores the characteristics of low lunar orbits and explains how the

LRO stationkeeping plan is designed to accommodate the dynamics in such an orbit. The stationkeeping algorithm used for LRO must meet five mission constraints. These five constraints are to maintain ground station contact during maneuvers, to control the altitude variation of the orbit, to distribute periselene equally between northern and southern hemispheres, to match eccentricity at the beginning and the end of the sidereal period, and to minimize stationkeeping deltaV. This paper addresses how the maneuver plan for LRO is designed to meet all of the above constraints.
Author
Lunar Orbiter; Stationkeeping; Mission Planning; Spacecraft Design; Lunar Exploration

20080012685 NASA Goddard Space Flight Center, Greenbelt, MD, USA
A Multibody Slosh Analysis for the Lunar Reconnaissance Orbiter
Shah, Neerav; Hsu, Oscar; Garrick, Joseph; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 9 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The Lunar Reconnaissance Orbiter (LRO) undergoes a series of thruster maneuvers to attain lunar orbit. The first of the series of lunar orbit insertion (LOI) maneuvers is crucial to the success of the mission. Therefore, it is important to characterize the disturbances acting on the spacecraft during this phase of the mission. This paper focuses on the internal disturbance force caused by fuel slosh and its impact on attitude control. During the first LOI maneuver (LOI-1), approximately 50% of the total fuel mass is used or roughly 25% of the spacecraft s wet mass, during the 38-minute burn. The forces imparted on the spacecraft from the fuel are dependent on the fill level of the two fuel tanks. During LOI-1, the fill level in both tanks varies greatly and thus so does the disturbance level caused by the fuel. It is therefore necessary to account for the time-varying mass properties of the spacecraft and the effects of the varying fuel levels during the entire 38-minute maneuver. Two simulations are developed in Mathworks s Simulink to analyze the fuel slosh effect. The first model, a baseline model, is a rigid body dynamics model where the fuel slosh is not modeled. The second is a multibody model, developed using a multibody dynamics toolbox, where each of the two fuel tanks and the remaining spacecraft body are treated as separate rigid bodies. The simulations are executed in a piece-wise fashion to account for the time-varying mass properties, and to accommodate the multibody toolbox. Disturbances caused by fuel slosh during both lunar and mission orbit insertions will be analyzed through simulation of different dynamics models. Results of the analysis will show the effects of the slosh disturbance on the spacecraft s attitude.
Author
Lunar Orbiter; Reconnaissance; Liquid Sloshing; Attitude Control; Fuel Tanks; Lunar Orbits; Attitude (Inclination)

20080012686 DEIMOS Space S.L., Madrid, Spain
Design and Analysis of a Formation Flying System for the Cross-Scale Mission Concept
Cornara, Stefania; Bastante, Juan C.; Jubineau, Franck; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The ESA-funded ‘Cross-Scale Technology Reference Study has been carried out with the primary aim to identify and analyse a mission concept for the investigation of fundamental space plasma processes that involve dynamical non-linear coupling across multiple length scales. To fulfill this scientific mission goal, a constellation of spacecraft is required, flying in loose formations around the Earth and sampling three characteristic plasma scale distances simultaneously, with at least two satellites per scale: electron kinetic (~10 km), ion kinetic (~100-2000 km), magnetospheric fluid (~3000-15000 km). The key Cross-Scale mission drivers identified are the number of S/C, the space segment configuration, the reference orbit design, the transfer and deployment strategy, the inter-satellite localization and synchronization process and the mission operations. This paper presents a comprehensive overview of the mission design and analysis for the Cross-Scale concept and outlines a technically feasible mission architecture for a multi-dimensional investigation of space plasma phenomena. The main effort has been devoted to apply a thorough mission-level trade-off approach and to accomplish an exhaustive analysis, so as to allow the characterization of a wide range of mission requirements and design solutions.
Author
Design Analysis; Formation Flying; Mission Planning; Systems Engineering; Spacecraft Maneuvers

20080012687 AI Solutions, Inc., Lanham, MD, USA

Solar Dynamics Observatory High Gain Antenna Handover Planning

Hashmall, Joseph A.; Mann, Laurie; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 12 pp.; In English; See also 20080012629; Original contains color illustrations

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The Solar Dynamics Observatory (SDO) is planned to launch in early 2009 as a mission to study the solar variability and its impact on Earth. To best satisfy its science goal, SDO will fly in a geosynchronous orbit with an inclination of approximately 29 deg. The spacecraft attitude is designed so that the science instruments point directly at the Sun with high accuracy. One of SDO s principal requirements is to obtain long periods of uninterrupted observations. The observations have an extremely high data volume so SDO must be in continuous contact with the ground during the observation periods. To maintain this contact, SDO is equipped with a pair of high gain antennas (HGAs) transmitting to a pair of ground antennas at the SDO ground station (SDOGS) located in White Sands, New Mexico. Either HGA can transmit to either SDOGS antenna. Neither HGA can be powered down. During a portion of each year, each of the HGA beams will intersect with the SDO body for a portion of the orbit. The original SDO antenna contact plan used each HGA for the half of each year during which its beam would not intersect the spacecraft. No data would be lost except, possibly, when switching from one antenna to another. After this plan was adopted, further analysis showed that daily handovers would be necessary for significant periods of the year. This unexpected need for extensive handovers necessitated that a handover design be developed to minimize the impact on the mission. This antenna handover design was developed and successfully tested with simulated data using the slew rate limits from preliminary jitter analysis. Subsequent analysis provided significant revision of allowed rates requiring modification of the handover plans.

Author

High Gain; Solar Observatories; Helioseismology; Antenna Design; Sun; Mission Planning

20080012688 EDS Operations Services G.m.b.H., Darmstadt, Germany

Analysis Method for Non-Nominal First Acquisition

Sieg, Detlef; Mugellesi-Dow, Roberta; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 10 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

First this paper describes a method how the trajectory of the launcher can be modelled for the contingency analysis without having much information about the launch vehicle itself. From a dense sequence of state vectors a velocity profile is derived which is sufficiently accurate to enable the Flight Dynamics Team to integrate parts of the launcher trajectory on its own and to simulate contingency cases by modifying the velocity profile. Then the paper focuses on the thorough visibility analysis which has to follow the contingency case or burn performance simulations. In the ideal case it is possible to identify a ground station which is able to acquire the satellite independent from the burn performance. The correlations between the burn performance and the pointing at subsequent ground stations are derived with the aim of establishing simple guidelines which can be applied quickly and which significantly improve the chance of acquisition at subsequent ground stations. In the paper the method is applied to the Soyuz/Fregat launch with the MetOp satellite. Overall the paper shows that the launcher trajectory modelling with the simulation of contingency cases in connection with a ground station visibility analysis leads to a proper selection of ground stations and acquisition methods. In the MetOp case this ensured successful contact of all ground stations during the first hour after separation without having to rely on any early orbit determination result or state vector update.

Author

Launch Vehicles; Orbit Determination; Soyuz Spacecraft; Velocity Distribution; Aerodynamics; Launching

20080012689 Real Observatorio de la Armada, Spain

Hill Problem Analytical Theory to the Order Four. Application to the Computation of Frozen Orbits around Planetary Satellites

Lara, Martin; Palacian, Jesus F.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629; Original contains color and black and white illustrations

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Frozen orbits of the Hill problem are determined in the double averaged problem, where short and long period terms are removed by means of Lie transforms. The computation of initial conditions of corresponding quasi periodic solutions in the

non-averaged problem is straightforward for the perturbation method used provides the explicit equations of the transformation that connects the averaged and non-averaged models. A fourth order analytical theory reveals necessary for the accurate computation of quasi periodic, frozen orbits.
Author
Natural Satellites; Transformations (Mathematics); Perturbation Theory

20080012690 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Mars Reconnaissance Orbiter Aerobraking Daily Operations and Collision Avoidance
Long, Stacia M.; You, Tung-Han; Halsell, C. Allen; Bhat, Ramachand S.; Demcak, Stuart W.; Graat, Eric J.; Higa, Earl S.; Highsmith, Dolan E.; Mottinger, Neil A.; Jah, Moriba K.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 16 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The Mars Reconnaissance Orbiter reached Mars on March 10, 2006 and performed a Mars orbit insertion maneuver of 1 km/s to enter into a large elliptical orbit. Three weeks later, aerobraking operations began and lasted about five months. Aerobraking utilized the atmospheric drag to reduce the large elliptical orbit into a smaller, near circular orbit. At the time of MRO aerobraking, there were three other operational spacecraft orbiting Mars and the navigation team had to minimize the possibility of a collision. This paper describes the daily operations of the MRO navigation team during this time as well as the collision avoidance strategy development and implementation.
Author
Aerobraking; Collision Avoidance; Mars Reconnaissance Orbiter; Navigation

20080012691 NASA Ames Research Center, Moffett Field, CA, USA
Trajectory Design and Orbit Determination for the Lunar CRater Observation and Sensing Satellite (LCROSS)
Galal, Ken; Colaprete, Tony; Cooley, Steven; Kennedy, Brian; McElrath, Tim; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The Lunar CRater Observation and Sensing Satellite (LCROSS) was competitively selected by the National Aeronautical and Space Administration (NASA) Exploration Systems Mission Directorate (ESMD) as a low-cost (< $80M) 1000 kg secondary payload to be launched with the Lunar Reconnaissance Orbiter (LRO) in October of 2008. LCROSS is a lunar impactor mission that will investigate the presence or absence of water in a permanently shadowed crater. Following launch, trans-lunar injection (TLI) and separation from LRO, LCROSS will remain attached to the launch vehicle's approximately 2300 kg spent Earth Departure Upper Stage (EDUS) and will guide it toward an impact of a permanently shadowed crater at the lunar South Pole. Hours prior to impact, LCROSS will separate from the EDUS and perform a braking maneuver that will allow the spacecraft to take measurements of the resulting EDUS impact ejecta cloud for several minutes, before impacting the crater as well. As a cost-capped secondary mission that must accommodate specific LRO launch dates, LCROSS faces unique challenges and constraints that must be carefully reconciled in order to satisfy an ambitious set of science observation requirements. This paper examines driving mission requirements and constraints and describes the trajectory design and navigation strategy that shape the LCROSS mission.
Derived from text
Impactors; Lunar Craters; Mission Planning; Orbit Determination; Earth-Moon Trajectories; Moon

20080012692 Japan Aerospace Exploration Agency, Japan
Optimization of Return Trajectories for Orbital Transfer Vehicle between Earth and Moon
Funase, Ryu; Tsuda, Yuichi; Kawaguchi, Jun'ichiro; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 10 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

In this paper, optimum trajectories in Earth Transfer Orbit (ETO) for a lunar transportation system are proposed. This paper aims at improving the payload ratio of the reusable orbital transfer vehicle (OTV), which transports the payload from Low Earth Orbit (LEO) to Lunar Low Orbit (LLO) and returns to LEO. In ETO, we discuss ballistic flight using chemical propulsion, multi-impulse flight using electrical propulsion, and aero-assisted flight using aero-brake. The feasibility of the OTV is considered.
Author
Low Earth Orbits; Trajectory Optimization; Transfer Orbits; Trajectories; Lunar Orbits; Chemical Propulsion; Aeroassist

20080012693 European Space Agency. European Space Operations Center, Darmstadt, Germany

Smart-1 Moon Impact Operations

Ayla, Andres; Rigger, Ralf; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 9 pp.; In English; See also 20080012629; Original contains color and black and white illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

This paper describes the operations to control the Moon impact of the 3-axis stabilized spacecraft SMART-1 in September 2006. SMART-1 was launched on 27/09/2003. It was the first ESA mission to use an Electric Propulsion (EP) engine as the main motor to spiral out of the Earth gravity field and reach a scientific moon orbit [1]. During September 2005 the last EP maneuvers were performed using the remaining Xenon, in order to compensate for the 3rd body perturbations of the Sun and Earth. These operations extended the mission for an additional year. Afterwards the EP performance became unpredictable and low, so that no meaningful operation for the moon impact could be done. To move the predicted impact point on the 16/8/2006 into visibility from Earth an alternative Delta-V strategy was designed. Due to their alignment, the attitude thrusters could not be used directly to generate the Delta-V, so this strategy was based on controlled angular momentum biasing. Firing along the velocity vector around apolune, the remaining Hydrazine left from the attitude control budget was used, to shift the impact to the required coordinates.

Author

Angular Momentum; Attitude Control; Electric Propulsion; Gravitational Fields; Moon; Alignment

20080012694 European Space Agency. European Space Operations Center, Darmstadt, Germany

Analysis of Envisat Orbit Maintenance Strategies to Improve/Increase Envisat ASAR Interferometry Opportunities

Kuijper, D.; Matatoros, Garcia; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 8 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The biggest and most advanced Earth Observation Satellite in-orbit, developed by the European Space Agency (ESA) and its member states, is Envisat. It was launched on March 1, 2002 by an Ariane V from French Guyana and holds a total of 10 multi-disciplinary Earth observation instruments, among which an Advanced Synthetic Aperture Radar (ASAR). The ASAR user community requested the Flight Dynamics division of the European Space Operations Centre (ESOC) to investigate how the orbit control maintenance strategy for Envisat could be changed to optimize ASAR interferometry opportunities overall and in addition support the International Polar Year 2007/2008 initiative. The Polar Regions play a pivotal role in understanding our planet and our impact on it as they are recognized as sensitive barometers of environmental change. One of the main themes of the International Polar Year 2007/2008 is therefore the study of Earth s changing ice and snow, and its impact on our planet and our lives. Naturally, ESA would like to support this very important initiative. This paper presents the investigations that have been conducted to support these requests in the best possible way. It discusses the orbit maintenance strategy that has been in place since its launch, ensuring the actual orbit to be within 1 km of a so-called reference orbit, and presents the new orbit maintenance strategy that is aimed at improving/increasing the opportunities for Envisat ASAR interferometry, while preserving the fuel on board the spacecraft. The hydrazine on-board Envisat happens to be a precious resource as only approximately 300 kg of it was available at launch, like ERS-2. The difference being however that the mass of Envisat is approximately 3.2 times that of ERS-2.

Author

Ariane Launch Vehicle; ERS-2 (ESA Satellite); Maintenance; Interferometry; Synthetic Aperture Radar; Satellite Observation; Earth Observations (From Space); Scientific Satellites

20080012695 European Space Agency. European Space Operations Center, Darmstadt, Germany

Effects on Spacecraft Radiometric Data at Superior Solar Conjunction

Morley, Trevor; Budnik, Frank; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 10 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

During 2006, three ESA interplanetary spacecraft, Rosetta, Mars Express (MEX) and Venus Express (VEX), passed through superior solar conjunction. For all three spacecraft, the noise in the post-fit range-rate residuals from the orbit determination was analysed. At small Sun-Earth-Probe (SEP) angles the level was almost two orders of magnitude higher than normal. The main objective was to characterize the Doppler (rangerate) noise as a function of SEP angle. At least then the range-rate data can be appropriately weighted within the orbit determination so that the solution uncertainties are realistic. For VEX, some intervals of particularly noisy Doppler data could be correlated with unusual solar activity. For Rosetta, the biases in the range data residuals were analysed with the aim of improving the model used for calibrating the signal delay due to the

solar plasma. The model, which originally had fixed coefficients, was adjusted to achieve better fits to the data. Even the relatively small Doppler biases were well represented. Using the improved model, the electron density at 20 solar radii was compared with earlier results obtained by radio science studies using Voyager 2 and Ulysses radiometric data. There is some evidence for a dependency of the density on the phase within the 11 years solar cycle.
Author
Rosetta Mission; Mars Express; Voyager 2 Spacecraft; Ulysses Mission; Solar Activity; Radiometers; Interplanetary Spacecraft; Orbit Determination

20080012696 Consiglio Nazionale delle Ricerche, Pisa, Italy
Evolution of the Debris Cloud Generated by the Fengyun-1C Fragmentation Event
Pardini, Carmen; Anselmo, Luciano; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 13 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The cloud of cataloged debris produced in low earth orbit by the fragmentation of the Fengyun-1C spacecraft was propagated for 15 years, taking into account all relevant perturbations. Unfortunately, the cloud resulted to be very stable, not suffering substantial debris decay during the time span considered. The only significant short term evolution was the differential spreading of the orbital planes of the fragments, leading to the formation of a debris shell around the earth approximately 7-8 months after the breakup, and the perigee precession of the elliptical orbits. Both effects will render the shell more 'isotropic' in the coming years. The immediate consequence of the Chinese anti-satellite test, carried out in an orbital regime populated by many important operational satellites, was to increase significantly the probability of collision with man-made debris. For the two Italian spacecraft launched in the first half of 2007, the collision probability with cataloged objects increased by 12% for AGILE, in equatorial orbit, and by 38% for COSMO-SkyMed 1, in sun-synchronous orbit.
Author
Debris; Fragmentation; Equatorial Orbits; Elliptical Orbits; Collisions; Probability Theory; Perturbation

20080012698 Deutsches Zentrum fuer Luft- und Raumfahrt e.V., Wessling, Germany
GPS-Based Precision Baseline Reconstruction for the TanDEM-X SAR-Formation
Montenbruck, O.; vanBarneveld, P. W. L.; Yoon, Y.; Visser, P. N. A. M.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 13 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The TanDEM-X formation employs two separate spacecraft to collect interferometric Synthetic Aperture Radar (SAR) measurements over baselines of about 1 km. These will allow the generation ofa global Digital Elevation Model (DEM) with an relative vertical accuracy of 2-4 m and a 10 m ground resolution. As part of the ground processing, the separation of the SAR antennas at the time of each data take must be reconstructed with a 1 mm accuracy using measurements from two geodetic grade GPS receivers. The paper discusses the TanDEM-X mission as well as the methods employed for determining the interferometric baseline with utmost precision. Measurements collected during the close fly-by of the two GRACE satellites serve as a reference case to illustrate the processing concept, expected accuracy and quality control strategies.
Author
Global Positioning System; Synthetic Aperture Radar; Flyby Missions; Digital Elevation Models; Interferometry; Radar Measurement

20080012702 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Mars Reconnaissance Orbiter Interplanetary Cruise Navigation
You, Tung-Han; Graat, Eric; Halsell, Allen; Highsmith, Dolan; Long, Stacia; Bhat, Ram; Demcak, Stuart; Higa, Earl; Mottinger, Neil; Jah, Moriba; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 16 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

Carrying six science instruments and three engineering payloads, the Mars Reconnaissance Orbiter (MRO) is the first mission in a low Mars orbit to characterize the surface, subsurface, and atmospheric properties with unprecedented detail. After a seven-month interplanetary cruise, MRO arrived at Mars executing a 1.0 km/s Mars Orbit Insertion (MOI) maneuver. MRO achieved a 430 km periapsis altitude with the final orbit solution indicating that only 10 km was attributable to navigation prediction error. With the last interplanetary maneuver performed four months before MOI, this was a significant accomplishment. This paper describes the navigation analyses and results during the 210-day interplanetary cruise. As of

August 2007 MRO has returned more than 18 Terabits of scientific data in support of the objectives set by the Mars Exploration Program (MEP). The robust and exceptional interplanetary navigation performance paved the way for a successful MRO mission.
Author
Navigation; Mars Reconnaissance Orbiter; Navigation Instruments; Orbit Insertion; Interplanetary Navigation; Mars Exploration; Meteorological Parameters

20080012703 Academy of Sciences (USSR), Moscow, Russian Federation
Motion Parameters Determination of the SC and Phobos in the Project Phobos-Grunt
Akim, E. L.; Stepanyants, V. A.; Tuchin, A. G.; Shishov, V. A.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629; Original contains black and white illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The SC 'Phobos-Grunt' flight is planned to 2009 in Russia with the purpose to deliver to the Earth the soil samples of the Mars satellite Phobos. The mission will pass under the following scheme [1-4]: the SC flight from the Earth to the Mars, the SC transit on the Mars satellite orbit, the motion round the Mars on the observation orbit and on the quasi-synchronous one [5], landing on Phobos, taking of a ground and start in the direction to the Earth. The implementation of complicated dynamical operations in the Phobos vicinity is foreseen by the project. The SC will be in a disturbance sphere of gravitational fields from the Sun, the Mars and the Phobos. The SC orbit determination is carried out on a totality of trajectory measurements executed from ground tracking stations and measurements of autonomous systems onboard space vehicle relatively the Phobos. As ground measurements the radio engineering measurements of range and range rate are used. There are possible as onboard optical observations of the Phobos by a television system and ranges from the SC up to the Phobos surface by laser locator. As soon as the Phobos orbit accuracy is insufficient for a solution of a problem of landing its orbit determination will be carried out together with determination of the SC orbit. Therefore the algorithms for joint improving of initial conditions of the SC and the Phobos are necessary to determine parameters of the SC relative the Phobos motion within a single dynamical motion model. After putting on the martial satellite orbit, on the Phobos observation orbit, on the quasi-synchronous orbit in the Phobos vicinity the equipment guidance and the following process of the SC orbit determination relatively Phobos requires a priori knowledge of the Phobos orbit parameters with sufficiently high precision. These parameters should be obtained beforehand using both all modern observations and historical ones.
Author
Trajectory Measurement; Satellite Orbits; Orbit Determination; Visual Observation; Autonomy; Gravitational Fields; Phobos; Transit Satellites

20080012704 Florida Univ., Gainesville, FL, USA
Game Theoretic Approach to Post-Docked Satellite Control
Hiramatsu, Takashi; Fitz-Coy, Norman G.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 10 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

This paper studies the interaction between two satellites after docking. In order to maintain the docked state with uncertainty in the motion of the target vehicle, a game theoretic controller with Stackelberg strategy to minimize the interaction between the satellites is considered. The small perturbation approximation leads to LQ differential game scheme, which is validated to address the docking interactions between a service vehicle and a target vehicle. The open-loop solution are compared with Nash strategy, and it is shown that less control efforts are obtained with Stackelberg strategy.
Author
Satellite Control; Game Theory; Perturbation; Docking; Controllers; Differential Games

20080012705 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Standardizing Navigation Data: A Status Update
VanEepoel, John M.; Berry, David S.; Pallaschke, Siegmar; Foliard, Jacques; Kiehling, Reinhard; Ogawa, Mina; Showell, Avanaugh; Fertig, Juergen; Castronuovo, Marco; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 16 pp.; In English; See also 20080012629; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

This paper presents the work of the Navigation Working Group of the Consultative Committee for Space Data Systems

(CCSDS) on development of standards addressing the transfer of orbit, attitude and tracking data for space objects. Much progress has been made since the initial presentation of the standards in 2004, including the progression of the orbit data standard to an accepted standard, and the near completion of the attitude and tracking data standards. The orbit, attitude and tracking standards attempt to address predominant parameterizations for their respective data, and create a message format that enables communication of the data across space agencies and other entities. The messages detailed in each standard are built upon a keyword = value paradigm, where a fixed list of keywords is provided in the standard where users specify information about their data, and also use keywords to encapsulate their data. The paper presents a primer on the CCSDS standardization process to put in context the state of the message standards, and the parameterizations supported in each standard, then shows examples of these standards for orbit, attitude and tracking data. Finalization of the standards is expected by the end of calendar year 2007.
Author
Navigation; Systems Engineering; Standardization; Attitude (Inclination); Data Systems; Aerospace Systems; Transfer Orbits

20080012707 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Determining a Method of Enabling and Disabling the Integral Torque in the SDO Science and Inertial Mode Controllers
Vess, Melissa F.; Starin, Scott R.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 11 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

During design of the SDO Science and Inertial mode PID controllers, the decision was made to disable the integral torque whenever system stability was in question. Three different schemes were developed to determine when to disable or enable the integral torque, and a trade study was performed to determine which scheme to implement. The trade study compared complexity of the control logic, risk of not reenabling the integral gain in time to reject steady-state error, and the amount of integral torque space used. The first scheme calculated a simplified Routh criterion to determine when to disable the integral torque. The second scheme calculates the PD part of the torque and looked to see if that torque would cause actuator saturation. If so, only the PD torque is used. If not, the integral torque is added. Finally, the third scheme compares the attitude and rate errors to limits and disables the integral torque if either of the errors is greater than the limit. Based on the trade study results, the third scheme was selected. Once it was decided when to disable the integral torque, analysis was performed to determine how to disable the integral torque and whether or not to reset the integrator once the integral torque was reenabled. Three ways to disable the integral torque were investigated: zero the input into the integrator, which causes the integral part of the PID control torque to be held constant; zero the integral torque directly but allow the integrator to continue integrating; or zero the integral torque directly and reset the integrator on integral torque reactivation. The analysis looked at complexity of the control logic, slew time plus settling time between each calibration maneuver step, and ability to reject steady-state error. Based on the results of the analysis, the decision was made to zero the input into the integrator without resetting it. Throughout the analysis, a high fidelity simulation was used to test the various implementation methods.
Author
Control Systems Design; Sequential Control; Systems Engineering; Steady State; Attitude (Inclination); Calibrating; Time Measurement; Controllers

20080012708 Aerospace Controls Corp., USA
Autonomous On-Board Calibration of Attitude Sensors and Gyros
Pittelkau, Mark E.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 10 pp.; In English; See also 20080012629; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

This paper presents the state of the art and future prospects for autonomous real-time on-orbit calibration of gyros and attitude sensors. The current practice in ground-based calibration is presented briefly to contrast it with on-orbit calibration. The technical and economic benefits of on-orbit calibration are discussed. Various algorithms for on-orbit calibration are evaluated, including some that are already operating on board spacecraft. Because Redundant Inertial Measurement Units (RIMUs, which are IMUs that have more than three sense axes) are almost ubiquitous on spacecraft, special attention will be given to calibration of RIMUs. In addition, we discuss autonomous on board calibration and how it may be implemented.
Author
Inertial Platforms; Autonomy; Attitude Control; Calibrating; Gyroscopes; Real Time Operation

20080012709 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Comparing Consider-Covariance Analysis with Sigma-Point Consider Filter and Linear-Theory Consider Filter Formulations

Lisano, Michael E.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

Recent literature in applied estimation theory reflects growing interest in the sigma-point (also called unscented) formulation for optimal sequential state estimation, often describing performance comparisons with extended Kalman filters as applied to specific dynamical problems [c.f. 1, 2, 3]. Favorable attributes of sigma-point filters are described as including a lower expected error for nonlinear even non-differentiable dynamical systems, and a straightforward formulation not requiring derivation or implementation of any partial derivative Jacobian matrices. These attributes are particularly attractive, e.g. in terms of enabling simplified code architecture and streamlined testing, in the formulation of estimators for nonlinear spaceflight mechanics systems, such as filter software onboard deep-space robotic spacecraft. As presented in [4], the Sigma-Point Consider Filter (SPCF) algorithm extends the sigma-point filter algorithm to the problem of consider covariance analysis. Considering parameters in a dynamical system, while estimating its state, provides an upper bound on the estimated state covariance, which is viewed as a conservative approach to designing estimators for problems of general guidance, navigation and control. This is because, whether a parameter in the system model is observable or not, error in the knowledge of the value of a non-estimated parameter will increase the actual uncertainty of the estimated state of the system beyond the level formally indicated by the covariance of an estimator that neglects errors or uncertainty in that parameter. The equations for SPCF covariance evolution are obtained in a fashion similar to the derivation approach taken with standard (i.e. linearized or extended) consider parameterized Kalman filters (c.f. [5]). While in [4] the SPCF and linear-theory consider filter (LTCF) were applied to an illustrative linear dynamics/linear measurement problem, in the present work examines the SPCF as applied to nonlinear sequential consider covariance analysis, i.e. in the presence of nonlinear dynamics and nonlinear measurements. A simple SPCF for orbit determination, exemplifying an algorithm hosted in the guidance, navigation and control (GN&C) computer processor of a hypothetical robotic spacecraft, was implemented, and compared with an identically-parameterized (standard) extended, consider-parameterized Kalman filter. The onboard filtering scenario examined is a hypothetical spacecraft orbit about a small natural body with imperfectly-known mass. The formulations, relative complexities, and performances of the filters are compared and discussed.

Author

Spacecraft Orbits; Guidance (Motion); Orbit Determination; Linear Filters; Kalman Filters; Dynamical Systems

20080012710 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Contingency Support Simulation for the Tracking and Data Relay Satellite System (TDRSS)

Dykes, Andy; Dunham, Joan; Ward, Douglas T.; Robertson, Mika; Nesbit, Gary; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 12 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

In March 2006, the Tracking and Data Relay Satellite (TDRS)-3 experienced an unexpected thrusting event, which caused significant changes to its orbit. Recovery from this anomaly was protracted, raising concerns during the Independent Review Team (IRT) investigation of the anomaly regarding the contingency response readiness. The simulations and readiness exercises discussed in this paper were part of the response to the IRT concerns. This paper explains the various levels of simulation needed to enhance the proficiency of the Flight Dynamics Facility (FDF) and supporting elements in recovery from a TDRS contingency situation. The main emergency to address is when a TDRS has experienced uncommanded, unreported, or misreported thrusting, causing a ground station to lose the ability to acquire the spacecraft, as happened in 2006. The following levels of simulation are proposed: 1) Tests that would be performed by the individual support sites to verify that internal procedures and tools are in place and up to date; 2) Tabletop simulations that would involve all of the key support sites talking through their respective operating procedures to ensure that proper notifications are made and communications links are established; and 3) Comprehensive simulations that would be infrequent, but realistic, involving data exchanges between ground sites and voice and electronic communications among the supporting elements.

Author

TDR Satellites; Ground Stations; Communication Networks; Voice Communication; Contingency; Anomalies

20080012711 Johns Hopkins Univ., MD, USA

Impacts of Center of Mass Shifts on Messenger Spacecraft Operations

O'Shaughnessy, D. J.; Vaughan, R. M.; Chouinard, T. L., III; Jaekle, D. E.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629; Original contains color illustrations

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The MESSENGER (MErcury Surface, Space ENvironment, GEochemistry, and Ranging) has successfully completed its first three years of flight operations following launch on August 3, 2004. As part of NASA s Discovery Program, MESSENGER will observe Mercury during flybys in 2008 and 2009, as well as from orbit beginning in March 2011. This paper discusses the impact that center of mass (CM) location changes have had on many mission activities, particularly angular momentum management and maneuver execution. Momentum trends were altered significantly following the first deep-space maneuver, and these changes were related to a change in the CM. The CM location also impacts maneuver execution, and uncertainties in its location led to the significant direction errors experienced at trajectory correction maneuver 11. Because of the spacecraft sensitivity to CM location, efforts to estimate its position are important to momentum and maneuver prediction. This paper summarizes efforts to estimate the CM from flight data, as well as the operational strategy to handle CM uncertainties and their impact on momentum trends and maneuver execution accuracy.

Author

Messenger (Spacecraft); Mercury Surface; Angular Momentum; Geochemistry; Flight Operations; Center of Mass

20080012712 GMV Aerospace and Defense S.A., Madrid, Spain

Autonomous GNC Algorithms for NEO Impactor Missions

Gil-Fernandez, Jesus; Prieto-Llanos, Tomas; Panzeca, Roberto; Drai, Remi; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 14 pp.; In English; See also 20080012629; Original contains color and black and white illustrations

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The design of a low-cost impactor spacecraft (SC), targeting a small, faint NEO, poses major challenges. One of the most demanding problems refers to the capability of the autonomous Guidance, Navigation & Control (GNC) to compensate the deviations affecting the impact point in order to achieve a successful collision. During the terminal phase, the autonomous GNC must use the information of the optical sensors to estimate the parameters allowing the computation of divert maneuvers to achieve the impact. GMV has developed a simulator, with different levels of sophistication, and a set of different GNC algorithms to help in the design process allowing for dimensioning the sensors and actuators, verifying mission requirements, computing figures of merit of different SC configuration and evaluating GNC performances. The implemented GNC algorithms are (1) low-thrust proportional navigation using a fading memory filter, (2) high-thrust predictive guidance using a Kalman filter or (3) a batch-sequential least-squares filter, and (4) a mid-thrust hybrid predictiveproportional guidance using a fading memory filter. Results of single-run and Monte Carlo simulations for two different asteroids (1989 ML and 2002 AT4) with these GNC algorithms are presented to compare performances and to show the mission parameters driving these performances.

Author

Algorithms; Asteroids; Collisions; Impactors; Mission Planning; Spacecraft Guidance; Autonomous Navigation; Control Simulation; Spacecraft Maneuvers; Spacecraft Control; Computerized Simulation; Near Earth Objects

20080012713 NASA Goddard Space Flight Center, Greenbelt, MD, USA

A Jitter-Mitigating High Gain Antenna Pointing Algorithm for the Solar Dynamics Observatory

Bourkland, Kristin L.; Liu, Kuo-Chia; Blaurock, Carl; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

This paper details a High Gain Antenna (HGA) pointing algorithm which mitigates jitter during the motion of the antennas on the Solar Dynamics Observatory (SDO) spacecraft. SDO has two HGAs which point towards the Earth and send data to a ground station at a high rate. These antennas are required to track the ground station during the spacecraft Inertial and Science modes, which include periods of inertial Sunpointing as well as calibration slews. The HGAs also experience handoff seasons, where the antennas trade off between pointing at the ground station and pointing away from the Earth. The science instruments on SDO require fine Sun pointing and have a very low jitter tolerance. Analysis showed that the nominal tracking

and slewing motions of the antennas cause enough jitter to exceed the HGA portion of the jitter budget. The HGA pointing control algorithm was expanded from its original form as a means to mitigate the jitter.
Author
Solar Observatories; Pointing Control Systems; Helioseismology; Calibrating; High Gain; Algorithms

20080012715 EDS Operations Services G.m.b.H., Darmstadt, Germany
The METOP-A Orbit Acquisition Strategy and its LEOP Operational Experience
Merz, K.; Serrano, M. A. Martin; Kuijper, D.; Matatoros, M. A. Garcia; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 9 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

Europe's first polar-orbiting weather satellite, METOPA, was launched by a Soyuz launcher from Baikonur Cosmodrome on the 19th of October of 2006. The routine operations of METOP-A are conducted by EUMETSAT (European Organization for Exploitation of Meteorological Satellites) in the frame of the European Polar System mission (EPS). The METOP-A Launch and Early Orbit Phase (LEOP) operations have been performed by ESA/ESOC. The Flight Dynamics Orbit Determination and Control team (OD&C) at ESOC was in charge of correcting the S/C orbit as delivered by the launcher in such a way that EUMETSAT would be able to acquire the reference orbit with a drift-stop manoeuvre approximately two weeks after a LEOP of 3 days and Hand-Over to the EUMETSAT Control Centre (EUMETSAT-CC) in Darmstadt, Germany. The various strict constraints and the short amount of time available for ESOC operations made this task challenging. Several strategies were prepared before launch and analysed during LEOP based on the achieved injection orbit. This paper presents the different manoeuvre strategies investigated and finally applied to acquire the operational orbit, reporting as well the details of its execution and final achieved state.
Author
Meteorological Satellites; Soyuz Spacecraft; Spacecraft Launching; Spacecraft Maneuvers; Orbit Determination

20080012716 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Observing Mode Attitude Controller for the Lunar Reconnaissance Orbiter
Calhoun, Philip C.; Garrick, Joseph C.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 10 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The Lunar Reconnaissance Orbiter (LRO) mission is the first of a series of lunar robotic spacecraft scheduled for launch in Fall 2008. LRO will spend at least one year in a low altitude polar orbit around the Moon, collecting lunar environment science and mapping data to enable future human exploration. The LRO employs a 3-axis stabilized attitude control system (ACS) whose primary control mode, the 'Observing mode', provides Lunar Nadir, off-Nadir, and Inertial fine pointing for the science data collection and instrument calibration. The controller combines the capability of fine pointing with that of on-demand large angle full-sky attitude reorientation into a single ACS mode, providing simplicity of spacecraft operation as well as maximum flexibility for science data collection. A conventional suite of ACS components is employed in this mode to meet the pointing and control objectives. This paper describes the design and analysis of the primary LRO fine pointing and attitude re-orientation controller function, known as the 'Observing mode' of the ACS subsystem. The control design utilizes quaternion feedback, augmented with a unique algorithm that ensures accurate Nadir tracking during large angle yaw maneuvers in the presence of high system momentum and/or maneuver rates. Results of system stability analysis and Monte Carlo simulations demonstrate that the observing mode controller can meet fine pointing and maneuver performance requirements.
Author
Attitude (Inclination); Attitude Control; Lunar Orbiter; Reconnaissance; Pointing Control Systems; Lunar Spacecraft; Robotics; Spacecraft Launching; Stability Tests

20080012717 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Wessling, Germany
Spaceborne Autonomous and Ground Based Relative Orbit Control for the TerraSAR-X/TanDEM-X Formation
Ardaens, J. S.; D'Amico, S.; Kazeminejad, B.; Montenbruck, O.; Gill, E.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 13 pp.; In English; See also 20080012629; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

TerraSAR-X (TSX) and TanDEM-X (TDX) are two advanced synthetic aperture radar (SAR) satellites flying in formation. SAR interferometry allows a high resolution imaging of the Earth by processing SAR images obtained from two

slightly different orbits. TSX operates as a repeat-pass interferometer in the first phase of its lifetime and will be supplemented after two years by TDX in order to produce digital elevation models (DEM) with unprecedented accuracy. Such a flying formation makes indeed possible a simultaneous interferometric data acquisition characterized by highly flexible baselines with range of variations between a few hundreds meters and several kilometers [1]. TSX has been successfully launched on the 15th of June, 2007. TDX is expected to be launched on the 31st of May, 2009. A safe and robust maintenance of the formation is based on the concept of relative eccentricity/inclination (e/i) vector separation whose efficiency has already been demonstrated during the Gravity Recovery and Climate Experiment (GRACE) [2]. Here, the satellite relative motion is parameterized by mean of relative orbit elements and the key idea is to align the relative eccentricity and inclination vectors to minimize the hazard of a collision. Previous studies have already shown the pertinence of this concept and have described the way of controlling the formation using an impulsive deterministic control law [3]. Despite the completely different relative orbit control requirements, the same approach can be applied to the TSX/TDX formation. The task of TDX is to maintain the close formation configuration by actively controlling its relative motion with respect to TSX, the leader of the formation. TDX must replicate the absolute orbit keeping maneuvers executed by TSX and also compensate the natural deviation of the relative e/i vectors. In fact the relative orbital elements of the formation tend to drift because of the secular non-keplerian perturbations acting on both satellites. The goal of the ground segment is thus to regularly correct this configuration by performing small orbit correction maneuvers on TDX. The ground station contacts are limited due to the geographic position of the station and the costs for contact time. Only with a polar ground station a contact visibility is possible every orbit for LEO satellites. TSX and TDX use only the Weilheim ground station (in the southern part of Germany) during routine operations. This station allows two scheduled contact per day for the nominal orbit configuration, meaning that the satellite conditions can be checked with an interval of 12 hours. While this limitation is usually not critical for single satellite operations, the visibility constraints drive the achievable orbit control accuracy for a LEO formation if a ground based approach is chosen. Along-track position uncertainties and maneuver execution errors affect the relative motion and can be compensated only after a ground station contact.

Author

Synthetic Aperture Radar; Low Earth Orbits; Formation Flying; Ground Based Control; Orbital Elements; Gravitation; Digital Elevation Models; Control Theory

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Analytical Approach Validation for the Spin-Stabilized Satellite Attitude

Zanardi, Maria Cecilia F. P. S.; Garcia, Roberta Veloso; Kuga, Helio Koiti; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 13 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

An analytical approach for spin-stabilized spacecraft attitude prediction is presented for the influence of the residual magnetic torques and the satellite in an elliptical orbit. Assuming a quadripole model for the Earth s magnetic field, an analytical averaging method is applied to obtain the mean residual torque in every orbital period. The orbit mean anomaly is used to compute the average components of residual torque in the spacecraft body frame reference system. The theory is developed for time variations in the orbital elements, giving rise to many curvature integrals. It is observed that the residual magnetic torque does not have component along the spin axis. The inclusion of this torque on the rotational motion differential equations of a spin stabilized spacecraft yields conditions to derive an analytical solution. The solution shows that the residual torque does not affect the spin velocity magnitude, contributing only for the precession and the drift of the spin axis of the spacecraft. The theory developed has been applied to the Brazilian s spin stabilized satellites, which are quite appropriated for verification and comparison of the theory with the data generated and processed by the Satellite Control Center of Brazil National Research Institute. The results show the period that the analytical solution can be used to the attitude propagation, within the dispersion range of the attitude determination system performance of Satellite Control Center of Brazil National Research Institute.

Author

Attitude (Inclination); Attitude Control; Satellite Control; Satellite Orbits; Elliptical Orbits; Differential Equations; Geomagnetism; Equations of Motion

20080012719 Technische Hogeschool, Delft, Netherlands

GPS-Based Reduced Dynamic Orbit Determination Using Accelerometer Data

VanHelleputte, Tom; Visser, Pieter; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 7 pp.; In English; See also 20080012629; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

Currently two gravity field satellite missions, CHAMP and GRACE, are equipped with high sensitivity electrostatic accelerometers, measuring the non-conservative forces acting on the spacecraft in three orthogonal directions. During the gravity field recovery these measurements help to separate gravitational and non-gravitational contributions in the observed orbit perturbations. For precise orbit determination purposes all these missions have a dual-frequency GPS receiver on board. The reduced dynamic technique combines the dense and accurate GPS observations with physical models of the forces acting on the spacecraft, complemented by empirical accelerations, which are stochastic parameters adjusted in the orbit determination process. When the spacecraft carries an accelerometer, these measured accelerations can be used to replace the models of the non-conservative forces, such as air drag and solar radiation pressure. This approach is implemented in a batch least-squares estimator of the GPS High Precision Orbit Determination Software Tools (GHOST), developed at DLR/GSOC and DEOS. It is extensively tested with data of the CHAMP and GRACE satellites. As accelerometer observations typically can be affected by an unknown scale factor and bias in each measurement direction, they require calibration during processing. Therefore the estimated state vector is augmented with six parameters: a scale and bias factor for the three axes. In order to converge efficiently to a good solution, reasonable a priori values for the bias factor are necessary. These are calculated by combining the mean value of the accelerometer observations with the mean value of the non-conservative force models and empirical accelerations, estimated when using these models. When replacing the non-conservative force models with accelerometer observations and still estimating empirical accelerations, a good orbit precision is achieved. 100 days of GRACE B data processing results in a mean orbit fit of a few centimeters with respect to high-quality JPL reference orbits. This shows a slightly better consistency compared to the case when using force models. A purely dynamic orbit, without estimating empirical accelerations thus only adjusting six state parameters and the bias and scale factors, gives an orbit fit for the GRACE B test case below the decimeter level. The in orbit calibrated accelerometer observations can be used to validate the modelled accelerations and estimated empirical accelerations computed with the GHOST tools. In along track direction they show the best resemblance, with a mean correlation coefficient of 93% for the same period. In radial and normal direction the correlation is smaller. During days of high solar activity the benefit of using accelerometer observations is clearly visible. The observations during these days show fluctuations which the modelled and empirical accelerations can not follow.

Author

Gravitational Fields; Accelerometers; Electrostatics; Global Positioning System; Orbit Determination; Correlation Coefficients; Calibrating

20080012720 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Guaranteeing Pointing Performance of the SDO Sun-Pointing Controllers in Light of Nonlinear Effects

Starin, Scott R.; Bourkland, Kristin L.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 8 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The Solar Dynamics Observatory (SDO) mission is the first Space Weather Research Network mission, part of NASA s Living With a Star program.1 This program seeks to understand the changing Sun and its effects on the Solar System, life, and society. To this end, the SDO spacecraft will carry three Sun-observing instruments to geosynchronous orbit: Helioseismic and Magnetic Imager (HMI), led by Stanford University; Atmospheric Imaging Assembly (AIA), led by Lockheed Martin Space and Astrophysics Laboratory; and Extreme Ultraviolet Variability Experiment (EVE), led by the University of Colorado. Links describing the instruments in detail may be found through the SDO web site.2 The basic mission goals are to observe the Sun for a very high percentage of the 5-year mission (10-year goal) with long stretches of uninterrupted observations and with constant, high-data-rate transmission to a dedicated ground station. These goals guided the design of the spacecraft bus that will carry and service the three-instrument payload. At the time of this publication, the SDO spacecraft bus is well into the integration and testing phase at the NASA Goddard Space Flight Center (GSFC). A three-axis stabilized attitude control system (ACS) is needed both to point at the Sun accurately and to keep the roll about the Sun vector correctly positioned. The ACS has four reaction wheel modes and 2 thruster actuated modes. More details about the ACS in general and the control modes in particular can be found in Refs. [3-6]. All four of SDO s wheel-actuated control modes involve Sun-pointing controllers, as might be expected from such a mission. Science mode, during which most science data is collected, uses specialized guide telescopes to point accurately at the Sun. Inertial mode has two sub-modes, one tracks a Sun-referenced target orientation, and another maintains an absolute (star-referenced) target orientation, that both employ a Kalman filter to

process data from a digital Sun sensor and two star trackers. However, this paper is concerned only with the other two modes: Safe Hold (SH) and Sun Acquisition (SA).
Author
Attitude Control; Solar Sensors; Reaction Wheels; Controllers; Helioseismology; Imaging Techniques

20080012722 AI Solutions, Inc., Lanham, MD, USA
Tracking and Data Relay Satellite (TDRS) Orbit Estimation Using an Extended Kalman Filter
Ward, Douglas T.; Dang, Ket D.; Slojkowski, Steve; Blizzard, Mike; Jenkins, Greg; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 9 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

Alternatives to the Tracking and Data Relay Satellite (TDRS) orbit estimation procedure were studied to develop a technique that both produces more reliable results and is more amenable to automation than the prior procedure. The Earth Observing System (EOS) Terra mission has TDRS ephemeris prediction 3(sigma) requirements of 75 meters in position and 5.5 millimeters per second in velocity over a 1.5-day prediction span. Meeting these requirements sometimes required reruns of the prior orbit determination (OD) process, with manual editing of tracking data to get an acceptable solution. After a study of the available alternatives, the Flight Dynamics Facility (FDF) began using the Real-Time Orbit Determination (RTOD(Registered TradeMark)) Kalman filter program for operational support of TDRSs in February 2007. This extended Kalman filter (EKF) is used for daily support, including within hours after most thrusting, to estimate the spacecraft position, velocity, and solar radiation coefficient of reflectivity (C(sub R)). The tracking data used are from the Bilateration Ranging Transponder System (BRTS), selected TDRS System (TDRSS) User satellite tracking data, and Telemetry, Tracking, and Command (TT&C) data. Degraded filter results right after maneuvers and some momentum unloads provided incentive for a hybrid OD technique. The results of combining EKF strengths with the Goddard Trajectory Determination System (GTDS) Differential Correction (DC) program batch-least-squares solutions, as recommended in a 2005 paper on the chain-bias technique, are also presented.
Author
Orbit Determination; Satellite Tracking; Spacecraft Tracking; Goddard Trajectory Determination System; Rangefinding; Satellite Orbits; TDR Satellites; Earth Observing System (EOS); Kalman Filters

20080012723 European Space Agency. European Space Operations Center, Darmstadt, Germany
Gaining Confidence in Navigating Rosetta at Mars Swing-By
Crammn, Ruediger; Budnik, Frank; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 9 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The Mars swing-by in the early morning of the 25th of February 2007 was one of the most critical events the Rosetta mission has experienced so far on its way to the comet Churyumov-Gerasimenko. The closest approach took place at a distance of only 250 km from the planet s surface. Missing the optimal target would have translated into considerable fuel cost. In order to achieve confidence in operating through this highly critical mission phase, a navigation analysis exercise was carried out beforehand. This paper describes the purpose and the chosen approach for this preparatory Flight Dynamics activity. It presents and discusses results of the analysis. Emphasis is put on the question of what is needed to simulate a valuable data set representative for operations. The results of the navigation analysis are compared with real data obtained during swing-by operations.
Author
Navigation; Rosetta Mission; Data Processing; Aerodynamics; Comets

20080012724 Virginia Polytechnic Inst. and State Univ., Blacksburg, VA, USA
Fuel-Optimal Trajectories in a Planet-Moon Environment Using Multiple Gravity Assists
Ross, Shane D.; Grover, Piyush; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 14 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

For low energy spacecraft trajectories such as multi-moon orbiters for the Jupiter system, multiple gravity assists by moons could be used in conjunction with ballistic capture to drastically decrease fuel usage. In this paper, we outline a procedure to obtain a family of zero-fuel multi-moon orbiter trajectories, using a family of Keplerian maps derived by the first

author previously. The maps capture well the dynamics of the full equations of motion; the phase space contains a connected chaotic zone where intersections between unstable resonant orbit manifolds provide the template for lanes of fast migration between orbits of different semimajor axes. Patched three body approach is used and the four body problem is broken down into two three-body problems, and the search space is considerably reduced by the use of properties of the Keplerian maps. We also introduce the notion of Switching Region where the perturbations due to the two perturbing moons are of comparable strength, and which separates the domains of applicability of the corresponding two Keplerian maps.
Author
Equations of Motion; Spacecraft Trajectories; Swingby Technique; Four Body Problem; Moon; Manifolds (Mathematics)

20080012725 Michigan Univ., MI, USA
Orbit Mechanics about Small Asteroids
Scheeres, D. J.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

Space missions to small solar system bodies must deal with multiple perturbations acting on the spacecraft. These include strong perturbations from the gravity field and solar tide, but for small bodies the most important perturbations may arise from solar radiation pressure (SRP) acting on the spacecraft. Previous research has generally investigated the effect of the gravity field, solar tide, and SRP acting on a spacecraft trajectory about an asteroid in isolation and has not considered their joint effect. In this paper a more general theoretical discussion of the joint effects of these forces is given.
Author
Asteroids; Spacecraft Trajectories; Perturbation; Gravitational Effects; Gravitational Fields; Solar Radiation

20080012726 Massachusetts Inst. of Tech., Cambridge, MA, USA
Multi-Objective Online Initialization of Spacecraft Formations
Jeffrey, Matthew; Breger, Louis; How, Jonathan P.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 12 pp.; In English; See also 20080012629; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

This paper extends a previously developed method for finding spacecraft initial conditions (ICs) that minimize the drift resulting from J2 disturbances while also minimizing the fuel required to attain those ICs. It generalizes the single spacecraft optimization to a formation-wide optimization valid for an arbitrary number of vehicles. Additionally, the desired locations of the spacecraft, separate from the starting location, can be specified, either with respect to a reference orbit, or relative to the other spacecraft in the formation. The three objectives (minimize drift, minimize fuel, and maintain a geometric template) are expressed as competing costs in a linear optimization, and are traded against one another through the use of scalar weights. By carefully selecting these weights and re-initializing the formation at regular intervals, a closed-loop, formation-wide control system is created. This control system can be used to reconfigure the formations on the fly, and creates fuel-efficient plans by placing the spacecraft in semi-invariant orbits. The overall approach is demonstrated through nonlinear simulations for two formations a GEO orbit, and an elliptical orbit.
Author
Formation Flying; On-Line Systems; Spacecraft Orbits; Simulation; Optimization; Linearity

20080012727 Atos Origin S.A., Labege, France
Detection of Orbital Debris Collision Risks for the Automated Transfer Vehicle
Peret, L.; Legendre, P.; Delavault, S.; Martin, T.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 10 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A02, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

In this paper, we present a general collision risk assessment method, which has been applied through numerical simulations to the Automated Transfer Vehicle (ATV) case. During ATV ascent towards the International Space Station, close approaches between the ATV and objects of the USSTRACOM catalog will be monitored through collision rosk assessment. Usually, collision risk assessment relies on an exclusion volume or a probability threshold method. Probability methods are more effective than exclusion volumes but require accurate covariance data. In this work, we propose to use a criterion defined by an adaptive exclusion area. This criterion does not require any probability calculation but is more effective than exclusion

volume methods as demonstrated by our numerical experiments. The results of these studies, when confirmed and finalized, will be used for the ATV operations.
Author
Automated Transfer Vehicle; Collisions; Detection; Risk; Space Debris; Criteria

20080012728 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Orbit Determination and Navigation of the Solar Terrestrial Relations Observatory (STEREO)
Mesarch, Michael; Robertson, Mika; Ottenstein, Neil; Nicholson, Ann; Nicholson, Mark; Ward, Douglas T.; Cosgrove, Jennifer; German, Darla; Hendry, Stephen; Shaw, James; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629; Original contains color illustrations
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This paper provides an overview of the required upgrades necessary for navigation of NASA's twin heliocentric science missions, Solar TErestrial RElations Observatory (STEREO) Ahead and Behind. The orbit determination of the STEREO spacecraft was provided by the NASA Goddard Space Flight Center's (GSFC) Flight Dynamics Facility (FDF) in support of the mission operations activities performed by the Johns Hopkins University Applied Physics Laboratory (APL). The changes to FDF s orbit determination software included modeling upgrades as well as modifications required to process the Deep Space Network X-band tracking data used for STEREO. Orbit results as well as comparisons to independently computed solutions are also included. The successful orbit determination support aided in maneuvering the STEREO spacecraft, launched on October 26, 2006 (00:52 Z), to target the lunar gravity assists required to place the spacecraft into their final heliocentric drift-away orbits where they are providing stereo imaging of the Sun.
Author
Navigation; Orbit Determination; STEREO (Observatory); Solar Observatories; Solar Orbits

20080012729 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Wessling, Germany
First In-Orbit Experience of TerraSAR-X Flight Dynamics Operations
Kahle, R.; Kazeminejad, B.; Kirschner, M.; Yoon, Y.; Kiehling, R.; D'Amico, S.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 11 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

TerraSAR-X is an advanced synthetic aperture radar satellite system for scientific and commercial applications that is realized in a public-private partnership between the German Aerospace Center (DLR) and the Astrium GmbH. TerraSAR-X was launched at June 15, 2007 on top of a Russian DNEPR-1 rocket into a 514 km sun-synchronous dusk-dawn orbit with an 11-day repeat cycle and will be operated for a period of at least 5 years during which it will provide high resolution SAR-data in the X-band. Due to the objectives of the interferometric campaigns the satellite has to comply to tight orbit control requirements, which are formulated in the form of a 250 m toroidal tube around a pre-flight determined reference trajectory (see [1] for details). The acquisition of the reference orbit was one of the main and key activities during the Launch and Early Orbit Phase (LEOP) and had to compensate for both injection errors and spacecraft safe mode attitude control thruster activities. The paper summarizes the activities of GSOC flight dynamics team during both LEOP and early Commissioning Phase, where the main tasks have been 1) the first-acquisition support via angle-tracking and GPS-based orbit determination, 2) maneuver planning for target orbit acquisition and maintenance, and 3) precise orbit and attitude determination for SAR processing support. Furthermore, a presentation on the achieved results and encountered problems will be addressed.
Author
Synthetic Aperture Radar; Spacecraft Control; Orbit Determination; Attitude Control; Aerodynamics; Satellite Orientation; Global Positioning System; Superhigh Frequencies

20080013221 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Space Technology 5 - A Successful Micro-Satellite Constellation Mission
Carlisle, Candace; Webb, Evan H.; [2007]; 7 pp.; In English; 21st Annual AIAA/USU Conference on Small Satellites, 13-16 Aug. 2007, Logan UT, USA; Original contains color illustrations
Report No.(s): SSC07-VII-6; No Copyright; Avail.: CASI: A02, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080013221

The Space Technology 5 (ST5) constellation of three micro-satellites was launched March 22, 2006. During the

three-month flight demonstration phase, the ST5 team validated key technologies that will make future low-cost micro-sat constellations possible, demonstrated operability concepts for future micro-sat science constellation missions, and demonstrated the utility of a micro-satellite constellation to perform research-quality science. The ST5 mission was successfully completed in June 2006, demonstrating high-quality science and technology validation results.
Author
Satellite Constellations; Aerospace Engineering; Small Satellite Technology; Research; Cost Analysis

20080013239 NASA Marshall Space Flight Center, Huntsville, AL, USA
Qualification Testing of Solid Rocket Booster Diagonal Strut Restraint Cable Assembly Part Number 10176-0031-102/103
Malone, T. W.; September 2006; 104 pp.; In English; Original contains color and black and white illustrations
Report No.(s): NASA/TM--2006-214603; M-1172; No Copyright; Avail.: CASI: A06, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080013239

This Technical Memorandum presents qualification test results for solid rocket booster diagonal strut restraint cable part number 101276-00313-102/103. During flight this assembly is exposed to a range of temperatures. MIL-W-83420 shows the breaking strength of the cable as 798 kg (1,760 lb) at room temperature but does not define cable strength at the maximum temperature to which the cable is exposed during the first 2 min of flight; 669 C (1,236 F). The cable, which can be built from different corrosion resistant steel alloys, may also vary in its chemical, physical, and mechanical properties at temperature. Negative margins of safety were produced by analysis of the cable at temperature using standard knockdown factors. However, MSFC-HDBK-5 allows the use of a less conservative safety factor of 1.4 and knockdown factors verified by testing. Test results allowed a calculated knockdown factor of 0.1892 to be determined for the restraint cables, which provides a minimum breaking strength of 151 kg (333 lb) at 677 C (1,250 F) when combined with the minimum breaking strength of 0.317-cm (0.125- or 1/8-in) diameter, type 1 composition rope.
Author
Booster Rocket Engines; Cables; Struts; Tensile Tests

20080013260 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Pumped Fluid Loop Heat Rejection and Recovery Systems for Thermal Control of the Mars Science Laboratory
Bhandari, Pradeep; Birur, Gajanana; Prina, Mauro; Ramirez, Brenda; Paris, Anthony; Novak, Keith; Pauken, Michael; March 16, 2006; 28 pp.; In English; 17th Spacecraft Thermal Control Workshop, 16 Mar. 2006, El Segundo, CA, USA; Original contains color illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40684

This viewgraph presentation reviews the heat rejection and heat recovery system for thermal control of the Mars Science Laboratory (MSL). The MSL mission will use mechanically pumped fluid loop based architecture for thermal control of the spacecraft and rover. The architecture is designed to harness waste heat from an Multi Mission Radioisotope Thermo-electric Generator (MMRTG) during Mars surface operations for thermal control during cold conditions and also reject heat during the cruise aspect of the mission. There are several test that are being conducted that will insure the safety of this concept. This architecture can be used during any future interplanetary missions utilizing radioisotope power systems for power generation.
CASI
Electric Generators; Temperature Control; Radioisotope Batteries; Thermoelectric Generators; Mars Roving Vehicles; Cooling Systems; Spacecraft Radiators

20080013271 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
A Channelized 2nd IF/LO Downconverter for the E0S Microwave Limb Sounder
LaBelle, Remi C.; October 9, 2003; 4 pp.; In English; IEEE European Microwave Conference, 6-10 Oct. 2003, Munich, Germany; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40703

The Earth Observing System (EOS) Microwave Limb Sounder (MLS) is scheduled for launch in 2004 on the EOS Aura spacecraft. The design, assembly and test of the flight 2nd Intermediate Frequency/ Local Oscillator (2nd IF/LO) subsystem for this instrument has been completed and is presented here. The 2nd IF/LO subsystem consists of 5 separate microwave assemblies, 1 for each of the 5 millimeter wave radiometer front ends, providing a total of 33 separate IF channels. Some key requirements of the subsystem are as follows: provide frequency multiplexing of overlapping or closely spaced 1st IF channels while maintaining low ripple in the passbands; generate 19 different 2nd LO frequencies, in the range of 4-20 GHz, with low

phase noise and a placement resolution of 400 KHz; downconvert the 1st IF's to a common 2nd IF frequency centered at 900 MHz; minimize cost and schedule by using common designs for the 5 different assemblies wherever possible.
Author
Microwave Sounding; Down-Converters; Intermediate Frequencies; Millimeter Waves; Aura Spacecraft; Multiplexing; Microwave Landing Systems; Earth Observing System (EOS)

19
SPACECRAFT INSTRUMENTATION AND ASTRIONICS

Includes the design, manufacture, or use of devices for the purpose of measuring, detecting, controlling, computing, recording, or processing data related to the operation of space vehicles or platforms. For related information see also *06 Avionics and Aircraft Instrumentation*; for spaceborne instruments not integral to the vehicle itself see *35 Instrumentation and Photography*; for spaceborne telescopes and other astronomical instruments see *89 Astronomy*.

20080012730 Johns Hopkins Univ., MD, USA
Attitude Sensor and Gyro Calibration for Messenger
O'Shaughnessy, Daniel; Pittelkau, Mark E.; Proceedings of the 20th International Symposium on Space Flight Dynamics; September 24, 2007; 15 pp.; In English; See also 20080012629; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

The Redundant Inertial Measurement Unit Attitude Determination/Calibration (RADICAL(TM)) filter was used to estimate star tracker and gyro calibration parameters using MESSENGER telemetry data from three calibration events. We present an overview of the MESSENGER attitude sensors and their configuration is given, the calibration maneuvers are described, the results are compared with previous calibrations, and variations and trends in the estimated calibration parameters are examined. The warm restart and covariance bump features of the RADICAL(TM) filter were used to estimate calibration parameters from two disjoint telemetry streams. Results show that the calibration parameters converge faster with much less transient variation during convergence than when the filter is cold-started at the start of each telemetry stream.
Author
Attitude (Inclination); Attitude Gyros; Attitude Indicators; Calibrating; Gyroscopes; Messenger (Spacecraft); Spacecraft Instruments; Navigation Instruments

20080013261 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Modular Avionics for the New Space Vision: The JPL Perspective
Bolotin, Gary S.; April 12, 2005; 21 pp.; In English; NASA Aerospace Technology Working Group, 12-14 Apr. 2005, Baltimore, MD, USA; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40660

This viewgraph presentation reviews the challenges and the development of modular avionics systems to be used during future space travel in accord with the new vision for space exploration.
CASI
Astrionics; Spacecraft Instruments; Modularity; Systems Engineering; Spacecraft Electronic Equipment

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SPACECRAFT PROPULSION AND POWER

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxiliary power sources. For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels, 15 Launch Vehicles and Launch Operations*, and *44 Energy Production and Conversion*.

20080012594 NASA Glenn Research Center, Cleveland, OH, USA
Proposed Facility Modifications to Support Propulsion Systems Testing Under Simulated Space Conditions at Plum Brook Station's Spacecraft Propulsion Research Facility (B-2)
Edwards, Daryl A.; September 10, 2007; 11 pp.; In English; Thermal and Fluid Analysis Workshop, TFAWS 20007, 10-14 Sept. 2007, Cleveland, OH, USA; Original contains color and black and white illustrations
Contract(s)/Grant(s): WBS 750271.09.04.03; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012594

Preparing NASA's Plum Brook Station's Spacecraft Propulsion Research Facility (B-2) to support NASA's new

generation of launch vehicles has raised many challenges for B-2 s support staff. The facility provides a unique capability to test chemical propulsion systems/vehicles while simulating space thermal and vacuum environments. Designed and constructed 4 decades ago to support upper stage cryogenic engine/vehicle system development, the Plum Brook Station B-2 facility will require modifications to support the larger, more powerful, and more advanced engine systems for the next generation of vehicles leaving earth's orbit. Engine design improvements over the years have included large area expansion ratio nozzles, greater combustion chamber pressures, and advanced materials. Consequently, it has become necessary to determine what facility changes are required and how the facility can be adapted to support varying customers and their specific test needs. Instrumental in this task is understanding the present facility capabilities and identifying what reasonable changes can be implemented. A variety of approaches and analytical tools are being employed to gain this understanding. This paper discusses some of the challenges in applying these tools to this project and expected facility configuration to support the varying customer needs.
Author
Research Facilities; Simulation; Spacecraft Propulsion; Engine Design; Launch Vehicles

20080012602 NASA Glenn Research Center, Cleveland, OH, USA
NEXT Ion Propulsion System Development Status and Capabilities
Patterson, Michael J.; Benson, Scott W.; January 2008; 16 pp.; In English; 2007 NASA Science Technology Conference (NSTC-07), 19-21 Jun. 2007, College Park, MD, USA; Original contains color illustrations
Contract(s)/Grant(s): WBS 346620.04.05.03.11
Report No.(s): NASA/TM-2008-214988; E-16147; Paper number D10P3; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012602

NASA s Evolutionary Xenon Thruster (NEXT) project is developing next generation ion propulsion technologies to provide future NASA science missions with enhanced mission performance benefit at a low total development cost. The objective of the NEXT project is to advance next generation ion propulsion technology by producing engineering model system components, validating these through qualification-level and integrated system testing, and ensuring preparedness for transitioning to flight system development. As NASA s Evolutionary Xenon Thruster technology program completes advanced development activities, it is advantageous to review the existing technology capabilities of the system under development. This paper describes the NEXT ion propulsion system development status, characteristics and performance. A review of mission analyses results conducted to date using the NEXT system is also provided.
Author
Ion Propulsion; Ion Engines; Systems Engineering; Systems Integration

20080012738 NASA Glenn Research Center, Cleveland, OH, USA
Environmental Testing of the NEXT PM1 Ion Engine
Synder, John S.; Anderson, John R.; VanNoord, Jonathan L.; Soulas, George C.; January 2008; 25 pp.; In English; 43rd AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, 8-11 Jul. 2007, Cincinnati, OH, USA; Original contains color illustrations
Report No.(s): NASA/TM-2008-215014; AIAA Paper 2007-5275; E-16186; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012738

The NEXT propulsion system is an advanced ion propulsion system presently under development that is oriented towards robotic exploration of the solar system using solar electric power. The Prototype Model engine PM1 was subjected to qualification-level environmental testing to demonstrate compatibility with environments representative of anticipated mission requirements. Random vibration testing, conducted with the thruster mated to the breadboard gimbal, was executed at 10.0 Grms for 2 minutes in each of three axes. Thermal-vacuum testing included a deep cold soak of the engine to temperatures of -168 C and thermal cycling from -120 to 203 C. Although the testing was largely successful, several issues were identified including the fragmentation of potting cement on the discharge and neutralizer cathode heater terminations during vibration which led to abbreviated thermal testing, and generation of particulate contamination from manufacturing processes and engine materials. Thruster performance was nominal throughout the test program, with minor variations in some engine operating parameters likely caused by facility effects. In general, the NEXT PM1 engine and the breadboard gimbal were found to be well-designed against environmental requirements based on the results reported herein. After resolution of the findings from this test program the hardware environmental qualification program can proceed with confidence.
Author
Engine Parts; Ion Engines; Thermal Cycling Tests; Systems Engineering; Performance Tests; Breadboard Models

20080012739 NASA Glenn Research Center, Cleveland, OH, USA

Performance Evaluation of the Prototype Model NEXT Ion Thruster

Herman, Daniel A.; Soulas, George C.; Patterson, Michael J.; February 2008; 25 pp.; In English; 43rd AIAA Joint Propulsion Conference and Exhibit, 8-11 Jul. 2007, Cincinnati, OH, USA; Original contains color illustrations

Contract(s)/Grant(s): GESS-2

Report No.(s): NASA/TM-2008-215029; AIAA Paper-2007-5212; E-16202; Copyright; Avail.: CASI: A03, Hardcopy

The performance testing results of the first prototype model NEXT ion engine, PM1, are presented. The NEXT program has developed the next generation ion propulsion system to enhance and enable Discovery, New Frontiers, and Flagship-type NASA missions. The PM1 thruster exhibits operational behavior consistent with its predecessors, the engineering model thrusters, with substantial mass savings, enhanced thermal margins, and design improvements for environmental testing compliance. The dry mass of PM1 is 12.7 kg. Modifications made in the thruster design have resulted in improved performance and operating margins, as anticipated. PM1 beginning-of-life performance satisfies all of the electric propulsion thruster mission-derived technical requirements. It demonstrates a wide range of throttleability by processing input power levels from 0.5 to 6.9 kW. At 6.9 kW, the PM1 thruster demonstrates specific impulse of 4190 s, 237 mN of thrust, and a thrust efficiency of 0.71. The flat beam profile, flatness parameters vary from 0.66 at low-power to 0.88 at full-power, and advanced ion optics reduce localized accelerator grid erosion and increases margins for electron backstreaming, impingement-limited voltage, and screen grid ion transparency. The thruster throughput capability is predicted to exceed 750 kg of xenon, an equivalent of 36,500 hr of continuous operation at the full-power operating condition.

Author

Ion Engines; Performance Tests; Specific Impulse; Ion Propulsion; Ion Optics; Electric Propulsion; Electric Potential; Thrust

20080012741 NASA Glenn Research Center, Cleveland, OH, USA

NEXT Ion Thruster Performance Dispersion Analyses

Soulas, George C.; Patterson, Michael J.; January 2008; 20 pp.; In English; 43rd AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, 8-11 Jul. 2007, Cincinnati, OH, USA; Original contains color illustrations

Contract(s)/Grant(s): WBS 346620.04.05.03.11

Report No.(s): NASA/TM-2008-215013; AIAA Paper 2007-5213; E-16185; No Copyright; Avail.: CASI: A03, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080012741

The NEXT ion thruster is a low specific mass, high performance thruster with a nominal throttling range of 0.5 to 7 kW. Numerous engineering model and one prototype model thrusters have been manufactured and tested. Of significant importance to propulsion system performance is thruster-to-thruster performance dispersions. This type of information can provide a bandwidth of expected performance variations both on a thruster and a component level. Knowledge of these dispersions can be used to more conservatively predict thruster service life capability and thruster performance for mission planning, facilitate future thruster performance comparisons, and verify power processor capabilities are compatible with the thruster design. This study compiles the test results of five engineering model thrusters and one flight-like thruster to determine unit-to-unit dispersions in thruster performance. Component level performance dispersion analyses will include discharge chamber voltages, currents, and losses; accelerator currents, electron backstreaming limits, and perveance limits; and neutralizer keeper and coupling voltages and the spot-to-plume mode transition flow rates. Thruster level performance dispersion analyses will include thrust efficiency.

Author

Ion Engines; Propulsion System Performance; Electric Potential; Transition Flow; Rocket Engines; Flow Velocity; Component Reliability

20080012743 NASA Glenn Research Center, Cleveland, OH, USA

Status of the NEXT Ion Thruster Long-Duration Test After 10,100 hr and 207 kg Demonstrated

Herman, Daniel A.; Soulas, George C.; Patterson, Michael J.; February 2008; 49 pp.; In English; 43rd AIAA Joint Propulsion Conference and Exhibit, 8-11 Jul. 2007, Cincinnati, OH, USA; Original contains color and black and white illustrations

Contract(s)/Grant(s): GESS-2; WBS 346620.04.05.03.13

Report No.(s): NASA/TM-2008-215030; AIAA Paper-2007-5272; E-16203; Copyright; Avail.: CASI: A03, Hardcopy

The NASA s Evolutionary Xenon Thruster (NEXT) program is developing the next-generation ion propulsion system with significant enhancements beyond the state-of-the-art in ion propulsion to provide future NASA science missions with enhanced mission capabilities at a low total development cost. As part of a comprehensive thruster service life assessment utilizing both testing and analyses, a Long-Duration Test (LDT) was initiated to validate and qualify the NEXT propellant throughput capability to a qualification-level of 450 kg, 1.5 times the mission-derived throughput requirement of 300 kg. This

wear test is being conducted with a modified, flight-representative NEXT engineering model ion thruster, designated EM3. As of June 21, 2007, the thruster has accumulated 10,100 hr of operation at the thruster full-input-power of 6.9 kW with 3.52 A beam current and 1800 V beam power supply voltage. The thruster has processed 207 kg of xenon and demonstrated a total impulse of 8.5 106 N-s; the highest total impulse ever demonstrated by an ion thruster in the history of space propulsion. Thruster performance tests are conducted periodically over the entire NEXT throttle table with input power ranging 0.5 to 6.9 kW. Overall ion thruster performance parameters including thrust, input power, specific impulse, and thruster efficiency have been nominal with little variation to date. Lifetime-limiting component erosion rates have been consistent with the NEXT service life assessment, which predicts the earliest failure sometime after 750 kg of xenon propellant throughput; well beyond the mission-derived lifetime requirement. The NEXT wear test data confirm that the erosion of the discharge keeper orifice, enlarging of nominal-current-density accelerator grid aperture cusps, and the decrease in cold grid-gap observed during the NSTAR Extended Life Test have been mitigated. This paper presents the status of the NEXT LDT to date.
Author
Ion Engines; Ion Propulsion; Specific Impulse; Electric Potential; Performance Tests; Power Efficiency; Total Impulse

20080013148 NASA Glenn Research Center, Cleveland, OH, USA
NASA Engineering Safety Center NASA Aerospace Flight Battery Systems Working Group 2007 Proactive Task Status
Manzo, Michelle A.; November 27, 2007; 16 pp.; In English; NASA Aerospace Battery Workshop, 27-29 Nov. 2007, Huntsville, AL, USA
Contract(s)/Grant(s): WBS 510505.04.03.01.09; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080013148

In 2007, the NASA Engineering Safety Center (NESC) chartered the NASA Aerospace Flight Battery Systems Working Group to bring forth and address critical battery-related performance/manufacturing issues for NASA and the aerospace community. A suite of tasks identifying and addressing issues related to Ni-H2 and Li-ion battery chemistries was submitted and selected for implementation. The current NESC funded are: (1) Wet Life of Ni-H2 Batteries (2) Binding Procurement (3) NASA Lithium-Ion Battery Guidelines (3a) Li-Ion Performance Assessment (3b) Li-Ion Guidelines Document (3b-i) Assessment of Applicability of Pouch Cells for Aerospace Missions (3b-ii) High Voltage Risk Assessment (3b-iii) Safe Charge Rates for Li-Ion Cells (4) Availability of Source Material for Li-Ion Cells (5) NASA Aerospace Battery Workshop This presentation provides a brief overview of the tasks in the 2007 plan and serves as an introduction to more detailed discussions on each of the specific tasks.
Author
Lithium Batteries; Storage Batteries; Nickel Hydrogen Batteries; Spacecraft Power Supplies

20080013225 NASA Glenn Research Center, Cleveland, OH, USA
Environmental Testing of the NEXT PM1R Ion Engine
Snyder, John S.; Anderson, John R.; VanNoord, Jonathan L.; Soulas, George C.; [2007]; 28 pp.; In English; 30th International Electric Propulsion Conference (IEPC 2007), 17-20 Sep. 2007, Florence, Italy; Original contains color illustrations
Contract(s)/Grant(s): WBS 346620.04.05.03.11
Report No.(s): NASA/TM-2008-215058; IEPC-2007-276; E-16280; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080013225

The NEXT propulsion system is an advanced ion propulsion system presently under development that is oriented towards robotic exploration of the solar system using solar electric power. The subsystem includes an ion engine, power processing unit, feed system components, and thruster gimbal. The Prototype Model engine PM1 was subjected to qualification-level environmental testing in 2006 to demonstrate compatibility with environments representative of anticipated mission requirements. Although the testing was largely successful, several issues were identified including the fragmentation of potting cement on the discharge and neutralizer cathode heater terminations during vibration which led to abbreviated thermal testing, and generation of particulate contamination from manufacturing processes and engine materials. The engine was reworked to address most of these findings, renamed PM1R, and the environmental test sequence was repeated. Thruster functional testing was performed before and after the vibration and thermal-vacuum tests. Random vibration testing, conducted with the thruster mated to the breadboard gimbal, was executed at 10.0 Grms for 2 min in each of three axes. Thermal-vacuum testing included three thermal cycles from 120 to 215 C with hot engine re-starts. Thruster performance was nominal throughout the test program, with minor variations in a few engine operating parameters likely caused by facility effects. There were no significant changes in engine performance as characterized by engine operating parameters, ion optics performance measurements, and beam current density measurements, indicating no significant changes to the hardware as a result of the environmental testing. The NEXT PM1R engine and the breadboard gimbal were found to be well-designed against environmental requirements

based on the results reported herein. The redesigned cathode heater terminations successfully survived the vibration environments. Based on the results of this test program and confidence in the engineering solutions available for the remaining findings of the first test program, specifically the particulate contamination, the hardware environmental qualification program can proceed with confidence
Author
Environmental Tests; Ion Engines; Ion Propulsion; Prototypes; Systems Engineering; Solar Electric Propulsion

20080013229 NASA Glenn Research Center, Cleveland, OH, USA
System Concepts for Affordable Fission Surface Power
Mason, Lee; Poston, David; Qualls, Louis; January 2008; 18 pp.; In English; Space Technology and Applications International Forum (STAIF 2008), 10-14 Feb. 2008, Albuquerque, NM, USA; Original contains color and black and white illustrations
Contract(s)/Grant(s): WBS 463169.02.03.01.01
Report No.(s): NASA/TM-2008-215166; E-16409; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080013229

This paper presents an overview of an affordable Fission Surface Power (FSP) system that could be used for NASA applications on the Moon and Mars. The proposed FSP system uses a low temperature, uranium dioxide-fueled, liquid metal-cooled fission reactor coupled to free-piston Stirling converters. The concept was determined by a 12 month NASA/DOE study that examined design options and development strategies based on affordability and risk. The system is considered a low development risk based on the use of terrestrial-derived reactor technology, high efficiency power conversion, and conventional materials. The low-risk approach was selected over other options that could offer higher performance and/or lower mass.
Author
Fission; Space Power Reactors; Systems Engineering; Cost Analysis; Reactor Technology; Lunar Exploration; Mars Exploration

20080013338 NASA Marshall Space Flight Center, Huntsville, AL, USA
An Exploration Perspective of Beamed Energy Propulsion
Cole, John W.; November 12, 2007; 33 pp.; 5th International Symposium on Beamed Energy Propulsion, 12-15 Nov. 2007, Kailua-Kona, HI, USA; Original contains color and black and white illustrations; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080013338

The Vision for Exploration is currently focused on flying the Space Shuttle safely to complete our Space Station obligations, retiring the Shuttle in 2010, then returning humans to the Moon and learning how to proceed to Mars and beyond. The NASA budget still includes funds for science and aeronautics but the primary focus is on human exploration. Fiscal constraints have led to pursuing exploration vehicles that use heritage hardware, particularly existing boosters and engines, with the minimum modifications necessary to satisfy mission requirements. So, pursuit of immature technologies is not currently affordable by NASA. Beamed energy is one example of an immature technology, from a human exploration perspective, that may eventually provide significant benefits for human exploration of space, but likely not in the near future. Looking to the more distant future, this paper will examine some of the criteria that must be achieved by beamed energy propulsion to eventually contribute to human exploration of the solar system. The analysis focuses on some of the implications of increasing the payload fraction of a launch vehicle, with a quick look at trans-lunar injection. As one would expect, there is potential for benefit, and there are concerns. The analysis concludes with an assessment of the Technology Readiness Level (TRL) for some beamed energy propulsion components, indicating that TRL 2 is close to being completed.
Author
Energy Technology; Launch Vehicles; Spacecraft Propulsion; Space Exploration; Power Beaming; Space Shuttles

20080013340 NASA Marshall Space Flight Center, Huntsville, AL, USA
Propulsion Technology Needs for Exploration
Brown, Thomas; November 14, 2007; 2 pp.; In English; ESMD Technology Exchange Conference, 14-15 Nov. 2007, Galveston, TX, USA; No Copyright; Avail.: Other Sources; Abstract Only

The objectives of currently planned exploration efforts, as well as those further in the future, require significant advancements in propulsion technologies. The current Lunar exploration architecture has set goals and mission objectives that

necessitate the use of new systems and the extension of existing technologies beyond present applications. In the near term, the majority of these technologies are the result of a need to apply high performing cryogenic propulsion systems to long duration in-space applications. Advancement of cryogenic propulsion to these applications is crucial to provide higher performing propulsion systems that reduce the vehicle masses; enhance the safety of vehicle systems and ground operations; and provide a path for In-situ Resource Utilization (ISRU).Use of a LOX/LH2 main propulsion system for Lunar Lander Descent is a top priority because more conventional storable propellants are far from meeting the performance needs of the current architecture. While LOX/LH2 pump feed engines have been used in flight applications for many years, these engines have limited throttle capabilities. Engines that are capable of much greater throttling while still meeting high performance goals are a necessity to achieving exploration goals. Applications of LOX/CH4 propulsion to Lander ascent propulsion systems and reaction control systems are also if interest because of desirable performance and operations improvements over conventional storable systems while being more suitable for use of in-situ produced propellants. Within the current lunar architecture, use of cryogenic propulsion for the Earth Departure Stage and Lunar Lander elements also necessitate the need for advanced Cryogenic Fluid Management technologies. These technologies include long duration propellant storage/ distribution, low-gravity propellant management, cryogenic couplings and disconnects, light weight composite tanks and support structure, and subsystem integration. In addition to the propulsive and fluid management system technologies described, many component level technologies are also required to enable to the success if the integrated systems. The components include, but are not limited to, variable/throttling valves, variable position actuators, leak detectors, light weight cryogenic fluid pumps, sensor technology and others. NASA, partnering with the Aerospace Industry must endeavor to develop these, and other promising propulsion technologies, to enable the implements of the country's goals in exploration of the Moon, Mars and beyond.

Author

Composite Structures; Cryogenic Rocket Propellants; Propulsion System Configurations; Hydrogen Oxygen Engines; Ascent Propulsion Systems

23
CHEMISTRY AND MATERIALS (GENERAL)

Includes general research topics related to the composition, properties, structure, and use of chemical compounds and materials as they relate to aircraft, launch vehicles, and spacecraft. For specific topics in chemistry and materials see *categories 25 through 29*. For astrochemistry see category *90 Astrophysics*.

20080012735 NASA Glenn Research Center, Cleveland, OH, USA

High Temperature Protonic Conductors

Dynys, Fred; Berger, Marie-Helen; Sayir, Ali; September 16, 2007; 29 pp.; In English; Materials Science and Technology Meeting, 16-20 Sep. 2007, Detroit, MI, USA; Original contains color and black and white illustrations

Contract(s)/Grant(s): FA8655-03-1-3040; WBS 561581.02.08.03.15.02; Copyright; Avail.: CASI: A03, Hardcopy

High Temperature Protonic Conductors (HTPC) with the perovskite structure are envisioned for electrochemical membrane applications such as H2 separation, H2 sensors and fuel cells. Successive membrane commercialization is dependent upon addressing issues with H2 permeation rate and environmental stability with CO2 and H2O. HTPC membranes are conventionally fabricated by solid-state sintering. Grain boundaries and the presence of intergranular second phases reduce the proton mobility by orders of magnitude than the bulk crystalline grain. To enhanced protonic mobility, alternative processing routes were evaluated. A laser melt modulation (LMM) process was utilized to fabricate bulk samples, while pulsed laser deposition (PLD) was utilized to fabricate thin film membranes . Sr3Ca(1+x)Nb(2-x)O9 and SrCe(1-x)Y(x)O3 bulk samples were fabricated by LMM. Thin film BaCe(0.85)Y(0.15)O3 membranes were fabricated by PLD on porous substrates. Electron microscopy with chemical mapping was done to characterize the resultant microstructures. High temperature protonic conduction was measured by impedance spectroscopy in wet air or H2 environments. The results demonstrate the advantage of thin film membranes to thick membranes but also reveal the negative impact of defects or nanoscale domains on protonic conductivity.

Author

High Temperature; Protons; Membranes; Pulsed Laser Deposition; Perovskites; Fuel Cells; Hydrogen

24
COMPOSITE MATERIALS

Includes physical, chemical, and mechanical properties of laminates and other composite materials.

20080012448 National Inst. of Aerospace, Hampton, VA, USA; NASA Langley Research Center, Hampton, VA, USA
Thermal Conductivity of Ethylene Vinyl Acetate Copolymer/Nanofiller Blends
Ghose, S.; Watson, K. A.; Working, D. C.; Connell, J. W.; Smith, J. G., Jr.; Lin, Y.; Sun, Y. P.; October 2007; 35 pp.; In English; Original contains color and black and white illustrations; Copyright; Avail.: CASI: A03, Hardcopy

To reduce weight and increase the mobility, comfort, and performance of future spacesuits, flexible, thermally conductive fabrics and plastic tubes are needed for the Liquid Cooling and Ventilation Garment. Such improvements would allow astronauts to operate more efficiently and safely for extended extravehicular activities. As an approach to raise the thermal conductivity (TC) of an ethylene vinyl acetate copolymer (Elvax 260), it was compounded with three types of carbon based nanofillers: multi-walled carbon nanotubes (MWCNTs), vapor grown carbon nanofibers (CNFs), and expanded graphite (EG). In addition, other nanofillers including metallized CNFs, nickel nanostrands, boron nitride, and powdered aluminum were also compounded with Elvax 260 in the melt at various loading levels. In an attempt to improve compatibility between Elvax 260 and the nanofillers, MWCNTs and EG were modified by surface coating and through noncovalent and covalent attachment of organic molecules containing alkyl groups. Ribbons of the nanocomposites were extruded to form samples in which the nanofillers were aligned in the direction of flow. Samples were also fabricated by compression molding to yield nanocomposites in which the nanofillers were randomly oriented. Mechanical properties of the aligned samples were determined by tensile testing while the degree of dispersion and alignment of nanoparticles were investigated using high-resolution scanning electron microscopy. TC measurements were performed using a laser flash (Nanoflash) technique. TC of the samples was measured in the direction of, and perpendicular to, the alignment direction. Additionally, tubing was also extruded from select nanocomposite compositions and the TC and mechanical flexibility measured.
Author
Acetates; Ethylene; Mechanical Properties; Thermal Conductivity; Vinyl Copolymers; Nanotechnology; Composite Materials; Fillers

20080012449 Ohio Aerospace Inst., Brook Park, OH, USA
Determination of the Shear Stress Distribution in a Laminate from the Applied Shear Resultant--A Simplified Shear Solution
Bednarcyk, Brett A.; Aboudi, Jacob; Yarrington, Phillip W.; December 2007; 34 pp.; In English; Original contains color and black and white illustrations
Contract(s)/Grant(s): NCC06ZA29A
Report No.(s): NASA/CR-2007-215022; E-16226; Copyright; Avail.: CASI: A03, Hardcopy

The simplified shear solution method is presented for approximating the through-thickness shear stress distribution within a composite laminate based on laminated beam theory. The method does not consider the solution of a particular boundary value problem, rather it requires only knowledge of the global shear loading, geometry, and material properties of the laminate or panel. It is thus analogous to lamination theory in that ply level stresses can be efficiently determined from global load resultants (as determined, for instance, by finite element analysis) at a given location in a structure and used to evaluate the margin of safety on a ply by ply basis. The simplified shear solution stress distribution is zero at free surfaces, continuous at ply boundaries, and integrates to the applied shear load. Comparisons to existing theories are made for a variety of laminates, and design examples are provided illustrating the use of the method for determining through-thickness shear stress margins in several types of composite panels and in the context of a finite element structural analysis.
Author
Laminates; Shear Stress; Stress Distribution; Structural Analysis; Stress Analysis; Mechanical Properties

20080012610 NASA Glenn Research Center, Cleveland, OH, USA
Oxidation of C/SiC Composites at Reduced Oxygen Partial Pressures
Opila, E. J.; Serra, J. L.; [2007]; 13 pp.; In English; 32nd Annual Conference on Composites, Materials and Structures, 27 Jan. - 1 Feb. 2008, Daytona Beach, FL, USA; Original contains black and white illustrations
Contract(s)/Grant(s): WBS 599489.02.07.03.02.04.01; Copyright; Avail.: CASI: A03, Hardcopy

T-300 carbon fibers and T-300 carbon fiber reinforced silicon carbide composites (C/SiC) were oxidized in flowing reduced oxygen partial pressure environments at a total pressure of one atmosphere (0.5 atm O2, 0.05 atm O2 and 0.005 atm

O2, balance argon). Experiments were conducted at four temperatures (816deg, 1149deg, 1343deg, and 1538 C). The oxidation kinetics were monitored using thermogravimetric analysis. T-300 fibers were oxidized to completion for times between 0.6 and 90 h. Results indicated that fiber oxidation kinetics were gas phase diffusion controlled. Oxidation rates had an oxygen partial pressure dependence with a power law exponent close to one. In addition, oxidation rates were only weakly dependent on temperature. The C/SiC coupon oxidation kinetics showed some variability, attributed to differences in the number and width of cracks in the SiC seal coat. In general, weight losses were observed indicating oxidation of the carbon fibers dominated the oxidation behavior. Low temperatures and high oxygen pressures resulted in the most rapid consumption of the carbon fibers. At higher temperatures, the lower oxidation rates were primarily attributed to crack closure due to SiC thermal expansion, rather than oxidation of SiC since these reduced rates were observed even at the lowest oxygen partial pressures where SiC oxidation is minimal.
Author
Carbon Fibers; Fiber Composites; Silicon Carbides; Reaction Kinetics; Oxidation; Thermal Expansion; Vapor Phases; Diffusion

20080013166 NASA Marshall Space Flight Center, Huntsville, AL, USA
Polymer-Ceramic Composite Materials for Pyroelectric Infrared Detectors: An Overview
Aggarwal, M. D>; Currie, J. R.; Penn, B. G.; Batra, A. K.; Lal, R. B.; December 2007; 60 pp.; In English; Original contains black and white illustrations
Contract(s)/Grant(s): NNG066C58A; DASG60-03-1-0003; W9113M-05-1-0011; HRD-0236525; HRD-0531183; WPAFB-2-327-14-3381
Report No.(s): NASA/TM-2007-215190; M-1214; Copyright; Avail.: CASI: A04, Hardcopy

Ferroelectrics:Polymer composites can be considered an established substitute for conventional electroceramics and ferroelectric polymers. The composites have a unique blend of polymeric properties such as mechanical flexibility, high strength, formability, and low cost, with the high electro-active properties of ceramic materials. They have attracted considerable interest because of their potential use in pyroelectric infrared detecting devices and piezoelectric transducers. These flexible sensors and transducers may eventually be useful for their health monitoring applications for NASA crew launch vehicles and crew exploration vehicles being developed. In the light of many technologically important applications in this field, it is worthwhile to present an overview of the pyroelectric infrared detector theory, models to predict dielectric behavior and pyroelectric coefficient, and the concept of connectivity and fabrication techniques of biphasic composites. An elaborate review of Pyroelectric-Polymer composite materials investigated to date for their potential use in pyroelectric infrared detectors is presented.
Author
Composite Materials; Infrared Detectors; Pyroelectricity; General Overviews; Fabrication; Polymer Blends

20080013213 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
An Improved Thermal Conductivity Polyurethane Composite for a Space Borne 20KV Power Supply
Shapiro, Andrew A.; Haque, Inam; March 2005; 9 pp.; In English; IEEE Aerospace Conference, 4-12 Mar. 2005, Big Sky, MT, USA; Original contains black and white illustrations
Report No.(s): IEEEAC Paper-1433; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40649

This effort was designed to find a way to reduce the temperature rise of critical components of a 20KV High Voltage Power Supply (HVPS) by improving the overall thermal conductivity of the encapsulated modules. Three strategies were evaluated by developing complete procedures, preparing samples, and performing tests. The three strategies were: 1. Improve the thermal conductivity of the polyurethane encapsulant through the addition of thermally conductive powder while minimizing impact on other characteristics of the encapsulant. 2. Improve the thermal conductivity of the polyurethane encapsulated assembly by the addition of a slab of thermally conductive, electrically insulating material, which is to act as a heat spreader. 3. Employ a more thermally conductive substrate (Al203) with the existing encapsulation scheme. The materials were chosen based on the following criteria: high dielectric breakdown strength; high thermal conductivity, ease of manufacturing, high compliance, and other standard space qualified materials properties (low out-gassing, etc.). An optimized cure was determined by a statistical design of experiments for both filled and unfilled materials. The materials were characterized for the desired properties and a complete process was developed and tested. The thermal performance was substantially improved and the strategies may be used for space flight.
Author
Polyurethane Resins; Thermal Conductivity; Temperature Effects; Spacecraft Construction Materials; High Strength; Dielectric Properties

20080013315 ATK Launch Systems, Brigham City, UT, USA

Comparisons of NDT Methods to Inspect Cork and Cork filled Epoxy Bands

Lingbloom, Mike; November 12, 2007; 30 pp.; In English; ASNT Fall Meeting, 12-16 Nov. 2007, Las Vegas,NV, USA; Original contains color illustrations

Contract(s)/Grant(s): NAS8-97238; Copyright; Avail.: CASI: A03, Hardcopy

Sheet cork and cork filled epoxy provide external insulation for the Reusable Solid Rocket Motor (RSRM) on the Nation's Space Transportation System (STS). Interest in the reliability of the external insulation bonds has increased since the Columbia incident. A non-destructive test (NDT) method that will provide the best inspection for these bonds has been under evaluation. Electronic Shearography has been selected as the primary NDT method for inspection of these bond lines in the RSRM production flow. ATK Launch Systems Group has purchased an electronic shearography system that includes a vacuum chamber that is used for evaluation of test parts and custom vacuum windows for inspection of full-scale motors. Although the electronic shearography technology has been selected as the primary method for inspection of the external bonds, other technologies that exist continue to be investigated. The NASA/Marshall Space Flight Center (MSFC) NDT department has inspected several samples for comparison with electronic shearography with various inspections systems in their laboratory. The systems that were evaluated are X-ray backscatter, terahertz imaging, and microwave imaging. The samples tested have some programmed flaws as well as some flaws that occurred naturally during the sample making process. These samples provide sufficient flaw variation for the evaluation of the different inspection systems. This paper will describe and compare the basic functionality, test method and test results including dissection for each inspection technology.

Author

Nondestructive Tests; Epoxy Resins; Inspection; Cork (Materials); Filling; Technology Utilization

20080013318 NASA Marshall Space Flight Center, Huntsville, AL, USA

Neural Network Burst Pressure Prediction in Composite Overwrapped Pressure Vessels

Hill, Eric v. K.; Dion, Seth-Andrew T.; Karl, Justin O.; Spivey, Nicholas S.; Walker, James L., II; October 29, 2007; 6 pp.; In English; The Fifth International Conference on Acoustic Emission, 29 Oct. - 2 Nov. 2007, Lake Tahoe, NV, USA; Original contains black and white illustrations; Copyright; Avail.: CASI: A02, Hardcopy

Acoustic emission data were collected during the hydroburst testing of eleven 15 inch diameter filament wound composite overwrapped pressure vessels. A neural network burst pressure prediction was generated from the resulting AE amplitude data. The bottles shared commonality of graphite fiber, epoxy resin, and cure time. Individual bottles varied by cure mode (rotisserie versus static oven curing), types of inflicted damage, temperature of the pressurant, and pressurization scheme. Three categorical variables were selected to represent undamaged bottles, impact damaged bottles, and bottles with lacerated hoop fibers. This categorization along with the removal of the AE data from the disbonding noise between the aluminum liner and the composite overwrap allowed the prediction of burst pressures in all three sets of bottles using a single backpropagation neural network. Here the worst case error was 3.38 percent.

Author

Acoustic Emission; Backpropagation (Artificial Intelligence); Pressure Vessels; Graphite-Epoxy Composites; Neural Nets; Nondestructive Tests; Composite Wrapping

20080013358 NASA Glenn Research Center, Cleveland, OH, USA

Full-field Strain Methods for Investigating Failure Mechanisms in Triaxial Braided Composites

Littell, Justin D.; Binienda, Wieslaw K.; Goldberg, Robert K.; Roberts, Gary D.; March 03, 2008; 12 pp.; In English; Earth and Space Annual Conference, 3-5 Mar. 2008, Long Beach, CA, USA; Original contains black and white illustrations

Contract(s)/Grant(s): NNX07AK57H; WBS 877868.02.07.03.05.03; Copyright; Avail.: CASI: A03, Hardcopy

Composite materials made with triaxial braid architecture and large tow size carbon fibers are beginning to be used in many applications, including composite aircraft and engine structures. Recent advancements in braiding technology have led to commercially viable manufacturing approaches for making large structures with complex shape. Although the large unit cell size of these materials is an advantage for manufacturing efficiency, the fiber architecture presents some challenges for materials characterization, design, and analysis. In some cases, the static load capability of structures made using these materials has been higher than expected based on material strength properties measured using standard coupon tests. A potential problem with using standard tests methods for these materials is that the unit cell size can be an unacceptably large fraction of the specimen dimensions. More detailed investigation of deformation and failure processes in large unit cell size triaxial braid composites is needed to evaluate the applicability of standard test methods for these materials and to develop alternative testing approaches. In recent years, commercial equipment has become available that enables digital image correlation to be used on a more routine basis for investigation of full field 3D deformation in materials and structures. In this

paper, some new techniques that have been developed to investigate local deformation and failure using digital image correlation techniques are presented. The methods were used to measure both local and global strains during standard straight-sided coupon tensile tests on composite materials made with 12 and 24 k yarns and a 0/+60/-60 triaxial braid architecture. Local deformation and failure within fiber bundles was observed, and this local failure had a significant effect on global stiffness and strength. The matrix material had a large effect on local damage initiation for the two matrix materials used in this investigation. Premature failure in regions of the unit cell near the edge of the straight-sided specimens was observed for transverse tensile tests in which the braid axial fibers were perpendicular to the specimen axis and the bias fibers terminated on the cut edges in the specimen gage section. This edge effect is one factor that could contribute to a measured strength that is lower than the actual material strength in a structure without edge effects.
Author
Braided Composites; Matrix Materials; Structural Strain; Fabrication; Composite Materials; Structural Failure; Triaxial Stresses; Epoxy Resins

20080013360 NASA Langley Research Center, Hampton, VA, USA
Analysis of SMA Hybrid Composite Structures in MSC.Nastran and ABAQUS
Turner, Travis L.; Patel, Hemant D.; January 2005; 39 pp.; In English; Original contains color and black and white illustrations
Contract(s)/Grant(s): 23-762-55-MO; Copyright; Avail.: CASI: A03, Hardcopy

A thermoelastic constitutive model for shape memory alloy (SMA) actuators and SMA hybrid composite (SMAHC) structures was recently implemented in the commercial finite element codes MSC.Nastran and ABAQUS. The model may be easily implemented in any code that has the capability for analysis of laminated composite structures with temperature dependent material properties. The model is also relatively easy to use and requires input of only fundamental engineering properties. A brief description of the model is presented, followed by discussion of implementation and usage in the commercial codes. Results are presented from static and dynamic analysis of SMAHC beams of two types; a beam clamped at each end and a cantilever beam. Nonlinear static (post-buckling) and random response analyses are demonstrated for the first specimen. Static deflection (shape) control is demonstrated for the cantilever beam. Approaches for modeling SMAHC material systems with embedded SMA in ribbon and small round wire product forms are demonstrated and compared. The results from the commercial codes are compared to those from a research code as validation of the commercial implementations; excellent correlation is achieved in all cases.
Author
Composite Structures; Computer Programs; Finite Element Method; Mathematical Models; Shape Memory Alloys

25
INORGANIC, ORGANIC AND PHYSICAL CHEMISTRY

Includes the analysis, synthesis, and use of inorganic and organic compounds; combustion theory; electrochemistry; and photochemistry. For related information see category *34 Fluid Dynamics and Thermodynamics*. For astrochemistry see category *90 Astrophysics*.

20080013158 NASA Johnson Space Center, Houston, TX, USA
Identification of Unknown Contaminants in Water Samples from ISS Employing Liquid Chromatography/Mass Spectrometry/Mass Spectrometry
Rutz, Jeffrey A.; Schultz, John R.; [2008]; 7 pp.; In English; 38th International Conference on Environmental Systems, 29 Jun. - 2 Jul. 2008, San Francisco, CA, USA; Original contains black and white illustrations
Report No.(s): 08ICES-0135; Copyright; Avail.: CASI: A02, Hardcopy

Mass Spectrometry/Mass Spectrometry (MS/MS) is a powerful technique for identifying unknown organic compounds. For non-volatile or thermally unstable unknowns dissolved in liquids, liquid chromatography/mass spectrometry/mass spectrometry (LC/MS/MS) is often the variety of MS/MS used for the identification. One type of LC/MS/MS that is rapidly becoming popular is time-of-flight (TOF) mass spectrometry. This technique is now in use at the Johnson Space Center for identification of unknown nonvolatile organics in water samples from the space program. An example of the successful identification of one unknown is reviewed in detail in this paper. The advantages of time-of-flight instrumentation are demonstrated through this example as well as the strategy employed in using time-of-flight data to identify unknowns.
Author
Contaminants; Liquid Chromatography; Mass Spectroscopy; Water Sampling; International Space Station

28
PROPELLANTS AND FUELS

Includes rocket propellants, igniters, and oxidizers; their storage and handling procedures; and aircraft fuels. For nuclear fuels see *73 Nuclear Physics*. For related information see also *07 Aircraft Propulsion and Power; 20 Spacecraft Propulsion and Power*; and *44 Energy Production and Conversion*.

20080013162 NASA Marshall Space Flight Center, Huntsville, AL, USA

Numerical Modeling of Propellant Boiloff in Cryogenic Storage Tank

Majumdar, A. K.; Steadman, T. E.; Maroney, J. L.; November 2007; 106 pp.; In English; Original contains color and black and white illustrations

Report No.(s): NASA/TM-2007-215131; M-1206; Copyright; Avail.: CASI: A06, Hardcopy

This Technical Memorandum (TM) describes the thermal modeling effort undertaken at Marshall Space Flight Center to support the Cryogenic Test Laboratory at Kennedy Space Center (KSC) for a study of insulation materials for cryogenic tanks in order to reduce propellant boiloff during long-term storage. The Generalized Fluid System Simulation program has been used to model boiloff in 1,000-L demonstration tanks built for testing the thermal performance of glass bubbles and perlite insulation. Numerical predictions of boiloff rate and ullage temperature have been compared with the measured data from the testing of demonstration tanks. A satisfactory comparison between measured and predicted data has been observed for both liquid nitrogen and hydrogen tests. Based on the experience gained with the modeling of the demonstration tanks, a numerical model of the liquid hydrogen storage tank at launch complex 39 at KSC was built. The predicted boiloff rate of hydrogen has been found to be in good agreement with observed field data. This TM describes three different models that have been developed during this period of study (March 2005 to June 2006), comparisons with test data, and results of parametric studies. Author

Mathematical Models; Cryogenics; Propellants; Storage Tanks; Cryogenic Fluid Storage

20080013359 NASA Glenn Research Center, Cleveland, OH, USA

Electrochemical Energy Storage and Power Sources for NASA Exploration Missions

Baldwin, Richard S.; August 23, 2007; 18 pp.; In English; 10th Electrochemical Power Sources R&D Symposium, 23-24 Aug. 2007, Williamsburg, VA, USA; Original contains color and black and white illustrations

Contract(s)/Grant(s): WBS 038957.04.01.02.03.01; No Copyright; Avail.: CASI: A03, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080013359

An overview of NASA s electrochemical energy storage programs for NASA Exploration missions is being presented at the 10th Electrochemical Power Sources R&D Symposium, which is being held in Williamsburg, VA on August 20-23, 2007. This public domain venue, which is sponsored by the U.S. Navy and held every two years, serves as a forum for the dissemination of research and development results related to electrochemical energy storage technology programs that are currently being supported and managed within governmental agencies. Technology areas of primary interest include batteries, fuel cells, and both overview and focused presentations on such are given by both governmental and contractual researchers. The forum also provides an opportunity to assess technology areas of mutual interest with respect to establishing collaborative and/or complementary programmatic interactions.

Author

Electrochemical Cells; Energy Sources; NASA Programs; General Overviews; Technology Utilization

32
COMMUNICATIONS AND RADAR

Includes radar; radio, wire, and optical communications; land and global communications; communications theory. For related information see also 04 Aircraft Communications and Navigation; and *17 Space Communications, Spacecraft Communications, Command and Tracking*; for search and rescue, see *03 Air Transportation and Safety*; and *16 Space Transportation and Safety*.

20080012445 American Inst. of Aeronautics and Astronautics, Reston, VA, USA

Our Strategic Space Shore: Opportunities in Near Space

Allen, Ned; Aerospace America; September 2007; ISSN 0740-722X; Volume 45, No. 9, pp. 26-30; In English; Original contains color illustrations; Copyright; Avail.: Other Sources

Many elements of out socioeconomic structures are dependent upon space-based assets. More than 4,000 satellites enable social, economic and logistic interactions, support spiritual enlightenment, entertain and relay current news. This space-based

infrastructure is subject to hacking, tampering, and jamming and possessing the means to disrupt or destroy these assets will be among the future's most threatening weapons. In recognition of this vulnerability, the Air Force's mission has been expanded to include cyberspace. Air Force strategists are now struggling to understand how to operationalize this new mission. In particular, the defensive militarization of near space, and its preemptive, political and technical limitations, are discussed. Derived from text

Satellites; Spacecraft Defense; Threat Evaluation

20080013366 NASA Langley Research Center, Hampton, VA, USA

The Novel Nonlinear Adaptive Doppler Shift Estimation Technique and the Coherent Doppler Lidar System Validation Lidar

Beyon, Jeffrey Y.; Koch, Grady J.; January 2006; 24 pp.; In English

Contract(s)/Grant(s): WBS 478643.02.05.04.05; Copyright; Avail.: CASI: A03, Hardcopy

The signal processing aspect of a 2-m wavelength coherent Doppler lidar system under development at NASA Langley Research Center in Virginia is investigated in this paper. The lidar system is named VALIDAR (validation lidar) and its signal processing program estimates and displays various wind parameters in real-time as data acquisition occurs. The goal is to improve the quality of the current estimates such as power, Doppler shift, wind speed, and wind direction, especially in low signal-to-noise-ratio (SNR) regime. A novel Nonlinear Adaptive Doppler Shift Estimation Technique (NADSET) is developed on such behalf and its performance is analyzed using the wind data acquired over a long period of time by VALIDAR. The quality of Doppler shift and power estimations by conventional Fourier-transform-based spectrum estimation methods deteriorates rapidly as SNR decreases. NADSET compensates such deterioration in the quality of wind parameter estimates by adaptively utilizing the statistics of Doppler shift estimate in a strong SNR range and identifying sporadic range bins where good Doppler shift estimates are found. The authenticity of NADSET is established by comparing the trend of wind parameters with and without NADSET applied to the long-period lidar return data.

Author

Doppler Effect; Doppler Radar; Nonlinearity; Optical Radar; Systems Engineering

33
ELECTRONICS AND ELECTRICAL ENGINEERING

Includes development, performance, and maintainability of electrical/electronic devices and components; related test equipment; and microelectronics and integrated circuitry. for related information see also *60 Computer Operations and Hardware*; and *76 Solid-State Physics*. For communications equipment and devices see *32 Communications and Radar*.

20080012478 NASA Johnson Space Center, Houston, TX, USA

Integrating the Gradient of the Thin Wire Kernel

Champagne, Nathan J.; Wilton, Donald R.; [2008]; 4 pp.; In English; 2008 IEEE AP-S International Symposium on Antennas and Propagation and USNC/URSI National Radio Science Meeting, 5-12 Jul. 2008, San Diego, CA, USA; Original contains black and white illustrations; Copyright; Avail.: CASI: A01, Hardcopy

A formulation for integrating the gradient of the thin wire kernel is presented. This approach employs a new expression for the gradient of the thin wire kernel derived from a recent technique for numerically evaluating the exact thin wire kernel. This approach should provide essentially arbitrary accuracy and may be used with higher-order elements and basis functions using the procedure described in [4].When the source and observation points are close, the potential integrals over wire segments involving the wire kernel are split into parts to handle the singular behavior of the integrand [1]. The singularity characteristics of the gradient of the wire kernel are different than those of the wire kernel, and the axial and radial components have different singularities. The characteristics of the gradient of the wire kernel are discussed in [2]. To evaluate the near electric and magnetic fields of a wire, the integration of the gradient of the wire kernel needs to be calculated over the source wire. Since the vector bases for current have constant direction on linear wire segments, these integrals reduce to integrals of the form

Derived from text

Gradients; Integrals; Wire; Kernel Functions; Magnetic Fields; Electric Fields

20080012552 NASA Glenn Research Center, Cleveland, OH, USA

Lithium-ion Battery Demonstration for the 2007 NASA Desert Research and Technology Studies (Desert RATS) Program

Bennett, William; Baldwin, Richard; November 27, 2007; 35 pp.; In English; 2007 NASA Aerospace Battery Workshop, 27-29 Nov. 2007, Huntsville, AL, USA; Original contains color and black and white illustrations

Contract(s)/Grant(s): WBS 038957.04.07.02.01.03; Copyright; Avail.: CASI: A03, Hardcopy

The NASA Glenn Research Center (GRC) Electrochemistry Branch designed and produced five lithium-ion battery packs for demonstration in a portable life support system (PLSS) on spacesuit simulators. The experimental batteries incorporated advanced, NASA-developed electrolytes and included internal protection against over-current, over-discharge and over-temperature. The 500-gram batteries were designed to deliver a constant power of 38 watts over 103 minutes of discharge time (130 Wh/kg). Battery design details are described and field and laboratory test results are summarized.

Author

Electric Batteries; Lithium; Metal Ions; Portable Life Support Systems; Electrochemistry; Field Tests; Space Suits

20080012603 NASA Glenn Research Center, Cleveland, OH, USA

Investigating Dielectric and Metamaterial Effects in a Terahertz Traveling-Wave Tube Amplifier

Starinshak, David P.; Wilson, Jeffrey D.; February 2008; 18 pp.; In English; Original contains color illustrations

Contract(s)/Grant(s): WBS 698671.01.03.45

Report No.(s): NASA/TM-2008-215059; E-16271; Copyright; Avail.: CASI: A03, Hardcopy

Adding material enhancements to a terahertz traveling-wave tube amplifier is investigated. Isotropic dielectrics, negative-index metamaterials, and anisotropic crystals are simulated, and plans to increase the efficiency of the device are discussed. Early results indicate that adding dielectric to the curved sections of the serpentine-shaped slow-wave circuit produce optimal changes in the cold-test characteristics of the device and a minimal drop in operating frequency. Additional results suggest that materials with simultaneously small relative permittivities and electrical conductivities are best suited for increasing the efficiency of the device. More research is required on the subject, and recommendations are given to determine the direction.

Author

Traveling Wave Tubes; Electric Fields; Dielectrics; Circuits; Permittivity; Wave Propagation; Anisotropy

20080012605 NASA Glenn Research Center, Cleveland, OH, USA

Compact Miniaturized Antenna for 210 MHz RFID

Lee, Richard Q.; Chun, Kue; [2008]; 5 pp.; In English; 2008 IEEE International Symposium on Antenna and Propagation, 5-12 Jul. 2008, San Diego, CA, USA; Original contains color illustrations

Contract(s)/Grant(s): WBS 561581.02.08.03.18.02; No Copyright; Avail.: CASI: A01, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080012605

This paper describes the design and simulation of a miniaturized square-ring antenna. The miniaturized antenna, with overall dimensions of approximately one tenth of a wavelength (0.1), was designed to operate at around 210 MHz, and was intended for radio-frequency identification (RFID) application. One unique feature of the design is the use of a parasitic element to improve the performance and impedance matching of the antenna. The use of parasitic elements to enhance the gain and bandwidth of patch antennas has been demonstrated and reported in the literature, but such use has never been applied to miniaturized antennas. In this work, we will present simulation results and discuss design parameters and their impact on the antenna performance.

Author

Patch Antennas; Radio Frequencies; Bandwidth; Design Analysis; Miniaturization

20080012611 NASA Glenn Research Center, Cleveland, OH, USA

RF and DC Power Handling Characterization of Thin Film Resistors Embedded on LCP

Ponchak, George E.; Jordan, Jennifer L.; Horst, Stephen; Papapolymerou, John; [2007]; 6 pp.; In English; IEEE Electronic Components and Technology Conference, 27-30 May 2008, Lake Buena Vista, FL, USA; Original contains color and black and white illustrations

Contract(s)/Grant(s): WBS 387625.02.05.03.01; Copyright; Avail.: CASI: A02, Hardcopy

For the first time, the DC and RF power handling capability of NiCrAlSi thin film resistors on Liquid Crystal Polymer

(LCP) is presented. It is shown that there is a maximum power that the resistors can handle without causing degradation of the resistors, and this value is significantly less than the power required for burn out of the resistors. EDAX shows that the resistors fail due to electromigration of Ni and Cr, and migration of C from the LCP.
Author
Thin Films; Embedding; Resistors; Radio Frequencies; Electromigration

20080013151 NASA Glenn Research Center, Cleveland, OH, USA
Electrically Small Folded Slot Antenna Utilizing Capacitive Loaded Slot Lines
Scardelletti, Maximilian C.; Ponchak, George E.; Merritt, Shane; Minor, John S.; Zorman, Christian A.; [2007]; 4 pp.; In English; IEEE Radio and Wireless Symposium, 22-24 Jan. 2008, Orlando, FL, USA; Original contains color and black and white illustrations; Copyright; Avail.: CASI: A01, Hardcopy

This paper presents an electrically small, coplanar waveguide fed, folded slot antenna that uses capacitive loading. Several antennas are fabricated with and without capacitive loading to demonstrate the ability of this design approach to reduce the resonant frequency of the antenna, which is analogous to reducing the antenna size. The antennas are fabricated on Cu-clad Rogers Duriod(TM) 6006 with multilayer chip capacitors to load the antennas. Simulated and measured results show close agreement, thus, validating the approach. The electrically small antennas have a measured return loss greater than 15 dB and a gain of 5.4, 5.6, and 2.7 dBi at 4.3, 3.95, and 3.65 GHz, respectively.
Author
Capacitance; Slot Antennas; Miniaturization; Coplanarity; Waveguides; Fabrication; Electrical Engineering

20080013152 NASA Glenn Research Center, Cleveland, OH, USA
Semi-Automated Diagnosis, Repair, and Rework of Spacecraft Electronics
Struk, Peter M.; Oeftering, Richard C.; Easton, John W.; Anderson, Eric E.; January 7, 2008; 11 pp.; In English; AIAA Aerospace Sciences Meeting and Exhibit, 7-10 Jan. 2008, Reno, NV, USA; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy

NASA's Constellation Program for Exploration of the Moon and Mars places human crews in extreme isolation in resource scarce environments. Near Earth, the discontinuation of Space Shuttle flights after 2010 will alter the up- and down-mass capacity for the International Space Station (ISS). NASA is considering new options for logistics support strategies for future missions. Aerospace systems are often composed of replaceable modular blocks that minimize the need for complex service operations in the field. Such a strategy however, implies a robust and responsive logistics infrastructure with relatively low transportation costs. The modular Orbital Replacement Units (ORU) used for ISS requires relatively large blocks of replacement hardware even though the actual failed component may really be three orders of magnitude smaller. The ability to perform in-situ repair of electronics circuits at the component level can dramatically reduce the scale of spares and related logistics cost. This ability also reduces mission risk, increases crew independence and improves the overall supportability of the program. The Component-Level Electronics Assembly Repair (CLEAR) task under the NASA Supportability program was established to demonstrate the practicality of repair by first investigating widely used soldering materials and processes (M&P) performed by modest manual means. The work will result in program guidelines for performing manual repairs along with design guidance for circuit reparability. The next phase of CLEAR recognizes that manual repair has its limitations and some highly integrated devices are extremely difficult to handle and demand semi-automated equipment. Further, electronics repairs require a broad range of diagnostic capability to isolate the faulty components. Finally repairs must pass functional tests to determine that the repairs are successful and the circuit can be returned to service. To prevent equipment demands from exceeding spacecraft volume capacity and skill demands from exceeding crew time and training limits, the CLEAR project is examining options provided by non-real time tele-operations, robotics, and a new generation of diagnostic equipment. This paper outlines a strategy to create an effective repair environment where, with the support of ground based engineers, crewmembers can diagnose, repair and test flight electronics in-situ. This paper also discusses the implications of successful tele-robotic repairs when expanded to rework and reconfiguration of used flight assets for building Constellation infrastructure elements.
Author
Constellation Program; Electronics; Robotics; Replacing; Spacecraft Electronic Equipment; Aerospace Systems

20080013206 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

High-Order Tunable Filters Based on a Chain of Coupled Crystalline Whispering Gallery-Mode Resonators

Savchenkov, Anatoliy A.; Ilchenko, Vladimir S.; Matsko, Andrey B.; Maleki, Lute; IEEE Photonics Technology Letters; January 2005; Volume 17, No. 1, pp. 136-138; In English; Original contains black and white illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40690; http://dx.doi.org/10.1109/LPT.2004.836906

We demonstrate experimentally a tunable third-order optical filter fabricated from the three voltage-controlled lithium niobate whispering gallery-mode resonators. The filter operates at 1550 nm with 30-MHz bandwidth and can be electrooptically tuned by 12 GHz in the linear regime with approximately 80-MHz/V tuning rate. With this filter, we have demonstrated 6-dB fiber-to-fiber insertion loss and 30-ns tuning speed, limited by the resonator buildup time.

Author

Electric Potential; Optical Filters; Tunable Filters; Insertion Loss; Lithium Niobates; Resonators; Coupled Modes

34
FLUID MECHANICS AND THERMODYNAMICS

Includes fluid dynamics and kinematics and all forms of heat transfer; boundary layer flow; hydrodynamics; hydraulics; fluidics; mass transfer and ablation cooling. For related information see also *02 Aerodynamics*.

20080012557 NASA Glenn Research Center, Cleveland, OH, USA

Low Viscosity Imides Based on Asymmetric Oxydiphthalic Anhydride

Chuang, Kathy C.; Criss, Jim M., Jr.; Mintz, Eric A.; Scheiman, Daniel A.; Nguyen, Baochau N.; McCorkle, Linda S.; February 04, 2008; 16 pp.; In English; 28th High Temple Workshop, 4-7 Feb. 2008, Savannah, GA, USA; Original contains color and black and white illustrations

Contract(s)/Grant(s): WBS 984754.02.07.03.16.03; Copyright; Avail.: CASI: A03, Hardcopy

A series of low-melt viscosity imide resins were prepared from asymmetric oxydiphthalic dianhydride (a-ODPA) and 4-phenylethynylphthalic anhydride as the endcap, along with 3,4' - oxydianiline (3,4' -ODA), 3,4' -methylenedianiline (3,4' -MDA), 3,3' -methylenedianiline (3,3' - MDA) and 3,3'-diaminobenzophenone (3,3'-DABP), using a solvent-free melt process. These imide oligomers displays low-melt viscosities (2-15 poise) at 260-280 C, which made them amenable to low-cost resin transfer molding (RTM) process. The a-ODPA based RTM resins exhibits glass transition temperatures (Tg's) in the range of 265-330 C after postcure at 343 C. The mechanical properties of these polyimide/carbon fiber composites fabricated by RTM will be discussed.

Author

Anhydrides; Asymmetry; Imides; Oligomers; Viscosity; Mechanical Properties; Fiber Composites; Polyimides; Fabrication

20080012598 NASA Glenn Research Center, Cleveland, OH, USA

Application of Micro-ramp Flow Control Devices to an Oblique Shock Interaction

Hirt, Stefanie; Anderson, Bernhard; October 30, 2007; 19 pp.; In English; NASA Fundamental Aeronautics Annual Meeting, 30 Oct. - 1 Nov. 2007, New Orleans, LA, USA; Original contains color and black and white illustrations

Contract(s)/Grant(s): WBS 984754.02.07.03.12.02; No Copyright; Avail.: CASI: A03, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080012598

Tests are planned in the 15cm x 15cm supersonic wind tunnel at NASA Glenn to demonstrate the applicability of micro-ramp flow control to the management of shock wave boundary layer interactions. These tests will be used as a database for computational fluid dynamics (CFD) validation and Design of Experiments (DoE) design information. Micro-ramps show potential for mechanically simple and fail-safe boundary layer control.

Author

Supersonic Wind Tunnels; Shock Wave Interaction; Oblique Shock Waves; Computational Fluid Dynamics; Boundary Layers

20080012600 NASA Langley Research Center, Hampton, VA, USA

Effect of Protuberance Shape and Orientation on Space Shuttle Orbiter Boundary-Layer Transition

King, RUdolph A.; Berry, Scott A.; Kegerise, Michael A.; February 2008; 102 pp.; In English; Original contains color illustrations

Contract(s)/Grant(s): WBS 377816.06.03.03.08

Report No.(s): NASA/TM-2008-215103; L-19425; No Copyright; Avail.: CASI: A06, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080012600

This document describes an experimental study conducted to examine the effects of protuberances on hypersonic

boundary-layer transition. The experiment was conducted in the Langley 20-Inch Mach 6 Tunnel on a series of 0.9%-scale Shuttle Orbiter models. The data were acquired to complement the existing ground-based boundary-layer transition database that was used to develop Version 1.0 of the boundary-layer transition RTF (return-to-flight) tool. The existing ground-based data were all acquired on 0.75%-scale Orbiter models using diamond-shaped (pizza-box) trips. The larger model scale facilitated in manufacturing higher fidelity protuberances. The end use of this experimental database will be to develop a technical basis (in the form of a boundary-layer transition correlation) to assess representative protrusion shapes, e.g., gap fillers and protrusions resulting from possible tile repair concepts. The primary objective of this study is to investigate the effects of protuberance-trip location and geometry on Shuttle Orbiter boundary-layer transition. Secondary goals are to assess the effects of gap-filler orientation and other protrusion shapes on boundary-layer transition. Global heat-transfer images using phosphor thermography of the Orbiter windward surface and the corresponding streamwise and spanwise heating distributions were used to infer the state of the boundary layer, i.e., laminar, transitional, or turbulent.
Author
Boundary Layer Transition; Hypersonics; Protuberances; Space Shuttle Orbiters; Thermography; Shapes; Heat Transfer

20080012608 NASA Glenn Research Center, Cleveland, OH, USA
On Flow Stagnation in a Tube Radiator
Motil, Brian; Chao, David F.; Sankovic, John M.; Zhang, Nengli; [2007]; 7 pp.; In English; AIAA Conference, 7-10 Jan. 2008, Reno, NV, USA; Original contains color and black and white illustrations
Contract(s)/Grant(s): WBS 644423.06.32.03.12.03
Report No.(s): AIAA Paper 2008-825; Copyright; Avail.: CASI: A02, Hardcopy

An analysis of the physical process for occurrence of flow stagnation in a space tube-radiator is performed and the mechanism and mathematic description for the flow stagnation are presented. Two causes for pressure drop unbalance between tubes of the radiator are identified: non-uniform cooling environment and different local flow resistances between the tubes. This analysis provides a theoretical basis for experimental simulations of the flow stagnation in a ground-based lab as well as two suggested methods to experimentally simulate flow stagnation. Criteria for the flow stagnation, depending on the viscosity data regressive polynomial, are derived from the extreme condition of the pressure drop in colder tubes. A preliminary numerical calculation is conducted for a space tube-radiator model which confirms the physical and mathematical analyses. The prediction by the criteria for flow stagnation in the tube-radiator model coincides with the numerical calculation result.
Author
Flow Resistance; Radiators; Viscosity; Drop Towers

20080012609 NASA Glenn Research Center, Cleveland, OH, USA
Cryogenic Fluid Technologies for Long Duration In-Space Operations
Motil, Susan M.; Tramel, Terri L.; February 12, 2008; 25 pp.; In English; Space Technology and Applications International Forum: 6th Symposium on Space Colonization, 10-14 Feb. 2008, Albuquerque, NM, USA; Original contains color illustrations
Contract(s)/Grant(s): WBS 936374.01.03; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012609

Reliable knowledge of low-gravity cryogenic fluid management behavior is lacking and yet is critical in the areas of storage, distribution, and low-gravity propellant management. The Vision for Space Exploration mission objectives will require the use of high performance cryogenic propellants (hydrogen, oxygen, and methane). Additionally, lunar missions will require success in storing and transferring liquid and gas commodities on the surface. The fundamental challenges associated with the in-space use of cryogens are their susceptibility to environmental heat, their complex thermodynamic and fluid dynamic behavior in low gravity and the uncertainty of the position of the liquid-vapor interface if the propellants are not settled. The Cryogenic Fluid Management (CFM) project is addressing these issues through ground testing and analytical model development, and has crosscutting applications and benefits to virtually all missions requiring in-space operations with cryogens. Such knowledge can significantly reduce or even eliminate tank fluid boil-off losses for long term missions, reduce propellant launch mass and on-orbit margins, and simplify vehicle operations. The Cryogenic Fluid Management (CFM) Project is conducting testing and performing analytical evaluation of several areas to enable NASA s Exploration Vision. This paper discusses the content and progress of the technology focus areas within CFM.
Author
Cryogenic Fluids; Liquid-Vapor Interfaces; Dynamic Characteristics; Fluid Management; Thermodynamics

20080012740 NASA Glenn Research Center, Cleveland, OH, USA

Intravenous Fluid Mixing in Normal Gravity, Partial Gravity, and Microgravity: Down-Selection of Mixing Methods

Niederhaus, Charles E.; Miller, Fletcher J.; January 2008; 21 pp.; In English; Original contains black and white illustrations

Contract(s)/Grant(s): WBS 444543.01.02.01

Report No.(s): NASA/TM-2008-215000; E-16208; Copyright; Avail.: CASI: A03, Hardcopy

The missions envisioned under the Vision for Space Exploration will require development of new methods to handle crew medical care. Medications and intravenous (IV) fluids have been identified as one area needing development. Storing certain medications and solutions as powders or concentrates can both increase the shelf life and reduce the overall mass and volume of medical supplies. The powders or concentrates would then be mixed in an IV bag with Sterile Water for Injection produced in situ from the potable water supply. Fluid handling in microgravity is different than terrestrial settings, and requires special consideration in the design of equipment. This document describes the analyses and down-select activities used to identify the IV mixing method to be developed that is suitable for ISS and exploration missions. The chosen method is compatible with both normal gravity and microgravity, maintains sterility of the solution, and has low mass and power requirements. The method will undergo further development, including reduced gravity aircraft experiments and computations, in order to fully develop the mixing method and associated operational parameters.

Author

Storage Stability; Water Injection; Powder (Particles); Microgravity; Potable Water; Intravenous Procedures; In Situ Resource Utilization

20080013165 NASA Marshall Space Flight Center, Huntsville, AL, USA

Modeling of Turbulence Effect on Liquid Jet Atomization

Trinh, H. P.; December 2007; 92 pp.; In English; Original contains color and black and white illustrations

Report No.(s): NASA/TM-2007-215189; M-1213; No Copyright; Avail.: CASI: A05, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080013165

Recent studies indicate that turbulence behaviors within a liquid jet have considerable effect on the atomization process. Such turbulent flow phenomena are encountered in most practical applications of common liquid spray devices. This research aims to model the effects of turbulence occurring inside a cylindrical liquid jet to its atomization process. The two widely used atomization models Kelvin-Helmholtz (KH) instability of Reitz and the Taylor analogy breakup (TAB) of O'Rourke and Amsden portraying primary liquid jet disintegration and secondary droplet breakup, respectively, are examined. Additional terms are formulated and appropriately implemented into these two models to account for the turbulence effect. Results for the flow conditions examined in this study indicate that the turbulence terms are significant in comparison with other terms in the models. In the primary breakup regime, the turbulent liquid jet tends to break up into large drops while its intact core is slightly shorter than those without turbulence. In contrast, the secondary droplet breakup with the inside liquid turbulence consideration produces smaller drops. Computational results indicate that the proposed models provide predictions that agree reasonably well with available measured data.

Author

Turbulence Effects; Mathematical Models; Computational Fluid Dynamics; Liquid Atomization; Turbulent Flow; Jet Flow

20080013294 NASA Glenn Research Center, Cleveland, OH, USA

Near-Field Noise Computation for a Subsonic Coannular Jet

Loh, Ching Y.; Hultgren, Lennart S.; Jorgenson, Philip C. E.; February 2008; 17 pp.; In English; 13th AIAA/CEAS Aeroacoustics Conference, 21-23 May 2007, Rome, Italy; Original contains color and black and white illustrations

Contract(s)/Grant(s): NAS3-0372; WBS 732759.03.01.02.02

Report No.(s): NASA/TM--2008-215033; AIAA Paper 2007-3651; E-16224; Copyright; Avail.: CASI: A03, Hardcopy

A high-Reynolds-number, subsonic coannular jet is simulated, using a three-dimensional finite-volume LES method, with emphasis on the near field noise. The nozzle geometry used is the NASA Glenn 3BB baseline model. The numerical results are generally in good agreement with existing experimental findings.

Author

Computation; Near Fields; Subsonic Flow; Jet Flow; Jet Aircraft Noise; Aeroacoustics; Nozzle Design

20080013300 NASA Ames Research Center, Moffett Field, CA, USA

Dissociation Cross Sections and Rate Coefficients for Nitrogen from Accurate Theoretical Calculations

Chaban, Galina; Jaffe, Richard; Schwenke, David W.; Huo, Winifred; January 2008; 10 pp.; In English; Original contains black and white illustrations

Contract(s)/Grant(s): NNA07BA89C

Report No.(s): AIAA Paper 2008-1209-247; Huo2008QI; No Copyright; Avail.: CASI: A02, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080013300

The N, N2 system is studied to yield rate coefficients and cross sections for molecular dissociation under conditions important for assessing nonequilibrium heating of hypersonic vehicles. First principle calculations are used to generate realistic nuclear interaction potentials, and these are used with accurate molecular dynamics to yield the fundamental data required for a rigorous treatment of nonequilibrium chemistry.

Author

Molecular Dynamics; Nitrogen; Computational Chemistry; Atmospheric Entry; Nitrogen Atoms; Aerodynamic Heating; Aerothermochemistry

20080013302 NASA Ames Research Center, Moffett Field, CA, USA

Vibrational and Rotational Excitation and Relaxation of Nitrogen from Accurate Theoretical Calculations

Jaffe, Richard; Schwenke, David W.; Chaban, Galina; Huo, Winifred; [2008]; 14 pp.; In English; Original contains color and black and white illustrations

Contract(s)/Grant(s): NNA07BA89C

Report No.(s): AIAA Paper 2008-1208-273; No Copyright; Avail.: CASI: A03, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080013302

Vibrational and rotational energy transfer rate coefficients are computed for high-temperature N2 under conditions expected for re-entry into Earth's atmosphere at 10-12 km/s. The calculations utilized classical mechanics to simulate individual collisions of N2 with N atoms and a quantum chemical potential energy surface to describe the interatomic forces between the nitrogen atoms. The results demonstrate the importance of exchange reactions, which result in multiquantum jumps in vibration and rotation level.

Author

Earth Atmosphere; Nitrogen; Atmospheric Entry; Aerodynamic Heating; Nitrogen Atoms; Potential Energy; Computational Chemistry

20080013306 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Thermal Cycle Reliability of PBGA/CCGA 717 I/Os

Ghaffarian, Reza; May 30, 2006; 15 pp.; In English; IEEE 56th Electronic Components and Technology Conference, 30 May - 2 Jun. 2006, San Diego, CA, USA; Original contains black and white illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40658

Status of thermal cycle test results for a nonfunctional daisy-chained peripheral ceramic column grid array (CCGA) and its plastic ball grid array (PBGA) version. both having 560 I/Os. were presented in last year's conference. Test results included environmental data for three different thermal cycle regimes (-55 C/125 C, -55 C/100 C, and -50 C /75 C). Update information on these - especially failure type for assemblies with high and low solder volumes-were presented. The thermal cycle test procedure followed those recommended IPC-9701 for tin-lead solder joint assemblies. Revision A of this specification covers guideline thermal cycle requirements for Pb-free solder joints. Some background information discussed during release of this specification with its current guideline recommendations were also presented. In a recent reliability investigation a fully populated CCGA with 717 I/Os was also considered for assembly reliability. evaluation. The functional package is a field-programmable gate array that has much higher processing power than its previous version. This new package is smaller in dimension, has no interposer, and has a thinner column wrapped with copper for reliability improvement. This paper will also present thermal cycle test results for this package assembly and its plastic version with 728 I/Os. both of which were exposed to three different cycle regimes. Two cycle profiles were those specified by IPC- 9701A for tin-lead, i.e. -55 to 100 C and -55 to 125 C and one was a cycle profile specified by Mil-Std-883, i.e.. -65 C/150 C which is generally used for ceramic hybrid packages. Per IPC-9701 A, test vehicles were built using daisy chain packages and were continuously monitored. The effects of many process and assembly variables-including corner staking commonly used for improving resistance to mechanical loading such as drop and vibration loads--were also considered as part of the test matrix. Optical photomicrographs were taken at various thermal cycle intervals to document damage progress and behavior. Representative

samples of these along with cross-sectional photomicrographs at higher magnification taken by scanning electron microscopy (SEM) to determine crack propagation and failure analyses for packages are also presented.
Author
Field-Programmable Gate Arrays; Crack Propagation; Loads (Forces); Thermal Cycling Tests; Ceramics

20080013316 NASA Marshall Space Flight Center, Huntsville, AL, USA
Gravity Scaling of a Power Reactor Water Shield
Reid, Robert S.; Pearson, J. Boise; November 11, 2007; 2 pp.; In English; American Nuclear Society Winter Meeting, 11-15 Nov. 2007, Washington, DC, USA; Original contains color illustrations; No Copyright; Avail.: CASI: A01, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080013316

A similarity analysis on a water-based reactor shield examined the effect of gravity on free convection between a reactor shield inner and outer vessel boundaries. Two approaches established similarity between operation on the Earth and the Moon: 1) direct scaling of Rayleigh number equating gravity-surface heat flux products, 2) temperature difference between the wall and thermal boundary layer held constant. Nusselt number for natural convection (laminar and turbulent) is assumed of form Nu = CRa(sup n).
Derived from text
Gravitation; Power Reactors; Thermal Boundary Layer; Radiation Shielding; Moisture

20080013356 NASA Glenn Research Center, Cleveland, OH, USA
Flow Instabilities in Feather Seals due to Upstream Harmonic Pressure Fluctuations
Deng, D.; Braun, M. J.; Henricks, Robert C.; February 17, 2008; 7 pp.; In English; Symposim on Transport Phenomena and Dynamics of Rotating Machinery (ISROMAC-12), 17-22 Feb. 2008, Honolulu, HI, USA; Original contains color and black and white illustrations
Contract(s)/Grant(s): WBS 561581.02.08.03.15.02
Report No.(s): ISROMAC12-2008-20206; Copyright; Avail.: CASI: A02, Hardcopy

Feather seals (also called slot seals) typically found in turbine stators limit leakage from the platform into the core cavities and from the shroud to the case. They are of various geometric shapes, yet all are contoured to fit the aerodynamic shape of the stator and placed as close as thermomechanically reasonable the powerstream flow passage. Oscillations engendered in the compressor or combustor alter the steady leakage characteristics of these sealing elements and in some instances generate flow instabilities downstream of the seal interface. In this study, a generic feather seal geometry was studied numerically by imposing an upstream harmonic pressure disturbance on the simulated stator-blade gap. The flow and thermal characteristics were determined; it was found that for high pressure drops, large fluctuations in flows in the downstream blade-stator gap can occur. These leakages and pulsations in themselves are not all that significant, yet if coupled with cavity parameters, they could set up resonance events. Computationally generated time-dependent flow fields are captured in sequence video streaming.
Author
Flow Stability; Computational Fluid Dynamics; Slots; Sealing; Feathering; Pressure Oscillations; Turbomachinery; Harmonics

20080013371 NASA Langley Research Center, Hampton, VA, USA
Flow Control Predictions using URANS Modeling: A Parametric Study
Rumsey, Christopher L.; Greenblatt, David; [2007]; 6 pp.; In English; 5th International Symposium on Turbulence and Shear Flow Phenomena, 27-29 Aug. 2007, Garching, Germany
Contract(s)/Grant(s): WBS 732759; Copyright; Avail.: CASI: A02, Hardcopy

A computational study was performed for steady and oscillatory flow control over a hump model with flow separation to assess how well the steady and unsteady Reynolds-averaged Navier-Stokes equations predict trends due to Reynolds number, control magnitude, and control frequency. As demonstrated previously, the hump model case is useful because it clearly demonstrates a failing in all known turbulence models: they under-predict the turbulent shear stress in the separated region and consequently reattachment occurs too far downstream. In spite of this known failing, three different turbulence models were employed to determine if trends can be captured even though absolute levels are not. The three turbulence models behaved similarly. Overall they showed very similar trends as experiment for steady suction, but only agreed qualitatively with some of the trends for oscillatory control.
Author
Parameterization; Computational Fluid Dynamics; Mathematical Models; Reynolds Averaging; Navier-Stokes Equation; Flow Regulators; Control Theory

20080013372 NASA Langley Research Center, Hampton, VA, USA

Receptivity of Supersonic Boundary Layers Due To Acoustic Disturbances Over Blunt Cones

Balakumar, P.; June 28, 2007; 24 pp.; In English; 37th AIAA Fluid Dynamics Conference and Exhibit, 25-28 Jun. 2007, Miami, FL, USA; Original contains color illustrations

Contract(s)/Grant(s): WBS 984754.02.07.07.14.04; No Copyright; Avail.: CASI: A03, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080013372

Receptivity and stability of supersonic boundary layers over a 5-degree straight cone with a blunt tip are numerically investigated at a free stream Mach number of 3.5 and at a high Reynolds number of 106/inch. Both the steady and unsteady solutions are obtained by solving the full Navier-Stokes equations using the 5th-order accurate weighted essentially non-oscillatory (WENO) scheme for space discretization and using third-order total-variation-diminishing (TVD) Runge-Kutta scheme for time integration. The linear stability results showed that bluntness has less stabilizing effects on the stability of boundary layers over cones than on flat plates and wedges. The unsteady simulations of the interaction of plane threedimensional acoustic waves with the cone showed that the modulation of wavelength and the generation of instability waves first occurred near the leading edge in the plane where the constant acoustic phase lines are perpendicular to the cone axis. Further downstream, this instability region spreads in the azimuthal direction from this plane.

Author

Supersonic Boundary Layers; Acoustics; Blunt Bodies; Cones; Supersonic Flow; Boundary Layers; Receiving

35
INSTRUMENTATION AND PHOTOGRAPHY

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography. For aerial photography see *43 Earth Resources and Remote Sensing*. For related information see also *06 Avionics and Aircraft Instrumentation*; and *19 Spacecraft Instrumentation and Astrionics*.

20080012499 NASA Dryden Flight Research Center, Edwards, CA, USA

10.3 High-temperature Instrumentation

Piazza, Anthony; February 28, 2008; 27 pp.; In English; Hypersonic Educational Initiative Training Seminar, 26-28 Feb. 2008, Hampton, VA, USA; Original contains color and black and white illustrations; No Copyright; Avail.: CASI: A03, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080012499

This viewgraph presentation describes high temperature instrumentation development from 1960-1970, 1980-1990 and 2000-present. The contents include: 1) Background; 2) Objective; 3) Application and Sensor; 4) Attachment Techniques; 5) Evaluation/Characterization Testing; and 6) Future testing.

CASI

Measuring Instruments; Mechanical Engineering; Thermal Analysis; Composite Structures; High Temperature Tests

20080012535 NASA Johnson Space Center, Houston, TX, USA

[Taylor and Hill, Incorporated's JSC Cryo Chamber A]

Morales, Rito; [2008]; 4 pp.; In English; Original contains color illustrations; Copyright; Avail.: CASI: A01, Hardcopy

NASA commissioned construction of an environmental simulation test chamber which was completed in 1964 at Johnson Space Center (JSC) in Houston, Texas. The facility, Chamber A, was invaluable for testing spacecraft and satellites before deployment to space. By testing spacecraft in an environment similar to the one they would be functioning in, potential problems could be addressed before launch. A new addition to NASA's observatory inventory is called the James Webb Space Telescope (JWST), after a former Administrator of NASA. The new telescope will have 7 times the mirror area of the Hubble, with a target destination approximately one million miles from earth. Scheduled for launch in 2013, the JWST will allow scientists the ability to see, for the first time, the first galaxies that formed in the early Universe. Pre-launch testing of JWST must be performed in environments that approximate its final target space environment as closely as possible.

Author

Cryogenics; Environment Simulation; Test Chambers; Technology Utilization; James Webb Space Telescope

20080013217 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

CHAMP (Camera, Handlens, and Microscope Probe)

Mungas, Greg S.; Boynton, John E.; Balzer, Mark A.; Beegle, Luther; Sobel, Harold R.; Fisher, Ted; Klein, Dan; Deans, Matthew; Lee, Pascal; Sepulveda, Cesar A.; March 2005; 10 pp.; In English; IEEE Aerospace Conference, 4-12 Mar. 2005, Big Sky, MT, USA; Original contains black and white illustrations

Report No.(s): IEEEAC Paper-1510, Version 5; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40633

CHAMP (Camera, Handlens And Microscope Probe)is a novel field microscope capable of color imaging with continuously variable spatial resolution from infinity imaging down to diffraction-limited microscopy (3 micron/pixel). As a robotic arm-mounted imager, CHAMP supports stereo imaging with variable baselines, can continuously image targets at an increasing magnification during an arm approach, can provide precision rangefinding estimates to targets, and can accommodate microscopic imaging of rough surfaces through a image filtering process called z-stacking. CHAMP was originally developed through the Mars Instrument Development Program (MIDP) in support of robotic field investigations, but may also find application in new areas such as robotic in-orbit servicing and maintenance operations associated with spacecraft and human operations. We overview CHAMP'S instrument performance and basic design considerations below.

Author

Imaging Techniques; Microscopy; Spatial Resolution; Cameras; Diffraction; Robotics; Robot Arms

20080013222 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Protograph LDPC Codes with Node Degrees at Least 3

Divsalar, Dariush; Jones, Christopher; November 27, 2006; 5 pp.; In English; IEEE Global Telecommunications Conference, 27 Nov. - 1 Dec. 2006, San Francisco, CA, USA; Original contains color and black and white illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40722

In this paper we present protograph codes with a small number of degree-3 nodes and one high degree node. The iterative decoding threshold for proposed rate 1/2 codes are lower, by about 0.2 dB, than the best known irregular LDPC codes with degree at least 3. The main motivation is to gain linear minimum distance to achieve low error floor. Also to construct rate-compatible protograph-based LDPC codes for fixed block length that simultaneously achieves low iterative decoding threshold and linear minimum distance. We start with a rate 1/2 protograph LDPC code with degree-3 nodes and one high degree node. Higher rate codes are obtained by connecting check nodes with degree-2 non-transmitted nodes. This is equivalent to constraint combining in the protograph. The condition where all constraints are combined corresponds to the highest rate code. This constraint must be connected to nodes of degree at least three for the graph to have linear minimum distance. Thus having node degree at least 3 for rate 1/2 guarantees linear minimum distance property to be preserved for higher rates. Through examples we show that the iterative decoding threshold as low as 0.544 dB can be achieved for small protographs with node degrees at least three. A family of low- to high-rate codes with minimum distance linearly increasing in block size and with capacity-approaching performance thresholds is presented. FPGA simulation results for a few example codes show that the proposed codes perform as predicted.

Author

Field-Programmable Gate Arrays; Decoding; Photography; Errors; Connectors

20080013262 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Multispectral Microimager for Astrobiology

Sellar, R. Glenn; Farmer, Jack D.; Kieta, Andrew; Huang, Julie; August 13, 2006; 5 pp.; In English; SPIE Optics and Photonics Symposium , Instruments, Methods, and Missions for Astrobiology X, 13-17 Aug. 2006, San Diego, CA, USA; Original contains color illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40657

A primary goal of the astrobiology program is the search for fossil records. The astrobiology exploration strategy calls for the location and return of samples indicative of environments conducive to life, and that best capture and preserve biomarkers. Successfully returning samples from environments conducive to life requires two primary capabilities: (1) in situ mapping of the mineralogy in order to determine whether the desired minerals are present; and (2) nondestructive screening of samples for additional in-situ testing and/or selection for return to laboratories for more in-depth examination. Two of the most powerful identification techniques are micro-imaging and visible/infrared spectroscopy. The design and test results are presented from a compact rugged instrument that combines micro-imaging and spectroscopic capability to provide in-situ analysis, mapping, and sample screening capabilities. Accurate reflectance spectra should be a measure of reflectance as a

function of wavelength only. Other compact multispectral microimagers use separate LEDs (light-emitting diodes) for each wavelength and therefore vary the angles of illumination when changing wavelengths. When observing a specularly-reflecting sample, this produces grossly inaccurate spectra due to the variation in the angle of illumination. An advanced design and test results are presented for a multispectral microimager which demonstrates two key advances relative to previous LED-based microimagers: (i) acquisition of actual reflectance spectra in which the flux is a function of wavelength only, rather than a function of both wavelength and illumination geometry; and (ii) increase in the number of spectral bands to eight bands covering a spectral range of 468 to 975 nm.
Author
Exobiology; Mineralogy; Spectroscopy; Imaging Techniques; Microinstrumentation

20080013276 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Attenuating Stereo Pixel-Locking via Affine Window Adaptation
Stein, Andrew N.; Huertas, Andres; Matthies, Larry H.; May 15, 2006; 8 pp.; In English; IEEE International Conference on Robotics and Automation, 15-19 May 2006, Orlando, FL, USA; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40673

For real-time stereo vision systems, the standard method for estimating sub-pixel stereo disparity given an initial integer disparity map involves fitting parabolas to a matching cost function aggregated over rectangular windows. This results in a phenomenon known as 'pixel-locking,' which produces artificially-peaked histograms of sub-pixel disparity. These peaks correspond to the introduction of erroneous ripples or waves in the 3D reconstruction of truly Rat surfaces. Since stereo vision is a common input modality for autonomous vehicles, these inaccuracies can pose a problem for safe, reliable navigation. This paper proposes a new method for sub-pixel stereo disparity estimation, based on ideas from Lucas-Kanade tracking and optical flow, which substantially reduces the pixel-locking effect. In addition, it has the ability to correct much larger initial disparity errors than previous approaches and is more general as it applies not only to the ground plane.
Author
Real Time Operation; Stereoscopic Vision; Histograms; Estimating; Autonomy; Attenuation; Parabolas; Locking

20080013339 NASA Marshall Space Flight Center, Huntsville, AL, USA
Expected Performance of the GLAST Burst Monitor
Meegan, Charles; Fishman, Gerald; Kouveliotou, Chryssa; Wilson-Hodge, Colleen; Paciesas, William; Preece, Robert; Briggs, Michael; Bhat, Narayana; Connaughton, Valerie; Greiner, Jochen; vonKienlin, Andreas; Diehl, Roland; Steinle, Helmut; Bissaldi, Elisabetta; Kippen, R. Marc; November 05, 2007; 1 pp.; In English; Gamma Ray Burst 2007 Conference, 5-9 Nov. 2007, Santa Fe, NM, USA; Copyright; Avail.: Other Sources; Abstract Only

The GLAST Burst Monitor (GBM) will enhance LAT observations of GRBs by extending the spectral coverage from the LAT threshold down to approx. 8 kev, and will provide a trigger for re-orienting the spacecraft to observe delayed emission from selected bursts outside the LAT field of view. GBM consists of twelve NaI scintillation detectors operating in the 8 kev to 1 MeV energy range and two BGO scintillation detectors operating in the 150 keV to 30 MeV energy range. Detector resolution, effective area, and angular response have been determined by calibrations. Analyses indicate that the on-board burst threshold will be approx. 0.7 photon/cm2/s and the on-board burst localization accuracy will typically be better than 8 degrees.
Author
Gamma Ray Bursts; Detectors; Measuring Instruments; Actuators

20080013368 NASA Langley Research Center, Hampton, VA, USA
A Comparison of EAST Shock-Tube Radiation Measurements with a New Air Radiation Model
Johnston, Christopher O.; January 07, 2008; 22 pp.; In English; 46th AIAA Aerospace Sciences Meeting and Exhibit, 7-10 Jan. 2008, Reno, NV, USA; Original contains color illustrations
Contract(s)/Grant(s): WBS 732759.07.05; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080013368

This paper presents a comparison between the recent EAST shock tube radiation measurements (Grinstead et al., AIAA 2008-1244) and the HARA radiation model. The equilibrium and nonequilibrium radiation measurements are studied for conditions relevant to lunar-return shock-layers; specifically shock velocities ranging from 9 to 11 kilometers per second at initial pressures of 0.1 and 0.3 Torr. The simulated shock-tube flow is assumed one-dimensional and is calculated using the LAURA code, while a detailed nonequilibrium radiation prediction is obtained in an uncoupled manner from the HARA code.

The measured and predicted intensities are separated into several spectral ranges to isolate significant spectral features, mainly strong atomic line multiplets. The equations and physical data required for the prediction of these strong atomic lines are reviewed and their uncertainties identified. The 700-1020 nm wavelength range, which accounts for roughly 30% of the radiative flux to a peak-heating lunar return shock-layer, is studied in detail and the measurements and predictions are shown to agree within 15% in equilibrium. The plus or minus 1.5% uncertainty on the measured shock velocity is shown to cause up to a plus or minus 30% difference in the predicted radiation. This band of predictions contains the measured values in almost all cases. For the highly nonequilibrium 0.1 Torr cases, the nonequilibrium radiation peaks are under-predicted by about half. This under-prediction is considered acceptable when compared to the order-of-magnitude over-prediction obtained using a Boltzmann population of electronic states. The reasonable comparison in the nonequilibrium regions provides validation for both the non-Boltzmann modeling in HARA and the thermochemical nonequilibrium modeling in LAURA. The N2 (+)(1-) and N2(2+) molecular band systems are studied in the 290 480 nm wavelength range for both equilibrium and nonequilibrium regimes. The non-Boltzmann rate models for these systems, which have significant uncertainties, are tuned to improve the comparison with measurements.
Author
Radiance; Shock Tubes; Radiation Measurement; Mathematical Models; Nonequilibrium Radiation

20080013369 NASA Langley Research Center, Hampton, VA, USA
Initial Retrieval Validation from the Joint Airborne IASI Validation Experiment (JAIVEx)
Zhou, Daniel K.; Liu, Xu; Smith, WIlliam L.; Larar, Allen M.; Taylor, Jonathan P.; Revercomb, Henry E.; Mango, Stephen A.; Schluessel, Peter; Calbet, Xavier; September 24, 2007; 1 pp.; In English; Joint 2007 EUMETSAT Meteorological Satellite Conference, 24-28 Sep. 2007, Amsterdam, Netherlands
Contract(s)/Grant(s): WBS 534173.02.07.9437; Copyright; Avail.: Other Sources; Abstract Only

The Joint Airborne IASI Validation Experiment (JAIVEx) was conducted during April 2007 mainly for validation of the Infrared Atmospheric Sounding Interferometer (IASI) on the MetOp satellite, but also included a strong component focusing on validation of the Atmospheric InfraRed Sounder (AIRS) aboard the AQUA satellite. The cross validation of IASI and AIRS is important for the joint use of their data in the global Numerical Weather Prediction process. Initial inter-comparisons of geophysical products have been conducted from different aspects, such as using different measurements from airborne ultraspectral Fourier transform spectrometers (specifically, the NPOESS Airborne Sounder Testbed Interferometer (NAST-I) and the Scanning-High resolution Interferometer Sounder (S-HIS) aboard the NASA WB-57 aircraft), UK Facility for Airborne Atmospheric Measurements (FAAM) BAe146-301 aircraft insitu instruments, dedicated dropsondes, radiosondes, and ground based Raman Lidar. An overview of the JAIVEx retrieval validation plan and some initial results of this field campaign are presented.
Author
Airborne Equipment; Atmospheric Sounding; Infrared Instruments; Interferometers

36
LASERS AND MASERS

Includes lasing theory, laser pumping techniques, maser amplifiers, laser materials, and the assessment of laser and maser outputs. For cases where the application of the laser or maser is emphasized see also the specific category where the application is treated. For related information see also *76 Solid-State Physics*.

20080013367 NASA Langley Research Center, Hampton, VA, USA
High-Energy 2-Micrometers Doppler Lidar for Wind Measurements
Koch, Grady J.; Beyon, Jeffrey Y.; Barnes, Bruce W.; Petros, Mulugeta; Yu, Jirong; Amzajerdian, Farzin; Kavaya, Michael J.; Singh, Upendra N.; January 2006; 39 pp.; In English; Original contains color and black and white illustrations
Contract(s)/Grant(s): WBS 23-258-80-70
Report No.(s): LAR-16099-1; Copyright; Avail.: CASI: A03, Hardcopy

High-energy 2-micrometer wavelength lasers have been incorporated in a prototype coherent Doppler lidar to test component technologies and explore applications for remote sensing of the atmosphere. Design of the lidar is presented including aspects in the laser transmitter, receiver, photodetector, and signal processing. Calibration tests and sample atmospheric data are presented on wind and aerosol profiling.
Author
Doppler Radar; Meteorological Radar; Remote Sensing; Wind (Meteorology); Solid State Lasers; Wind Velocity Measurement

20080013373 NASA Langley Research Center, Hampton, VA, USA

High Energy, Single-Mode, All-Solid-State and Tunable UV Laser Transmitter

Prasad, Narasimha S.; Singh, Upendra N.; Hovis, FLoyd; June 22, 2007; 22 pp.; In English; CLEO/Europe IQEC 2007: European Conference on Lasers and Electro-Optics and the International Quantum Electronics Conference, 17-22 Jun. 2007, Munich, Germany; Original contains color illustrations

Contract(s)/Grant(s): WBS 478643.02.02.02.15

Report No.(s): Paper-CA-1708; Copyright; Avail.: CASI: A03, Hardcopy

A high energy, single mode, all solid-state Nd:YAG laser primarily for pumping an UV converter is developed. Greater than 1 J/pulse at 50 HZ PRF and pulse widths around 22 ns have been demonstrated. Higher energy, greater efficiency may be possible. Refinements are known and practical to implement. Technology Demonstration of a highly efficient, high-pulse-energy, single mode UV wavelength generation using flash lamp pumped laser has been achieved. Greater than 90% pump depletion is observed. 190 mJ extra-cavity SFG; IR to UV efficiency > 21% (> 27% for 1 mJ seed). 160 mJ intra-cavity SFG; IR to UV efficiency up to 24% Fluence < 1 J/sq cm for most beams. The pump beam quality of the Nd:YAG pump laser is being refined to match or exceed the above UV converter results. Currently the Nd:YAG pump laser development is a technology demonstration. System can be engineered for compact packaging.

Author

Tunable Lasers; Ultraviolet Lasers; YAG Lasers; Neodymium Lasers; Solid State Lasers; Transmitters

37
MECHANICAL ENGINEERING

Includes mechanical devices and equipment; machine elements and processes. For cases where the application of a device or the host vehicle is emphasized see also the specific category where the application or vehicle is treated. For robotics see *63 Cybernetics, Artificial Intelligence, and Robotics*; and *54 Man/System Technology and Life Support*.

20080012450 Sest, Inc., Middleburgh Heights, OH, USA

Development of a Linear Stirling System Model with Varying Heat Inputs

Regan, Timothy F.; Lewandowski, Edward J.; December 2007; 18 pp.; In English; Fifth International Energy COnversion Engineering Conference and Exhibit (IECEC), 25--27 Jun. 2007, St. Louis, MO, USA; Original contains color illustrations

Contract(s)/Grant(s): NNC07TA38T; WBS 138494.04.01.01

Report No.(s): NASA/CR-2007-215012; E-16188; No Copyright; Avail.: CASI: A03, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080012450

The linear model of the Stirling system developed by NASA Glenn Research Center (GRC) has been extended to include a user-specified heat input. Previously developed linear models were limited to the Stirling convertor and electrical load. They represented the thermodynamic cycle with pressure factors that remained constant. The numerical values of the pressure factors were generated by linearizing GRC's nonlinear System Dynamic Model (SDM) of the convertor at a chosen operating point. The pressure factors were fixed for that operating point, thus, the model lost accuracy if a transition to a different operating point were simulated. Although the previous linear model was used in developing controllers that manipulated current, voltage, and piston position, it could not be used in the development of control algorithms that regulated hot-end temperature. This basic model was extended to include the thermal dynamics associated with a hot-end temperature that varies over time in response to external changes as well as to changes in the Stirling cycle. The linear model described herein includes not only dynamics of the piston, displacer, gas, and electrical circuit, but also the transient effects of the heater head thermal inertia. The linear version algebraically couples two separate linear dynamic models, one model of the Stirling convertor and one model of the thermal system, through the pressure factors. The thermal system model includes heat flow of heat transfer fluid, insulation loss, and temperature drops from the heat source to the Stirling convertor expansion space. The linear model was compared to a nonlinear model, and performance was very similar. The resulting linear model can be implemented in a variety of computing environments, and is suitable for analysis with classical and state space controls analysis techniques.

Author

Stirling Cycle; Mathematical Models; Nonlinear Systems; Heat Transmission; Linear Systems; Heat Sources; Dynamic Models

20080012551 NASA Glenn Research Center, Cleveland, OH, USA

Morphology-dependent Resonances and Their Applications to Sensing in Aerospace Environments

Adamovsky, G.; Otugen, M. V.; January 2007; 24 pp.; In English; Original contains color and black and white illustrations

Contract(s)/Grant(s): NAG3-2679; NSF CTS-0502421; NSF IIP-0539067; NSF CBET-0619193; WBS645846.02.07.03.03.03.01; No Copyright; Avail.: CASI: A03, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080012551

This paper reviews recent developments in Morphology Dependent Resonance (MDR) based sensors for aerospace applications. The sensor concept is based on the detection of small shifts of optical resonances (also called the whispering gallery modes or WGM) of dielectric spheres caused by external effects. Recent developments in MRD-based micro-optical sensors for temperature, force, pressure and concentration are discussed. In addition to the experimental configurations used in each type of prototype sensor, a brief overview is also given for analytical approaches to describe the sensor principle. Author

Aerospace Engineering; Morphology; Optical Resonance; Sensors; Dielectrics

20080012560 Army Research Lab., Cleveland, OH, USA; NASA Glenn Research Center, Cleveland, OH, USA

Wear of Spur Gears Having a Dithering Motion and Lubricated with a Perfluorinated Polyether Grease

Krantz, Timothy; Oswald, Fred; Handschuh, Robert; December 2007; 14 pp.; In English; International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, 4-7 Sep. 2007, Las Vegas, NV, USA; Original contains color and black and white illustrations

Contract(s)/Grant(s): WBS 877868.02.07.03.01.01

Report No.(s): NASA/TM-2007-215008; ARL-TR-4124; E-16195; No Copyright; Avail.: CASI: A03, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080012560

Gear contact surface wear is one of the important failure modes for gear systems. Dedicated experiments are required to enable precise evaluations of gear wear for a particular application. The application of interest for this study required evaluation of wear of gears lubricated with a grade 2 perfluorinated polyether grease and having a dithering (rotation reversal) motion. Experiments were conducted using spur gears made from AISI 9310 steel. Wear was measured using a profilometer at test intervals encompassing 10,000 to 80,000 cycles of dithering motion. The test load level was 1.1 GPa maximum Hertz contact stress at the pitch-line. The trend of total wear as a function of test cycles was linear, and the wear depth rate was approximately 1.2 nm maximum wear depth per gear dithering cycle. The observed wear rate was about 600 times greater than the wear rate for the same gears operated at high speed and lubricated with oil. Author

Gears; Greases; Wear; Lubricants; Dithers

20080012570 NASA Glenn Research Center, Cleveland, OH, USA

Further Characterization of an Active Clearance Control Concept

Taylor, Shawn C.; Steinetz, Bruce M.; Oswald, Jay J.; December 2007; 24 pp.; In English; 43rd AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, 8-11 Jul. 2007, Cincinnati, OH, USA; Original contains color illustrations

Contract(s)/Grant(s): WBS 984754.02.07.03.13.06

Report No.(s): NASA/TM-2007-215039; AIAA Paper 2007-5739; E-16213; Copyright; Avail.: CASI: A03, Hardcopy

A new test chamber and precision hydraulic actuation system were incorporated into an active clearance control (ACC) test rig at NASA Glenn Research Center. Using the improved system, a fast-acting, mechanically-actuated, ACC concept was evaluated at engine simulated temperatures and pressure differentials up to 1140 F and 120 psig, on the basis of secondary seal leakage and kinematic controllability. During testing, the ACC concept tracked a simulated flight clearance transient profile at 1140 F, 120 psig, with a maximum error of only 0.0012 in. Comparison of average dynamic leakage of the system with average static leakage did not show significant differences between the two operating conditions. Calculated effective clearance values for the rig were approximately 0.0002 in. at 120 psig, well below the industry specified effective clearance threshold of 0.001 in. Author

Active Control; Actuators; Hydraulic Equipment; Test Chambers; Gas Turbine Engines

20080012607 NASA Glenn Research Center, Cleveland, OH, USA

Effect of Pressure on Piloted Ignition Delay of PMMA

McAllister, Sara; Lai, Janice; Scott, Sarah; Ramirez-Correa, Amelia; Fernandez-Pello, Carlos; Urban, David; Ruff, Gary; [2008]; 9 pp.; In English; 36th AIAA Aerospace Sciences Meeting, 7-10 Jan. 2008, Reno, NV, USA; Original contains color and black and white illustrations

Contract(s)/Grant(s): NNC05GA02G; Copyright; Avail.: CASI: A02, Hardcopy

In order to reduce the risk of decompression sickness associated with spacewalks, NASA is considering designing the next generation of exploration vehicles and habitats with a different cabin environment than used previously. The proposed environment uses a total cabin pressure of 52.7 to 58.6 kPa with an oxygen concentration of 30 to 34% by volume and was chosen with material flammability in mind. Because materials may burn differently under these conditions and there is little information on how this new environment affects the flammability of the materials onboard, it is important to conduct material flammability experiments at the intended exploration atmosphere. One method to evaluate material flammability is by its ease of ignition. To this end, piloted ignition delay tests were conducted in the Forced Ignition and Spread Test (FIST) apparatus subject to this new environment. In these tests, polymethylmethacylate (PMMA) was exposed to a range of oxidizer flow velocities and externally applied heat fluxes. The ultimate goal is to determine the individual effect of pressure and the combined effect of pressure and oxygen concentration on the ignition delay. Tests were conducted for a baseline case of normal pressure and oxygen concentration, low pressure (58.6 kPa) with normal oxygen (21%). Future work will focus on low pressure with 32% oxygen concentration (space exploration atmosphere - SEA) conditions. It was found that reducing the pressure while keeping the oxygen concentration at 21% reduced the ignition time by 17% on average. It was also noted that the critical heat flux for ignition decreases in low-pressure conditions. Because tests conducted in standard atmospheric conditions will underpredict the flammability of materials intended for use on spacecraft, fire safety onboard at exploration atmospheres may be compromised.

Author

Pressure Effects; Cabin Atmospheres; Decompression Sickness; Pressure Reduction; Ignition

20080012737 NASA Glenn Research Center, Cleveland, OH, USA

Imaging and Analysis of Void-defects in Solder Joints Formed in Reduced Gravity using High-Resolution Computed Tomography

Easton, John W.; Struk, Peter M.; Rotella, Anthony; January 08, 2008; 10 pp.; In English; AIAA Aerospace Sciences Meeting and Exhibit, 7-10 Jan. 2008, Reno, NV, USA; Original contains color and black and white illustrations

Contract(s)/Grant(s): WBS 140765.04.01.02.03; Copyright; Avail.: CASI: A02, Hardcopy

As a part of efforts to develop an electronics repair capability for long duration space missions, techniques and materials for soldering components on a circuit board in reduced gravity must be developed. This paper presents results from testing solder joint formation in low gravity on a NASA Reduced Gravity Research Aircraft. The results presented include joints formed using eutectic tin-lead solder and one of the following fluxes: (1) a no-clean flux core, (2) a rosin flux core, and (3) a solid solder wire with external liquid no-clean flux. The solder joints are analyzed with a computed tomography (CT) technique which imaged the interior of the entire solder joint. This replaced an earlier technique that required the solder joint to be destructively ground down revealing a single plane which was subsequently analyzed. The CT analysis technique is described and results presented with implications for future testing as well as implications for the overall electronics repair effort discussed.

Author

Defects; High Resolution; Imaging Techniques; Microgravity; Research Aircraft; Soldered Joints; Computer Aided Tomography

20080012742 NASA Glenn Research Center, Cleveland, OH, USA

Characteristics of Elastomer Seals Exposed to Space Environments

Daniels, Christopher C.; deGroh, Henry, III; Dunlap, Patrick H., Jr.; Finkbeiner, Joshua R.; Steinetz, Bruce M.; Bastrzyk, Marta B.; Oswald, Jay J.; Banks, Bruce A.; Dever, Joyce A.; Miller, Sharon K.; Waters, Deborah L.; January 2008; 44 pp.; In English; 43rd AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, 8-11 Jul. 2007, Cincinnati, OH, USA; Original contains color and black and white illustrations

Contract(s)/Grant(s): WBS 644423.06.31.04.01.03.22

Report No.(s): NASA/TM-2008-215005; AIAA Paper-2007-5741; E-16189; Copyright; Avail.: CASI: A03, Hardcopy

A universal docking and berthing system is being developed by the National Aeronautics and Space Administration (NASA) to support all future space exploration missions to low-Earth orbit (LEO), to the Moon, and to Mars. The Low Impact

Docking System (LIDS) is being designed to operate using a seal-on-seal configuration in numerous space environments, each having unique exposures to temperature, solar radiation, reactive elements, debris, and mission duration. As the LIDS seal is likely to be manufactured from an elastomeric material, performance evaluation of elastomers after exposure to atomic oxygen (AO) and ultraviolet radiation (UV) was conducted, of which the work presented herein was a part. Each of the three candidate silicone elastomer compounds investigated, including Esterline ELA-SA-401, and Parker Hannifin S0383-70 and S0899-50, was characterized as a low outgassing compound, per ASTM E595, having percent total mass loss (TML) less than 1.0 percent and collected volatile condensable materials (CVCM) less than 0.1 percent. Each compound was compatible with the LIDS operating environment of -50 to 50 C. The seal characteristics presented include compression set, elastomer-to-elastomer adhesion, and o-ring leakage rate. The ELA-SA-401 compound had the lowest variation in compression set with temperature. The S0383-70 compound exhibited the lowest compression set after exposure to AO and UV. The adhesion for all of the compounds was significantly reduced after exposure to AO and was further decreased after exposure to AO and UV. The leakage rates of o-ring specimens showed modest increases after exposure to AO. The leakage rates after exposure to AO and UV were increased by factors of up to 600 when compared to specimens in the as-received condition.
Author
Elastomers; Ultraviolet Radiation; Oxygen Atoms; Exposure; Docking; Aerospace Environments; Debris; O Ring Seals

20080013150 NASA Glenn Research Center, Cleveland, OH, USA
Ballistic Impact Response of Kevlar 49 and Zylon under Conditions Representing Jet Engine Fan Containment
Pereira, J. Michael; Revilock, Duane M.; [2007]; 10 pp.; In English; Original contains color illustrations
Contract(s)/Grant(s): WBS 984754.02.07.03.16.05; No Copyright; Avail.: CASI: A02, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080013150

A ballistic impact test program was conducted to provide validation data for the development of numerical models of blade out events in fabric containment systems. The impact response of two different fiber materials - Kevlar 49 (E.I. DuPont Nemours and Company) and Zylon AS (Toyobo Co., Ltd.) was studied by firing metal projectiles into dry woven fabric specimens using a gas gun. The shape, mass, orientation and velocity of the projectile were varied and recorded. In most cases the tests were designed such that the projectile would perforate the specimen, allowing measurement of the energy absorbed by the fabric. The results for both Zylon and Kevlar presented here represent a useful set of data for the purposes of establishing and validating numerical models for predicting the response of fabrics under conditions simulating those of a jet engine blade release situation. In addition some useful empirical observations were made regarding the effects of projectile orientation and the relative performance of the different materials.
Author
Containment; Jet Engines; Kevlar (Trademark); Mathematical Models; Terminal Ballistics; Fans

39
STRUCTURAL MECHANICS

Includes structural element design, analysis and testing; dynamic responses of structures; weight analysis; fatigue and other structural properties; and mechanical and thermal stresses in structures. For applications see *05 Aircraft Design, Testing and Performance*; and *18 Spacecraft Design, Testing and Performance*.

20080013159 NASA Dryden Flight Research Center, Edwards, CA, USA
10.2 Thermal-Structural Testing
Hudson, Larry D.; February 28, 2008; 33 pp.; In English; Original contains color and black and white illustrations; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080013159

Objective: Test a C/SiC Ruddervator Subcomponent under relevant thermal, mechanical & dynamic loading a) Thermal-structural mission cycling for re-entry and hypersonic cruise conditions; b) High-temperature modal survey to study the effect of heating on mode shapes, natural frequencies and damping. Supports NASA ARMD Hypersonics Material & Structures Program. Partners: NASA Dryden / Langley / Glenn, Lockheed-Martin, Materials Research & Design, GE CCP Test Phases - Phase 1: Acoustic-Vibration Testing (LaRC) completed - Phase 2: Thermal-Mechanical Testing (DFRC) in assembly - Phase 3: Mechanical Testing (DFRC) in assembly
Author
Dynamic Loads; Thermal Cycling Tests; Temperature Effects; Resonant Frequencies; Hypersonics

20080013355 NASA Glenn Research Center, Cleveland, OH, USA

Recent Advanced Signal Processing Methods for Waveform-based NDE Methods

Roth, Don J.; Aldrin, John C.; Seebo, Jeff P.; Trinh, Long B.; Walker, James L.; Winfree, William P.; December 27, 2006; 1 pp.; In English; Copyright; Avail.: Other Sources; Abstract Only

The critical NASA problem of foam release from the foam-based thermal protection system of the Space Shuttle external tank during ascent has spurred the advanced development and tailoring of NDE methods to inspect the foam for flaws that might facilitate release. NDE methods under consideration include terahertz, microwave, shearography and xray backscatter imaging. In parallel with the development of waveform-based methods such as terahertz, a sophisticated broadband signal and image processing software package has been developed. One of the unique aspects of the software is the inclusion of a merit assessment algorithm to 'grade' various signal processing methods by providing a quantitative measure well correlated to the ability to subjectively distinguish flaw data from noise or background data. This chapter describes the software and provides a case history for its focus and use to process and analyze terahertz imaging results on a foam sample standard containing seeded voids.

Author

Nondestructive Tests; Signal Processing; Space Shuttles; Waveforms; Metal Foams; Thermal Protection

20080013363 NASA Langley Research Center, Hampton, VA, USA

Geometrically Nonlinear Shell Analysis of Wrinkled Thin-Film Membranes with Stress Concentrations

Tessler, Alexander; Sleight, David W.; January 2006; 21 pp.; In English; Original contains color and black and white illustrations

Contract(s)/Grant(s): WBS 992858.13.07.03; No Copyright; Avail.: CASI: A03, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080013363

Geometrically nonlinear shell finite element analysis has recently been applied to solar-sail membrane problems in order to model the out-of-plane deformations due to structural wrinkling. Whereas certain problems lend themselves to achieving converged nonlinear solutions that compare favorably with experimental observations, solutions to tensioned membranes exhibiting high stress concentrations have been difficult to obtain even with the best nonlinear finite element codes and advanced shell element technology. In this paper, two numerical studies are presented that pave the way to improving the modeling of this class of nonlinear problems. The studies address the issues of mesh refinement and stress-concentration alleviation, and the effects of these modeling strategies on the ability to attain converged nonlinear deformations due to wrinkling. The numerical studies demonstrate that excessive mesh refinement in the regions of stress concentration may be disadvantageous to achieving wrinkled equilibrium states, causing the nonlinear solution to lock in the membrane response mode, while totally discarding the very low-energy bending response that is necessary to cause wrinkling deformation patterns.

Author

Nonlinearity; Stress Concentration; Thin Films; Mathematical Models; Surface Geometry; Shells (Structural Forms); Solar Sails

42
GEOSCIENCES (GENERAL)

Includes general research topics related to the Earth sciences, and the specific areas of petrology, mineralogy, and general geology. For other specific topics in geosciences see *categories 42 through 48*.

20080013140 NASA Langley Research Center, Hampton, VA, USA

Equatorial Enhancement of the Nighttime OH Mesospheric Infrared Airglow

Baker, D. J.; Mlynczak, M. G.; Russell, J. M.; Physica Scripta; March 08, 2007; Volume 75, pp. 615-619; In English; Copyright; Avail.: Other Sources; Abstract Only

ONLINE: http://dx.doi.org/10.1088/0031-8949/75/5/004

Global measurements of the hydroxyl mesospheric airglow over an extended period of time have been made possible by the NASA SABER infrared sensor aboard the TIMED satellite which has been functioning since December of 2001. The orbital mission has continued over a significant portion of a solar cycle. Experimental data from SABER for several years have exhibited equatorial enhancements of the nighttime mesospheric OH (delta v = 2) airglow layer consistent with the high average diurnal solar flux. The brightening of the OH airglow typically means more H + O3 is being reacted. At both the spring and autumn seasonal equinoxes when the equatorial solar UV irradiance mean is greatest, the peak volume emission rate

(VER) of the nighttime Meinel infrared airglow typically appears to be both significantly brighter plus lower in altitude by several kilometres at low latitudes compared with midlatitude findings.
Author
Mesosphere; Night; Airglow; Infrared Radiation; Hydroxides; Equatorial Regions; Augmentation

20080013264 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Orbit Design Based on the Global Maps of Telecom Metrics
Lee, Charles H.; Cheung, Kar-Ming; Edwards, Chad; Noreen, Gary K.; Vaisnys, Arvydas; March 2, 2004; 6 pp.; In English; IEEE Aerospace Conference, 5-12 Mar. 2005, Big Sky, MT, USA; Original contains color illustrations
Report No.(s): IEEE Aerospace Conference 2004 Paper No. 1376; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40712

In this paper we describe an orbit design aide tool, called Telecom Orbit Analysis and Simulation Tool(TOAST). Although it can be used for studying and selecting orbits for any planet, we solely concentrate on its use for Mars. By specifying the six orbital elements for an orbit, a time frame of interest, a horizon mask angle, and some telecom parameters such as the transmitting power, frequency, antenna gains, antenna losses, link margin, received threshold powers for the rates, etc. this tool enables the user to view the animation of the orbit in two and three-dimensional different telecom metrics at any point on the Mars, namely the global planetary map.
Author
Planetary Mapping; Mars Surface; Orbital Elements; Antenna Gain; Frequencies

20080013291 NASA Marshall Space Flight Center, Huntsville, AL, USA
Inner Magnetospheric Electric Fields Derived from IMAGE EUV
Gallagher, D. L.; Adrian, M. L.; December 10, 2007; 1 pp.; In English; AGU Fall Meeting, 10-14 Dec. 2007, San Francisco, CA, USA; No Copyright; Avail.: Other Sources; Abstract Only

The local and global patterns of plasmaspheric plasma transport reflect the influence of electric fields imposed by all sources in the inner magnetosphere. Image sequences of thermal plasma G:istribution obtained from the IMAGE Mission Extreme Ultraviolet Imager can be used to derive plasma motions and, using a magnetic field model, the corresponding electric fields. These motions and fields directly reflect the dynamic coupling of injected plasmasheet plasma and the ionosphere, in addition to solar wind and atmospheric drivers. What is being learned about the morphology of inner magnetospheric electric fields during storm and quite conditions from this new empirical tool will be presented and discussed.
Author
Electric Fields; Extreme Ultraviolet Radiation; Magnetospheres; Image Satellite

20080013296 Colorado Univ., Boulder, CO, USA
A Comparison of Land Surface Model Soil Hydraulic Properties Estimated by Inverse Modeling and Pedotransfer Functions
Gutmann, Ethan D.; Small, Eric E.; Water Resources Research; May 10, 2007; Volume 43; 1 pp.; In English
Contract(s)/Grant(s): NNG04GO83G; Copyright; Avail.: Other Sources; Abstract Only
ONLINE: http://dx.doi.org/10.1029/2006WR005135

Soil hydraulic properties (SHPs) regulate the movement of water in the soil. This in turn plays an important role in the water and energy cycles at the land surface. At present, SHPS are commonly defined by a simple pedotransfer function from soil texture class, but SHPs vary more within a texture class than between classes. To examine the impact of using soil texture class to predict SHPS, we run the Noah land surface model for a wide variety of measured SHPs. We find that across a range of vegetation cover (5 - 80% cover) and climates (250 - 900 mm mean annual precipitation), soil texture class only explains 5% of the variance expected from the real distribution of SHPs. We then show that modifying SHPs can drastically improve model performance. We compare two methods of estimating SHPs: (1) inverse method, and (2) soil texture class. Compared to texture class, inverse modeling reduces errors between measured and modeled latent heat flux from 88 to 28 w/m(exp 2). Additionally we find that with increasing vegetation cover the importance of SHPs decreases and that the van Genuchten m parameter becomes less important, while the saturated conductivity becomes more important.
Author
Earth Surface; Soil Science; Soils; Surface Properties; Textures; Hydrology

20080013344 NASA Marshall Space Flight Center, Huntsville, AL, USA

Discovering the Ancient Maya From Space

Sever, T. L.; November 08, 2007; 1 pp.; In English; Saint Louis Explorer's Society Monthly Meeting, 8 Nov. 2007, Saint Lous, MO, USA; No Copyright; Avail.: Other Sources; Abstract Only

The Peten region of northern Guatemala contains some of the most significant Mayan archeological sites in Latin America. It was in this region that the Maya civilization began, flourished, and abruptly disappeared. Remote sensing technology is helping to locate and map ancient Maya sites that are threatened today by accelerating deforestation and looting. Thematic Mapper, IKONOS, and QuickBird satellite, and airborne STAR-3i and AIRSAR radar data, combined with Global Positioning System (GPS) technology, are successfully detecting ancient Maya features such as sites, roadways, canals, and water reservoirs. Satellite imagery is also being used to map the bajos, which are seasonally flooded swamps that cover over 40% of the land surface. Through the use of various airborne and satellite sensor systems we have been able to detect and map ancient causeways, temples, reservoirs, and land forms, and locate these features on the ground through GPS technology. Recently, we have discovered that there is a strong relationship between a tropical forest vegetation signature in satellite imagery and the location of archeological sites. We believe that the use o f limestone and lime plasters in ancient Maya construction affects the moisture, nutrition, and plant species of the surface vegetation. We have mapped these vegetation signatures in the imagery and verified through field survey that they are indicative of archeological sites. Through the use of remote sensing and GIS technology it is possible to identify unrecorded archeological features in a dense tropical forest environment and monitor these cultural features for their protection.

Author

Archaeology; Satellite Imagery; Thematic Mappers (Landsat); Remote Sensing; Radar Data; Global Positioning System; Airborne Equipment; Landforms

43
EARTH RESOURCES AND REMOTE SENSING

Includes remote sensing of earth features, phenomena and resources by aircraft, balloon, rocket, and spacecraft; analysis of remote sensing data and imagery; development of remote sensing products; photogrammetry; and aerial photography. For related instrumentation see *35 Instrumentation and Photography*.

20080012590 NASA Goddard Space Flight Center, Greenbelt, MD, USA

The Global Impact of Clouds on the Production of MODIS Bidirectional Reflectance Model-based Composites for Terrestrial Monitoring

Roy, D. P.; Lewis, P.; Schaaf, C. B.; Devadiga, S.; Boschetti, L.; IEEE Geoscience and Remote Sensing Letters; October 2006; Volume 3, No. 5, pp. 452-456; In English; Original contains black and white illustrations

Contract(s)/Grant(s): NNG04GP09; Copyright; Avail.: Other Sources

ONLINE: http://dx.doi.org/10.1109/LGRS.2006.875433

A global data set of cloud occurrence probability derived from Moderate Resolution Imaging Spectroradiometer (MODIS) Terra and Aqua gridded daily data is analyzed to investigate the probability of obtaining at least a minimum number of cloud-free observations within various compositing periods. The probabilities derived from Terra and Aqua, with morning and afternoon overpass times, respectively, are similar and increase with compositing period. Compositing both Terra and Aqua observations results is considerably higher probabilities of obtaining a sufficient number of observations for bidirectional reflectance model-based compositing. Given that the only alternative is obtaining sufficient samples to extend the observation period, which can cause significant problems when the surface state changes, it is concluded that using data from the two MODIS sensors provides the most effective way of generating composited products. Findings with respect to the availability of cloud free composites when n-day composites are generated on a temporally overlapping daily rolling basis, i.e., every day, rather than every n-days, are also discussed for regional and global applications.

Author

Bidirectional Reflectance; Imaging Spectrometers; MODIS (Radiometry); Probability Theory; Remote Sensing; Imaging Techniques

20080013204 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Performance Evaluation of the Geostationary Synthetic Thinned Array Radiometer (GeoSTAR) Demonstrator Instrument

Tanner, Alan B.; Wilson, William J.; Lambrigsten, Bjorn H.; Dinardo, Steven J.; Brown, Shannon T.; Kangaslahti, Pekka P.; Gaier, Todd C.; Ruf, C. S.; Gross, S. M.; Lim, B. H.; Musko, S.; Rogacki, S.; February 28, 2006; 19 pp.; In English; Original contains color and black and white illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40654

The design, error budget, and preliminary test results of a 50-56 GHz synthetic aperture radiometer demonstration system are presented. The instrument consists of a fixed 24-element array of correlation interferometers, and is capable of producing calibrated images with 0.8 degree spatial resolution within a 17 degree wide field of view. This system has been built to demonstrate performance and a design which can be scaled to a much larger geostationary earth imager. As a baseline, such a system would consist of about 300 elements, and would be capable of providing contiguous, full hemispheric images of the earth with 1 Kelvin of radiometric precision and 50 km spatial resolution.

Author

Microwave Radiometers; Synthetic Apertures; Performance Tests; Instrument Errors; Synthetic Arrays

20080013283 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

HAMSR - The High Altitude MMIC Sounding Radiometer

Lambrigtsen, Bjorn H.; Riley, A. L.; August 28, 2001; 6 pp.; In English; Earth Science Technology Conference, 28-30 Aug. 2001, MD, USA; Original contains color and black and white illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40692

WAMSR is a millimeter wave atmospheric temperature and humidity sounder that utilizes state of the art technology to enable substantial reductions in size and mass while at the same time achieve improved measurement sensitivity and accuracy. It is the first such instrument to use receivers based entirely on newly developed monolithic microwave integrated circuit technology. Sponsored by the NASA Instrument Incubator Program, HAMSR has been under development for the past 2 112 years. The first science mission takes place in Florida this summer, where HAMSR is deployed on the NASA ER-2 during the CAMEX-4 hurricane field campaign and will provide core atmospheric soundings to a number of investigators. HAMSR represents the next generation of microwave sounders.

Author

Microwave Sounding; Millimeter Waves; Radiometers; High Altitude; Atmospheric Sounding; Atmospheric Temperature; Time Measurement; Integrated Circuits; Microwave Circuits

20080013288 NASA Marshall Space Flight Center, Huntsville, AL, USA

Using High Frequency Passive Microwave, A-train, and TRMM Data to Evaluate Hydrometer Structure in the NASA GEOS-5 Data Assimilation System

Robertson, Franklin; Bacmeister, Julio; Bosilovich, Michael; Pittman, Jasna; December 10, 2007; 1 pp.; In English; AGU Fall Meeting, 10-14 Dec. 2007, San Francisco, CA, USA; No Copyright; Avail.: Other Sources; Abstract Only

Validating water vapor and prognostic condensate in global models remains a challenging research task. Model parameterizations are still subject to a large number of tunable parameters; furthermore, accurate and representative in situ observations are very sparse, and satellite observations historically have significant quantitative uncertainties. Progress on improving cloud / hydrometeor fields in models stands to benefit greatly from the growing inventory ofA-Train data sets. ill the present study we are using a variety of complementary satellite retrievals of hydrometeors to examine condensate produced by the emerging NASA Modem Era Retrospective Analysis for Research and Applications, MERRA, and its associated atmospheric general circulation model GEOS5. Cloud and precipitation are generated by both grid-scale prognostic equations and by the Relaxed Arakawa-Schubert (RAS) diagnostic convective parameterization. The high frequency channels (89 to 183.3 GHz) from AMSU-B and MRS on NOAA polar orbiting satellites are being used to evaluate the climatology and variability of precipitating ice from tropical convective anvils. Vertical hydrometeor structure from the Tropical Rainfall Measuring Mission (TRMM) and CloudSat radars are used to develop statistics on vertical hydrometeor structure in order to better interpret the extensive high frequency passive microwave climatology. Cloud liquid and ice water path data retrieved from the Moderate Resolution Imaging Spectroradiometer, MODIS, are used to investigate relationships between upper level cloudiness and tropical deep convective anvils. Together these data are used to evaluate cloud / ice water path, gross aspects of vertical hydrometeor structure, and the relationship between cloud extent and surface precipitation that the MERRA reanalysis must capture.

Author

High Frequencies; Hydrometers; Microwaves; TRMM Satellite; Earth Sciences; MODIS (Radiometry)

20080013334 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

MISR Multi-Angle Imaging SpectroRadiometer

Martonchik, John V.; June 2, 2003; 15 pp.; In English; First AEROCOM Model/Satellite Intercomparison Meeting, 2-3 Jun. 2003, Paris, France; Original contains black and white illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40644

This viewgraph presentation reviews the concept of the Multi-Angle Imaging SpectroRadiometer (MISR), a methodology to use the MISR to retrieve aerosols over water and land. The presentation shows some of the results of the use of the MISR in graphs and charts. Multi-angle remote sensing provides unique ways of retrieving aerosol properties over many surface types, including bright deserts which are major source regions.

CASI

Aerosols; MISR (Radiometry); Remote Sensing; Satellite Imagery

20080013336 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Hyperion On-Orbit Calibration Validation with AVIRIS in Argentina

Green, Robert O.; Chrien, Thomas; Pavri, Betina; November 6, 2001; 27 pp.; In English; EO-1 Argentina Summer Field Campaign Workshop and Science Validation Team Meeting, 6 Nov. 2001, Buenos Aires, Argentina; Original contains black and white illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40646

This viewgraph presentation reviews the AVIRIS Argentina Campaign. 125 flight lines were collected for EO-1 science validation team and CONAE-funded investigators. The preliminary results from two vicarious calibration experiments conducted in Argentina are shown. AVIRIS has been shown to be well calibrated. Charts of optical depth measurements, calibration target measured surface reflectance, top-of atmosphere radiance, and images of various sites in Argentina are shown

Author

Argentina; Infrared Spectrometers; Spectral Reflectance; Surface Properties

20080013364 NASA Langley Research Center, Hampton, VA, USA

Terrain-Moisture Classification Using GPS Surface-Reflected Signals

Grant, Michael S.; Acton, Scott T.; Katzberg, Stephen J.; January 2006; 6 pp.; In English; Original contains black and white illustrations

Contract(s)/Grant(s): 992858.13.07.02; Copyright; Avail.: CASI: A02, Hardcopy

In this study we present a novel method of land surface classification using surface-reflected GPS signals in combination with digital imagery. Two GPS-derived classification features are merged with visible image data to create terrain-moisture (TM) classes, defined here as visibly identifiable terrain or landcover classes containing a surface/soil moisture component. As compared to using surface imagery alone, classification accuracy is significantly improved for a number of visible classes when adding the GPS-based signal features. Since the strength of the reflected GPS signal is proportional to the amount of moisture in the surface, use of these GPS features provides information about the surface that is not obtainable using visible wavelengths alone. Application areas include hydrology, precision agriculture, and wetlands mapping.

Author

Classifications; Global Positioning System; Soil Moisture; Terrain; Aerial Photography

44
ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells; and solar, geothermal, windpower, and waterwave conversion systems; energy storage; and traditional power generators. For technologies related to nuclear energy production see *73 Nuclear Physics*. For related information see also *07 Aircraft Propulsion and Power; 20 Spacecraft Propulsion and Power*; and *28 Propellants and Fuels*.

20080012553 Auburn Univ., AL, USA

New 5 Kilowatt Free-piston Stirling Space Convertor Developments

Brandhorst, Henry W., Jr.; Chapman, Peter A., Jr.; September 24, 2007; 7 pp.; In English; 58th International Astronautical Congress, 24-28 Sep. 2007, Hyderabad, India; Original contains color and black and white illustrations

Contract(s)/Grant(s): NNC06CB81C

Report No.(s): IAC-07-C3.2.07; No Copyright; Avail.: CASI: A02, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080012553

The NASA Vision for Exploration of the moon may someday require a nuclear reactor coupled with a free-piston Stirling

convertor at a power level of 30-40 kW. In the 1990s, Mechanical Technology Inc. s Stirling Engine Systems Division (some of whose Stirling personnel are now at Foster-Miller, Inc.) developed a 25 kW free piston Stirling Space Power Demonstrator Engine under the SP-100 program. This system consisted of two 12.5 kW engines connected at their hot ends and mounted in tandem to cancel vibration. Recently, NASA and DoE have been developing dual 55 W and 80 W Stirling convertor systems for potential use with radioisotope heat sources. Total test times of all convertors in this effort exceed 120,000 hours. Recently, NASA began a new project with Auburn University to develop a 5 kW, single convertor for potential use in a lunar surface reactor power system. Goals of this development program include a specific power in excess of 140 W/kg at the convertor level, lifetime in excess of five years and a control system that will safely manage the convertors in case of an emergency. Auburn University awarded a subcontract to Foster-Miller, Inc. to undertake development of the 5 kW Stirling Convertor Assembly. The characteristics of the design along with progress in developing the system will be described.
Author
Stirling Engines; Radioisotope Heat Sources; Piston Engines; Stirling Cycle; Space Power Reactors; Power Converters

20080012733 Foster-Miller Technologies, Inc., Albany, NY, USA
5-kWe Free-piston Stirling Engine Convertor
Chapman, Peter A.; Vitale, Nicholas A.; Walter, Thomas J.; February 10, 2008; 8 pp.; In English; Space Technology Applications International Forum (STAIF-2008), 10-14 Feb. 2008, Albuquerque, NM, USA; Original contains color and black and white illustrations
Contract(s)/Grant(s): NNC06CB81C; 07-SRI-208446-FMI; WBS 463169.04.03.04.01.03; No Copyright; Avail.: CASI: A02, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012733

The high reliability, long life, and efficient operation of Free-Piston Stirling Engines (FPSEs) make them an attractive power system to meet future space power requirements with less mass, better efficiency, and less total heat exchanger area than other power convertor options. FPSEs are also flexible in configuration as they can be coupled with many potential heat sources and various heat input systems, heat rejection systems, and power management and distribution systems. Development of a 5-kWe Stirling Convertor Assembly (SCA) is underway to demonstrate the viability of an FPSE for space power. The design is a scaled-down version of the successful 12.5-kWe Component Test Power Converter (CTPC) developed under NAS3-25463. The ultimate efficiency target is 25% overall convertor efficiency (electrical power out over heat in). For the single cylinder prototype now in development, cost and time constraints required use of economical and readily available materials (steel versus beryllium) and components (a commercially available linear alternator) and thus lower efficiency. The working gas is helium at 150 bar mean pressure. The design consists of a displacer suspended on internally pumped gas bearings and a power piston/alternator supported on flexures. Non-contacting clearance seals are used between internal volumes. Heat to and from the prototype convertor is done via pumped liquid loops passing through shell and tube heat exchangers. The preliminary and detail designs of the convertor, controller, and support systems (heating loop, cooling loop, and helium supply system) are complete and all hardware is on order. Assembly and test of the prototype at Foster- Miller is planned for early 2008, when work will focus on characterizing convertor dynamics and steady-state operation to determine maximum power output and system efficiency. The device will then be delivered to Auburn University where assessments will include start-up and shutdown characterization and transient response to temperature and load variations. Future activities may include testing at NASA GRC.
Author
Stirling Engines; Power Converters; Free-Piston Engines; Power Efficiency; Stirling Cycle; Controllers; Heat Exchangers; Tube Heat Exchangers

45
ENVIRONMENT POLLUTION

Includes atmospheric, water, soil, noise, and thermal pollution.

20080013200 American Inst. of Aeronautics and Astronautics, Reston, VA, USA
Climate Change: A Geoengineering Fix?
David, Leonard; Aerospace America; September 2007; ISSN 0740-722CX; Volume 45, No. 9, pp. 32-38; In English; Original contains poor quality, truncated or crooked pages; Copyright; Avail.: Other Sources

This document discusses creative remedies for addressing global warming and climate change, including geoengineering--making choices that involve large-scale engineering of Earth's environment to take on the effects of altered

atmospheric chemistry. Study findings suggest that even after greenhouse gases warm the planet, geoengineering schemes could cool it off within a few decades to temperatures not seen since the dawn of the industrial revolution. Some approaches could involve power-beaming microwave energy from satellites to weaken storms, or launching millions of small spacecraft that would shade the planet from sunlight to offset global warming. However, Intergovernmental Panel on Climate Change (IPCC) experts sense that geoengineering options remain largely speculative and unproven. They also carry with them the risk of unknown side effects and reliable cost estimates for these options have not yet been established.
Derived from text
Climate Change; Global Warming; Greenhouse Effect; Environmental Engineering; Atmospheric Chemistry

46
GEOPHYSICS

Includes Earth structure and dynamics, aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism. For related information see *47 Meteorology and Climatology*; and *93 Space Radiation*.

20080012477 NASA Johnson Space Center, Houston, TX, USA; Hamilton Sundstrand Corp., Houston, TX, USA
Synthetic (Hydrothermal) Hematite-Rich Mars-Analog Spherules from Acid-Sulfate Brines: Implications for Formation and Diagenesis of Hematite Spherules in Outcrops at Meridiani Planum, Mars
Golden, D. C.; Ming, D. W.; Morris, R. V.; Graff, T. G.; [2008]; 2 pp.; In English; 39th Lunar and Planetary Science Conference, 10-14 Mar. 2008, League City, TX; Original contains black and white illustrations; Copyright; Avail.: CASI: A01, Hardcopy

The Thermal Emission Spectrometer (TES) onboard the Mars Global Surveyor (MGS) orbiter discovered a large area at Meridiani Planum (MP) covered with the Fe-oxide hematite (alpha-Fe2O3) [1,2]. This discovery and favorable landing site characteristics led to selection of MP as the landing site for the Opportunity Mars Exploration Rover (MER) [3]. The Athena science payload onboard the Opportunity rover identified hematite-rich spherules (mean spherule diameter approx.4.2+/-0.8 mm) embedded in S-rich outcrop rock and also as lag deposits of whole and broken spherules [4,5,6,7,8,9]. Although the chemical and mineralogical compositions of spherules are not fully constrained, Moessbauer spectrometer (MB) Miniature Thermal Emission Spectrometer (Mini-TES) and chemical analyses from the Alpha Particle X-Ray Spectrometer (APXS) are consistent with a hematite mineralogical composition and an oxide bulk chemical composition consisting of Fe2O3. MGS-TES, also provides an important constraint that emission from the hematite-rich spherules is dominated by emission along the crystallographic c-axis [1,2,10,11]. The formation of hematite-rich spherules with similar chemical, mineralogical, morphological, and crystallographic properties to the MP spherules is rare on Earth, to date, only two natural analogs have been proposed; one from Utah (Navaho Concretions) and the other from Mauna Kea, Hawaii [12,13]. In this study, we synthesized in the laboratory hematite-rich spherules using conditions that may have existed on Early Mars [14] and compared their properties to those for MP hematite spherules of Mars and the analog spherules from Utah and Mauna Kea in order to assess their relative merit as MP hematite spherule analogs. Such comparisons yield clues to the formation pathway for MP spherules.
Author
Chemical Composition; Thermal Emission; X Ray Spectrometers; Iron Oxides; Hematite; Mineralogy; Geochemistry

20080012486 NASA Johnson Space Center, Houston, TX, USA
A Simplified View of the Geochemical Diversity Surrounding Home Plate
Yen, A. S.; Morris, R. V.; Clark, B. C.; Gellert, R.; [2008]; 2 pp.; In English; 39th Lunar Planetary Science Conference, 10-14 Mar. 2008, League City, TX, USA; Original contains color and black and white illustrations; Copyright; Avail.: CASI: A01, Hardcopy

The Home Plate feature (Fig. 1) within the Inner Basin of the Columbia Hills consists of layered rocks and has been interpreted as an accumulation of pyroclastic deposits [1]. Samples analyzed by the Alpha Particle X-ray Spectrometer within ~25 meters of the eastern margin of Home Plate exhibit a strikingly diverse range of geochemical compositions, including the highest levels of Mg, Si, K, Zn, and Ni measured at Gusev Crater. This wide range of chemical variability across the 40+ samples analyzed on and near Home Plate can be represented by contributions from only six primary components. This reconstruction is not reflected in the M ssbauer mineralogy suggesting that significant alteration of the contributing components has occurred.
Derived from text
Geochemistry; Alpha Particles; Mineralogy; X Ray Spectrometers; Mars Landing Sites; Mars Craters

20080012523 NASA Johnson Space Center, Houston, TX, USA

Prospects for Chronological Studies of Martian Rocks and Soils

Nyquist, L. E.; Shih, C-Y.; Reese, Y. D.; January 2008; 2 pp.; In English; Ground Truth from Mars: Science Payoff from a Sample Return Mission, 21-23 Apr. 2008, Albuquerque, NM, USA; Original contains color illustrations; [2008]; Copyright; Avail.: CASI: A01, Hardcopy

Chronological information about Martian processes comes from two sources: Crater-frequency studies and laboratory studies of Martian meteorites. Each has limitations that could be overcome by studies of returned Martian rocks and soils. Chronology of Martian volcanism: The currently accepted chronology of Martian volcanic surfaces relies on crater counts for different Martian stratigraphic units [1]. However, there is a large inherent uncertainty for intermediate ages near ~2 Ga ago. The effect of differing preferences for Martian cratering chronologies [1] is shown in Fig. 1. Stoeffler and Ryder [2] summarized lunar chronology, upon which Martian cratering chronology is based. Fig. 2 shows a curve fit to their data, and compares to it a corresponding lunar curve from [3]. The radiometric ages of some lunar and Martian meteorites as well as the crater-count delimiters for Martian epochs [4] also are shown for comparison to the craterfrequency curves. Scaling the Stoeffler-Ryder curve by a Mars/Moon factor of 1.55 [5] places Martian shergottite ages into the Early Amazonian to late Hesperian epochs, whereas using the lunar curve of [3] and a Mars/Moon factor ~1 consigns the shergottites to the Middle-to-Late Amazonian, a less probable result. The problem is worsened if a continually decreasing cratering rate since 3 Ga ago is accepted [6]. We prefer the adjusted St ffler-Ryder curve because it gives better agreement with the meteorite ages (Fig.

Derived from text

Chronology; Soils; Rocks; SNC Meteorites; Planetary Geology; Shergottites; Mars Volcanoes; Mars Surface; Mars Craters

20080012532 NASA Johnson Space Center, Houston, TX, USA

Chemostratigraphy and Fe Mineralogy of the Victoria Crater Duck Bay Section: Opportunity APXS and Moessbauer Results

Mittlefehldt, D. W.; Schroeder, C.; Gellert, R.; Klingelhoefer, G.; Jolliff, B. L.; Morris, R. V., et al.; [2008]; 2 pp.; In English; 39th Lunar and Planetary Science Conference, 10-14 Mar. 2008, League City, TX, USA; Original contains color and black and white illustrations; Copyright; Avail.: CASI: A01, Hardcopy

Meridiani Planum is a vast plain of approximately horizontally bedded sedimentary rocks composed of mixed and reworked basaltic and evaporitic sands containing secondary, diagenetic minerals [e.g., 1-5]. Because bedding planes are subparallel to topography, investigation of contiguous stratigraphy requires examining exposures in impact craters. Early in the mission (sols 130-317), Opportunity was commanded to do detailed study of exposed outcrops in Endurance crater, including the contiguous Karatepe section at the point of ingress. Just over 1000 sols later and roughly 7 km to the south, the rover is being commanded to do a similar study of the Duck Bay section of Victoria crater. Here we report on the preliminary results from the Alpha Particle X-ray Spectrometer (APXS) and Moessbauer instruments.

Author

Geochemistry; X Ray Spectrometers; Stratigraphy; Sedimentary Rocks; Basalt; Mineralogy; Minerals

20080013167 NASA Johnson Space Center, Houston, TX, USA

Sample Return from Ancient Hydrothermal Springs

Allen, Carlton C.; Oehler, Dorothy Z.; [2008]; 2 pp.; In English; Ground Truth from Mars: Science Payoff, 21-23 Apr. 2008, Albuquerque, NM, USA; Original contains color and black and white illustrations; No Copyright; Avail.: CASI: A01, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080013167

Hydrothermal spring deposits on Mars would make excellent candidates for sample return. Molecular phylogeny suggests that that life on Earth may have arisen in hydrothermal settings [1-3], and on Mars, such settings not only would have supplied energy-rich waters in which martian life may have evolved [4-7] but also would have provided warm, liquid water to martian life forms as the climate became colder and drier [8]. Since silica, sulfates, and clays associated with hydrothermal settings are known to preserve geochemical and morphological remains of ancient terrestrial life [9-11], such settings on Mars might similarly preserve evidence of martian life. Finally, because formation of hydrothermal springs includes surface and subsurface processes, martian spring deposits would offer the potential to assess astrobiological potential and hydrological history in a variety of settings, including surface mineralized terraces, associated stream deposits, and subsurface environments where organic remains may have been well protected from oxidation. Previous attempts to identify martian spring deposits from orbit have been general or limited by resolution of available data [12-14]. However, new satellite imagery

from HiRISE has a resolution of 28 cm/pixel, and based on these new data, we have interpreted several features in Vernal Crater, Arabia Terra as ancient hydrothermal springs [15, 16].
Derived from text
Geochemistry; Planetary Geology; Sample Return Missions; Mars Surface; Morphology; Silicon Dioxide; Satellite Imagery; Life Sciences; Exobiology

20080013197 NASA Marshall Space Flight Center, Huntsville, AL, USA
Recent Plasma Observations Related to Dayside Magnetic Merging and the Low-latitude Boundary Layer
Chandler, Michael O.; Avanov, Levon A.; Craven, Paul D.; Mozer, Forrest S.; Moore, Thomas E.; December 10, 2007; 1 pp.; In English; 2007 Fall Meeting of the American Geophysical Union, 10-14 Dec. 2007, San Francisco, CA, USA; No Copyright; Avail.: Other Sources; Abstract Only

We have begun an investigation of the nature of the low-latitude boundary layer in the mid-altitude cusp region using data from the Polar spacecraft. This region has been routinely sampled for about three months each year for the periods 1999-2001 and 2004-2006. The low-to-mid-energy ion instruments frequently observed dense, magnetosheath-like plasma deep (in terms of distance from the magnetopause and in invariant latitude) in the magnetosphere. One such case, taken during a period of northward interplanetary magnetic field (IMF), shows magnetosheath ions within the magnetosphere with velocity distributions resulting from two separate merging sites along the same field lines. Cold ionospheric ions were also observed counterstreaming along the field lines, evidence that these field lines were closed. These results are consistent with the hypothesis that double merging can produce closed field lines populated by solar wind plasma. Through the use of individual cases such as this and statistical studies of a broader database we seek to understand the morphology of the LLBL as it projects from the sub-solar region into the cusp. We will present preliminary results of our ongoing study.
Author
Boundary Layers; Plasmas (Physics); Geophysics; Interplanetary Magnetic Fields; Tropical Regions

20080013226 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Prospecting for In Situ Resources on the Moon and Mars Using Wheel-Based Sensors
Buehler, Martin G.; Anderson, Robert C.; Seshadri, Suresh; Schaap, Marcel G.; March 15, 2005; 9 pp.; In English; IEEE Aerospace Conference, 5-12 Mar. 2005, Big Sky, MT, USA; Original contains black and white illustrations
Report No.(s): Paper-1573/rev 1; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40693

The Apollo and Russian missions during 1970's were reviewed to rediscover the type and distribution of minerals on the Moon. This study revealed that the Moon is a relatively barren place in mineral content when compared with the Earth. Results from the Lunar minerals brought back to Earth, indicate that the Moon lacks water, hydroxyl ions, and carbon based minerals. Our approach to prospecting utilizes a vehicle with sensors embedded in a wheel that allow measurements while the vehicle is in motion. Once a change in soil composition is detected, decision making software stops the vehicle and analytical instruments perform a more definitive analysis of the soil. The focus of this paper is to describe the instrumentation and data from the wheel-based sensors.
Author
In Situ Resource Utilization; Minerals; Soils; Mars (Planet); Carbon; Embedding

20080013234 Colorado Univ., Boulder, CO, USA
The Effect of Soil Hydraulic Properties vs. Soil Texture in Land Surface Models
Gutmann, E. D.; Small, E. E.; Geophysical Research Letters; January 21, 2005; Volume 32; 1 pp.; In English
Contract(s)/Grant(s): NNC04GO83G; Copyright; Avail.: Other Sources; Abstract Only
ONLINE: http://dx.doi.org/10.1029/2004GL021843

This study focuses on the effect of Soil Hydraulic Property (SHP) selection on modeled surface fluxes following a rain storm in a semi-arid environment. SHPs are often defined based on a Soil Texture Class (STC). To examine the effectiveness of this approach, the Noah land surface model was run with each of 1306 soils in a large SHP database. Within most STCs, the outputs have a range of 350 W/m2 for latent and sensible heat fluxes, and 8K for surface temperature. The average difference between STC median values is only 100 W/m2 for latent and sensible heat. It is concluded that STC explains 5-15% of the variance in model outputs and should not be used to determine SHPs.
Derived from text
Soil Moisture; Arid Lands; Heat Flux; Rain; Soils

47
METEOROLOGY AND CLIMATOLOGY

Includes weather observation forecasting and modification.

20080013182 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Sensitivity of Stratospheric Retrievals from Radio Occultations on Upper Boundary Conditions

Ao, Chi O.; Hajj, George A.; Iijima, Byron A.; Mannucci, Anthony J.; Schroder, Thomas M.; delaTorreJuarez, Manuel; Leroy, Stephen S.; September 13, 2005; 9 pp.; In English; 2nd International Workshop on Occultations for Probing Atmosphere and Climate (OPAC), 13-17 Sep. 2004, Graz, Austria; Original contains black and white illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40630

The main uncertainty in the stratospheric retrievals from GPS radio occultation (RO) measurements comes from the lack of reliable measurements in the upper stratosphere and above where the bending due to the neutral atmosphere is weak and residual ionospheric effects are strong. In this work, we quantify the bias and uncertainty of the refractivity and temperature retrievals due to different upper boundary strategies using a simulation study. We use lidar refractivity and temperature profiles as the input states in generating the synthetic occultations. Random noise levels commensurate with the CHAMP RO measurements are then added to the simulated data. Through this study, the sensitivity of stratospheric retrievals to upper boundary methods and parameters are examined. Such error characterizations are important prerequisites towards the effective use of GPS RO data in climate monitoring.

Author

Radio Occultation; Global Positioning System; Stratosphere; Optical Radar; Noise Intensity; Temperature Profiles; Boundary Conditions; Climate; Random Noise

20080013189 NASA Marshall Space Flight Center, Huntsville, AL, USA

Climatology and Impact of Convection on the Tropical Tropopause Layer

Robertson, Franklin; Pittman, Jasna; December 10, 2007; 1 pp.; In English; AGU Fall Meeting, 10-14 Dec. 2007, San Francisco, CA, USA; No Copyright; Avail.: Other Sources; Abstract Only

Water vapor plays an important role in controlling the radiative balance and the chemical composition of the Tropical Tropopause Layer (TTL). Mechanisms ranging from slow transport and dehydration under thermodynamic equilibrium conditions to fast transport in convection have been proposed as regulators of the amount of water vapor in this layer. However,.details of these mechanisms and their relative importance remain poorly understood, The recently completed Tropical Composition, Cloud, and Climate Coupling (TC4) campaign had the opportunity to sample the.TTL over the Eastern Tropical Pacific using ground-based, airborne, and spaceborne instruments. The main goal of this study is to provide the climatological context for this campaign of deep and overshooting convective activity using various satellite observations collected during the summertime. We use the Microwave Humidity Sensor (MRS) aboard the NOAA-18 satellite to investigate the horizontal extent.and the frequency of convection reaching and penetrating into the TTL. We use the Moderate Resolution I1l1aging Spectroradiometer (MODIS) aboard the Aqua satellite to investigate the frequency distribution of daytime cirrus clouds. We use the Tropical Rainfall Measuring Mission(TRMM) and CloudSat to investigate the vertical structure and distribution of hydrometeors in the convective cells, In addition to cloud measurements; we investigate the impact that convection has on the concentration of radiatively important gases such as water vapor and ozone in the TTL by examining satellite measurement obtained from the Microwave Limb Sounder(MLS) aboard the Aura satellite.

Author

Tropopause; Chemical Composition; Convection; Climatology; Frequency Distribution; Microwave Sensors; Satellite Observation; Thermodynamic Equilibrium; Water Vapor

20080013195 NASA Marshall Space Flight Center, Huntsville, AL, USA

Forecasting Lightning Threat using Cloud-resolving Model Simulations

McCaul, Eugene W., Jr.; Goodman, Steven J.; LaCasse, Katherine M.; Cecil, Daniel J.; October 2007; 54 pp.; In English; Original contains color and black and white illustrations; Copyright; Avail.: Other Sources

Three separate methods are proposed and evaluated for making time and space-dependent short-term forecasts of lightning threat, using hydrometeor and reflectivity fields generated by cloud-resolving numerical simulations. These methods are based on established observational evidence linking cloud hydrometeor and reflectivity profile structure to total flash rates. The methods are straightforward and easy to implement, and offer an alternative to the incorporation of complex and costly

cloud electrification schemes into the models. One method is based on upward fluxes of precipitating ice hydrometeors at the -15 C level, while the second method is based on the profiles of radar reflectivity in the upper mixed-phase precipitation regions of storms. A third method is based on the vertically integrated amounts of ice hydrometeors in each model grid column. Each method can be roughly calibrated by comparing domainwide statistics of the simulated flash rate proxy fields against domainwide total lightning flash rate density data from observations. Our prototype tests for selected North Alabama cases show that; while models can distinguish intense storm events from weak ones, they have more difficulty in predicting the instantaneous placement and areal coverage of the storms, and hence of the lightning threat. Although these model shortcomings limit the precision of lightning threat forecasts from current generation models, the techniques proposed herein should continue to be useful as newer and more accurate physically-based model versions, physical parameterizations, initialization techniques and ensembles of forecasts become available.
Author
Lightning; Weather Forecasting; Atmospheric Models; Simulation; Clouds (Meteorology)

20080013201 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Microwave Sounder for GEOS-R - A GeoSTAR Progress Report
Lambrigtsen, Bjorn H.; Wilson, William; Tanner, Alan; Kangaslahti, Pekka P.; May 25, 2005; 11 pp.; In English; 14th International TOVS Study Conference, 25-31 May 2005, Beijing, China; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40637

The Geostationary Synthetic Thinned Aperture Radiometer (GeoSTAR) is a new concept for a microwave sounder, intended to be deployed on NOAA's next generation of geostationary weather satellites, GOES-R. A ground based prototype has been developed at the Jet Propulsion Laboratory, under NASA Instrument Incubator Program sponsorship, and is now undergoing tests and performance characterization. The initial space version of GeoSTAR will have performance characteristics equal to those of the AMSU system currently operating on polar orbiting environmental satellites, but subsequent versions will significantly outperform AMSU. In addition to all-weather temperature and humidity soundings, GeoSTAR will also provide continuous rain mapping, tropospheric wind profiling and real time storm tracking.
Author
Microwave Sounding; Synthetic Apertures; Radiometers; Geosynchronous Orbits; Atmospheric Temperature; Artificial Satellites; Real Time Operation

20080013203 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA; Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Forecasting of Weather Effects for the Deep Space Network
Mendoza, Ricardo; Benjauthrit, Boonsieng; July 3, 2005; 5 pp.; In English; 2005 IEEE International Symposium on Antennas, 3-8 Jul. 2005, Washington, DC, USA; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40638

This paper presents a proposed approach for Ka-band link management for deep space applications using daily weather forecasts and discusses the tools that will be employed for operations. Performance metrics are also presented. The proposed approach will be tested in a two-year experiment campaign.
Author
Deep Space Network; Weather Forecasting; Extremely High Frequencies

20080013252 Government Accountability Office, Washington, DC, USA
Services at Key Aviation Facilities Lack Performance Measures, but Improvement Efforts Are Under Way
February 26, 2008; 24 pp.; In English; Original contains black and white illustrations
Report No.(s): GAO-08-491T; No Copyright; Avail.: CASI: A03, Hardcopy

This document reports on the Government Accountability Office's (GAO's) assessment of National Weather Service (NWS) and the Federal Aviation Administration (FAA) efforts to ensure the quality of aviation weather services at en route centers, and its recommendations to improve these efforts. Additionally, GAO provides an update on the FAA's recent efforts to establish aviation weather requirements and performance measures, and NWS's plans for responding to these requirements. To summarize, even though center weather service units have been in operation for over two decades, neither the FAA nor NWS has implemented performance measures and metrics, regularly evaluated weather service unit performance, or provided

feedback to improve these aviation weather products and services. Until the agencies establish a system of performance tracking and oversight, NWS will not be able to demonstrate the quality or value of its services, and FAA will not be able to ensure the value of the service it funds. To address these shortfalls, FAA has defined more precise requirements that include performance measures and evaluation methods, and NWS is working to respond to these requirements. In its response, NWS is expected to prepare plans for three alternative operational concepts for fulfilling these requirements. In its response, NWS is expected to prepare plans for three alternative operational concepts for fulfilling these requirements. It is important that FAA and NWS work together to ensure that NWS's aviation weather services address requirements and that effective performance measures and evaluation methods are established. This collaboration will help both agencies ensure the quality and consistency of these services, and ensure that FAA has the information it needs to effectively manage air traffic.
CASI
Meteorological Services; Aviation Meteorology; Flight Safety; Government/Industry Relations; Information Dissemination; Air Traffic Control

20080013290 NASA Marshall Space Flight Center, Huntsville, AL, USA
Differences in the Optical Characteristics of Continental US Ground and Cloud Flashes as Observed from Space
Koshak, William; December 10, 2007; 1 pp.; In English; AGU Fall Meeting, 10-14 Dec. 2007, San Francisco, CA, USA; No Copyright; Avail.: Other Sources; Abstract Only

Continental US lightning flashes observed by the Optical Transient Detector (OTD) are categorized according to flash type (ground or cloud flash) using US National Lightning Detection Network (TM) (NLDN) data. The statistics of the ground and cloud flash optical parameters (e.g., radiance, area, duration, number of optical groups, and number of optical events) are inter-compared. On average, the ground flash cloud-top emissions are more radiant, illuminate a larger area, are longer lasting, and have more optical groups and optical events than those cloud-top emissions associated with cloud flashes. Given these differences, it is suggested that the methods of Bayesian Inference could be used to help discriminate between ground and cloud flashes. The ability to discriminate flash type on-orbit is highly desired since such information would help researchers and operational decision makers better assess the intensification, evolutionary state, and severe weather potential of thunderstorms. This work supports risk reduction activities presently underway for the future launch of the GOES-R Geostationary Lightning Mapper (GLM).
Author
Lightning; Optical Properties; Cloud Physics; Weather

20080013292 NASA Marshall Space Flight Center, Huntsville, AL, USA; Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Evaluation of Radiation Belt Space Weather Forecasts for Internal Charging Analyses
Minow, Joseph I.; Coffey, Victoria N.; Jun, Insoo; Garrett, Henry B.; December 10, 2007; 1 pp.; In English; AGU Fall Meeting, 10-14 Dec. 2007, San Francisco, CA, USA; No Copyright; Avail.: Other Sources; Abstract Only

A variety of static electron radiation belt models, space weather prediction tools, and energetic electron datasets are used by spacecraft designers and operations support personnel as internal charging code inputs to evaluate electrostatic discharge risks in space systems due to exposure to relativistic electron environments. Evaluating the environment inputs is often accomplished by comparing whether the data set or forecast tool reliability predicts measured electron flux (or fluence over a given period) for some chosen period. While this technique is useful as a model metric, it does not provide the information necessary to evaluate whether short term deviances of the predicted flux is important in the charging evaluations. In this paper, we use a 1-D internal charging model to compute electric fields generated in insulating materials as a function of time when exposed to relativistic electrons in the Earth's magnetosphere. The resulting fields are assumed to represent the 'true' electric fields and are compared with electric field values computed from relativistic electron environments derived from a variety of space environment and forecast tools. Deviances in predicted fields compared to the 'true' fields which depend on insulator charging time constants will be evaluated as a potential metric for determining the importance of predicted and measured relativistic electron flux deviations over a range of time scales.
Author
Radiation Belts; Space Weather; Weather Forecasting; Electrostatics; Electric Charge

20080013312 NASA Marshall Space Flight Center, Huntsville, AL, USA

Prediction of Geomagnetic Activity and Key Parameters in High-latitude Ionosphere

Khazanov, George V.; Lyatsky, Wladislaw; Tan, Arjun; Ridley, Aaron; December 10, 2007; 1 pp.; In English; 2007 Fall Meeting of the American Geophysical Union, 10-14 Dec. 2007, San Francisco, CA, USA; Copyright; Avail.: Other Sources; Abstract Only

Prediction of geomagnetic activity and related events in the Earth's magnetosphere and ionosphere are important tasks of US Space Weather Program. Prediction reliability is dependent on the prediction method, and elements included in the prediction scheme. Two of the main elements of such prediction scheme are: an appropriate geomagnetic activity index, and an appropriate coupling function (the combination of solar wind parameters providing the best correlation between upstream solar wind data and geomagnetic activity). We have developed a new index of geomagnetic activity, the Polar Magnetic (PM) index and an improved version of solar wind coupling function. PM index is similar to the existing polar cap PC index but it shows much better correlation with upstream solar wind/IMF data and other events in the magnetosphere and ionosphere. We investigate the correlation of PM index with upstream solar wind/IMF data for 10 years (1995-2004) that include both low and high solar activity. We also have introduced a new prediction function for the predicting of cross-polar-cap voltage and Joule heating based on using both PM index and upstream solar wind/IMF data. As we show such prediction function significantly increase the reliability of prediction of these important parameters. The correlation coefficients between the actual and predicted values of these parameters are approx. 0.9 and higher.

Author

Earth Magnetosphere; Geomagnetism; Space Weather; Earth Ionosphere; Polar Regions

51
LIFE SCIENCES (GENERAL)

Includes general research topics related to plant and animal biology (non-human); ecology; microbiology; and also the origin, development, structure, and maintenance of animals and plants in space and related environmental conditions. For specific topics in life sciences see *categories 52 through 55*.

20080012485 NASA Johnson Space Center, Houston, TX, USA

Amino Acid Degradation after Meteoritic Impact Simulation

Bertrand, M.; Westall, F.; vanderGaast, S.; Vilas, F.; Hoerz, F.; Barnes, G.; Chabin, A.; Brack, A.; [2008]; 2 pp.; In English; 39th Lunar Planetary Science Conference, 10-14 Mar. 2008, League City, TX, USA; Original contains color illustrations; Copyright; Avail.: CASI: A01, Hardcopy

Amino acids are among the most important prebiotic molecules as it is from these precursors that the building blocks of life were formed [1]. Although organic molecules were among the components of the planetesimals making up the terrestrial planets, large amounts of primitive organic precursor molecules are believed to be exogenous in origin and to have been imported to the Earth via micrometeorites, carbonaceous meteorites and comets, especially during the early stages of the formation of the Solar System [1,2]. Our study concerns the hypothesis that prebiotic organic matter, present on Earth, was synthesized in the interstellar environment, and then imported to Earth by meteorites or micrometeorites. We are particularly concerned with the formation and fate of amino acids. We have already shown that amino acid synthesis is possible inside cometary grains under interstellar environment conditions [3]. We are now interested in the effects of space conditions and meteoritic impact on these amino acids [4-6]. Most of the extraterrestrial organic molecules known today have been identified in carbonaceous chondrite meteorites [7]. One of the components of these meteorites is a clay with a composition close to that of saponite, used in our experiments. Two American teams have studied the effects of impact on various amino acids [8,9]. [8] investigated amino acids in saturated solution in water with pressure ranges between 5.1 and 21 GPa and temperature ranges between 412 and 870 K. [9] studied amino acids in solid form associated with and without minerals (Murchison and Allende meteorite extracts) and pressure ranges between 3 and 30 GPa. In these two experiments, the amino acids survived up to 15 GPa. At higher pressure, the quantity of preserved amino acids decreases quickly. Some secondary products such as dipeptides and diketopiperazins were identified in the [8] experiment.

Author

Meteorite Collisions; Micrometeorites; Simulation; Hypervelocity Impact; Amino Acids; Carbonaceous Meteorites; Degradation

20080012580 NASA Johnson Space Center, Houston, TX, USA

Three-Dimensionally Engineered Normal Human Lung Tissue-Like Assemblies: Target Tissues for Human Respiratory Viral Infections

Goodwin, Thomas J.; McCarthy, M.; Lin, Y-H.; Deatly, A. M.; February 11, 2008; 35 pp.; In English

Contract(s)/Grant(s): NAS9-17720; Copyright; Avail.: CASI: A03, Hardcopy

In vitro three-dimensional (3D) human lung epithelio-mesenchymal tissue-like assemblies (3D hLEM TLAs) from this point forward referred to as TLAs were engineered in Rotating Wall Vessel (RWV) technology to mimic the characteristics of in vivo tissues thus providing a tool to study human respiratory viruses and host cell interactions. The TLAs were bioengineered onto collagen-coated cyclodextran microcarriers using primary human mesenchymal bronchial-tracheal cells (HBTC) as the foundation matrix and an adult human bronchial epithelial immortalized cell line (BEAS-2B) as the overlying component. The resulting TLAs share significant characteristics with in vivo human respiratory epithelium including polarization, tight junctions, desmosomes, and microvilli. The presence of tissue-like differentiation markers including villin, keratins, and specific lung epithelium markers, as well as the production of tissue mucin, further confirm these TLAs differentiated into tissues functionally similar to in vivo tissues. Increasing virus titers for human respiratory syncytial virus (wtRSVA2) and the detection of membrane bound glycoproteins over time confirm productive infection with the virus. Therefore, we assert TLAs mimic aspects of the human respiratory epithelium and provide a unique capability to study the interactions of respiratory viruses and their primary target tissue independent of the host s immune system.

Author

In Vitro Methods and Tests; Viruses; Respiratory System; Bioreactors; Tissue Engineering; Cell Culturing; Immunology

20080013251 NASA Glenn Research Center, Cleveland, OH, USA

Triamcinolone Acetonide Selectively Inhibits Angiogenesis in Small Blood Vessels and Decreases Vessel Diameter within the Vascular Tree

McKay, Terri L.; Gredeon, Dan J.; Vickerman, Mary B.; Hylton, alan G.; Ribita, Daniela; Olar, Harry H.; Kaiser, Peter K.; Parsons-Wingerter, Patricia; December 13, 2007; 26 pp.; In English; Original contains color and black and white illustrations

Contract(s)/Grant(s): WBS 667266.01.03.0543.01; Copyright; Avail.: CASI: A03, Hardcopy

The steroid triamcinolone acetonide (TA) is a potent anti-angiogenesis drug used to treat retinal vascular diseases that include diabetic retinopathy, vascular occlusions and choroidal neovascularization. To quantify the effects of TA on branching morphology within the angiogenic microvascular tree of the chorioallantoic membrane (CAM) of quail embryos. Increasing concentrations of TA (0-16 ng/ml) were applied topically on embryonic day 7 (E7) to the chorioallantoic membrane (CAM) of quail embryos cultured in Petri dishes, and incubated for an additional 24 or 48 hours until fixation. Binary (black/white) microscopic images of arterial end points were quantified by VESGEN software (for Generational Analysis of Vessel Branching) to obtain major vascular parameters that include vessel diameter (Dv), fractal dimension (Df), tortuosity (Tv) and densities of vessel area, length, number and branch point (Av, Lv, Nv and Brv). For assessment of specific changes in vascular morphology induced by TA, the VESGEN software automatically segmented the vascular tree into branching generations (G1...G10) according to changes in vessel diameter and branching. Vessel density decreased significantly up to 34% as the function of increasing concentration of TA according to Av, Lv, Brv, Nv and Df. TA selectively inhibited the growth of new, small vessels, because Lv decreased from 13.14plus or minus 0.61 cm/cm2 for controls to 8.012 plus or minus 0.82 cm/cm2 at 16 ng TA/ml in smaller branching generations (G7-G10), and for Nv from 473.83 plus or minus 29.85 cm(-)2 to 302.32 plus or minus 33.09 cm-()2. In contrast, vessel diameter (Dv) decreased throughout the vascular tree (G1-G10).

Author

Steroids; Angiogenesis; Blood Vessels; Morphology; Ocular Circulation; Eye Diseases; Blood Flow

52
AEROSPACE MEDICINE

Includes the biological and physiological effects of atmospheric and space flight (weightlessness, space radiation, acceleration, and altitude stress) on the human being; and the prevention of adverse effects on those environments. For psychological and behavioral effects of aerospace environments, see *53 Behavioral Sciences*. For the effects of space on animals and plants see *51 Life Sciences*.

20080012475 NASA Johnson Space Center, Houston, TX, USA

Data Mining Activities for Bone Discipline - Current Status

Sibonga, J. D.; Pietrzyk, R. A.; Johnston, S. L.; Arnaud, S. B.; February 04, 2008; 17 pp.; In English; Human Research Program Investigators' Workshop, 4-6 Feb. 2008, League City, TX, USA; Original contains color illustrations; Copyright; Avail.: CASI: A03, Hardcopy

The disciplinary goals of the Human Research Program are broadly discussed. There is a critical need to identify gaps in the evidence that would substantiate a skeletal health risk during and after spaceflight missions. As a result, data mining activities will be engaged to gather reviews of medical data and flight analog data and to propose additional measures and specific analyses. Several studies are briefly reviewed which have topics that partially address these gaps in knowledge, including bone strength recovery with recovery of bone mass density, current renal stone formation knowledge, herniated discs, and a review of bed rest studies conducted at Ames Human Research Facility.

Derived from text

Data Mining; Musculoskeletal System; Space Flight; Physiological Effects; Bone Demineralization

20080012487 NASA Johnson Space Center, Houston, TX, USA

16 Weeks of Training with the International Space Station Advanced Resistive Exercise Device (aRED) Is not Different than Training with Free Weights

Loehr, J. A.; Lee, S. M. C.; English, K. E.; Leach, M.; Bentley, J.; Nash, R.; Hagan, R. D.; [2008]; 1 pp.; In English; National Strength and Conditioning Association National Conference and Exhibition, 9-12 Jul. 2008, Las Vegas, NV, USA; No Copyright; Avail.: Other Sources; Abstract Only

The advanced Resistive Exercise Device (aRED) is a resistive exercise system designed to maintain muscle mass and strength in microgravity by simulating free weight (FW) exercise. aRED utilizes vacuum cylinders and inertial flywheels to replicate the constant mass and inertial components, respectively, of FW exercise in normal gravity. PURPOSE: To compare the effectiveness of aRED and FW resistive exercise training in ambulatory subjects. METHODS: Untrained subjects were assigned to two groups, FW (6 males, 3 females) and aRED (8 males, 3 females), and performed squat (SQ), heel raise (HR), and deadlift (DL) exercises 3 d wk-1 for 16 wks. SQ, HR and DL strength (1RM) were measured using FW hardware pre-, mid- and post-training. Subjects participated in a periodized training protocol with the exercise prescription based on a percentage of 1RM. Thigh and lower leg muscle volume were assessed using Magnetic Resonance Imaging (MRI), and leg (LLM) and total body lean mass (BLM) were measured using Dual Energy X-ray Absorptiometry (DXA) pre- and post-training. RESULTS: SQ 1RM increased in both FW (48.9+/-6.1%) and aRED (31.2+/-3.8%) groups, and there was a greater training response in FW compared with aRED (p=0.01). HR and DL 1RM increased in FW (HR: 12.3+/-2.4%, DL: 23.3+/-4.4%) and aRED (HR: 18.0+/-1.6%, DL: 23.2+'-2.8%), but there were no differences between groups. Thigh muscle volume was greater following training in both groups (FW: 9.8+/-0.9%, aRED: 7.1+/-1.2%) but lower leg muscle volume increased only in the FW group (3.0+/-1.1%). Lean tissue mass increased in both FW (LLM: 3.9+/-1.1%, BLM: 2.5+/-0.7%) and aRED (LLM: 4.8+/-0.7%, BLM: 2.6 0.7%). There were no between group differences in muscle volume or lean mass in response to training. CONCLUSIONS: In general, the increase in muscle strength, muscle volume, and lean tissue mass when training with aRED was not different than when using the same training protocol with FW. The smaller increase in SQ 1RM in the aRED group may be the result of undersizing the aRED flywheels which were intended to mimic the inertial component of the SQ movement when performing FW exercises. However, the biomechanical differences observed in body position during the performance of the aRED SQ, which may have affected training and testing, cannot be excluded as a factor that may have affected SQ 1RM results. PRACTICAL APPLICATIONS: Improvements in muscle strength, muscle volume and lean mass similar to FW exercise training may be elicited using an alternative source of resistance during exercise training. The acceleration of a mass during resistive exercise may result in greater muscle tension when changing the direction of movement resulting in enhanced strength gains. Therefore, to maximize the benefits of resistive exercise, the inertial components of FW exercise should be considered during exercise selection and hardware design. ACKNOWLEDGEMENT: This investigation was supported by NASA-JSC s Exercise Countermeasures Project.

Author

Physical Exercise; Biodynamics; International Space Station; Microgravity; Medical Services; Muscles; Gravitation

20080012518 NASA Johnson Space Center, Houston, TX, USA

Human Research Program Integrated Research Plan: December 20, 2007, Interim Baseline

February 04, 2008; 296 pp.; In English; Human Research Program Investigators' Workshop, 4-6 Feb. 2008, League City, TX, USA; Original contains color illustrations

Report No.(s): HRP-47065; Copyright; Avail.: CASI: A13, Hardcopy

The Human Research Program (HRP) delivers human health and performance countermeasures, knowledge, technologies, and tools to enable safe, reliable, and productive human space exploration. This Integrated Research Plan (IRP) describes the program s research activities that are intended to address the needs of human space exploration and serve HRP customers. The timescale of human space exploration is envisioned to take many decades. The IRP illustrates the program s research plan through the timescale of early lunar missions of extended duration. The document serves several purposes for the Human Research Program: The IRP provides a means to assure that the most significant risks to human space explorers are being adequately mitigated and/or addressed, The IRP shows the relationship of research activities to expected outcomes and need dates, The IRP shows the interrelationships among research activities that may interact to produce products that are integrative or cross defined research disciplines, The IRP illustrates the non-deterministic nature of research and technology activities by showing expected decision points and potential follow-on activities, The IRP shows the assignments of responsibility within the program organization and, as practical, the intended solicitation approach, The IRP shows the intended use of research platforms such as the International Space Station, NASA Space Radiation Laboratory, and various space flight analogs. The IRP does not show all budgeted activities of the Human research program, as some of these are enabling functions, such as management, facilities and infrastructure

Author

Research and Development; Human Performance; Health; Project Planning; Extraterrestrial Radiation

20080012521 NASA Johnson Space Center, Houston, TX, USA

Lightweight Trauma Module - LTM

Hatfield, Thomas; February 04, 2008; 1 pp.; In English; Human Research Program Investigators' Workshop, 4-6 Feb. 2008, League City, TX, USA; Original contains color illustrations; Copyright; Avail.: CASI: A01, Hardcopy

Current patient movement items (PMI) supporting the military's Critical Care Air Transport Team (CCATT) mission as well as the Crew Health Care System for space (CHeCS) have significant limitations: size, weight, battery duration, and dated clinical technology. The LTM is a small, ~20 lb., system integrating diagnostic and therapeutic clinical capabilities along with onboard data management, communication services and automated care algorithms to meet new Aeromedical Evacuation requirements. The Lightweight Trauma Module is an Impact Instrumentation, Inc. project with strong Industry, DoD, NASA, and Academia partnerships aimed at developing the next generation of smart and rugged critical care tools for hazardous environments ranging from the battlefield to space exploration. The LTM is a combination ventilator/critical care monitor/therapeutic system with integrated automatic control systems. Additional capabilities are provided with small external modules.

Derived from text

Aerospace Medicine; Air Transportation; Systems Integration; Automatic Control

20080012528 Universities Space Research Association, Houston, TX, USA; NASA Johnson Space Center, Houston, TX, USA

Comparison of Organ Dose and Dose Equivalent Using Ray Tracing of Male and Female Voxel Phantoms to Space Flight Phantom Torso Data

Kim, Myung-Hee Y.; Qualls, Garry D.; Cucinotta, Francis A.; [2008]; 1 pp.; In English; 37th COSPAR Scientific Assembly, Montreal, 13-20 Jul. 2008, Montreal, Canada; Copyright; Avail.: Other Sources; Abstract Only

Phantom torso experiments have been flown on the space shuttle and International Space Station (ISS) providing validation data for radiation transport models of organ dose and dose equivalents. We describe results for space radiation organ doses using a new human geometry model based on detailed Voxel phantoms models denoted for males and females as MAX (Male Adult voXel) and Fax (Female Adult voXel), respectively. These models represent the human body with much higher fidelity than the CAMERA model currently used at NASA. The MAX and FAX models were implemented for the evaluation of directional body shielding mass for over 1500 target points of major organs. Radiation exposure to solar particle events (SPE), trapped protons, and galactic cosmic rays (GCR) were assessed at each specific site in the human body by coupling space radiation transport models with the detailed body shielding mass of MAX/FAX phantom. The development of multiple-point body-shielding distributions at each organ site made it possible to estimate the mean and variance of space dose equivalents at the specific organ. For the estimate of doses to the blood forming organs (BFOs), active marrow distributions

in adult were accounted at bone marrow sites over the human body. We compared the current model results to space shuttle and ISS phantom torso experiments and to calculations using the CAMERA model.
Author
Extraterrestrial Radiation; Human Body; Radiation Dosage; Biological Effects; Organs; Models; Health Physics; Radiation Shielding

20080012529 Wyle Labs., Inc., Houston, TX, USA
Persistence of Space Radiation Induced Cytogenetic Damage in the Blood Lymphocytes of Astronauts
George, Kerry; Cucinotta, Francis A.; [2008]; 1 pp.; In English; 37th COSPAR Scientific Assembly, 13-20 Jul. 2008, Montreal, Canada; Copyright; Avail.: Other Sources; Abstract Only

Cytogenetic damage in astronaut's peripheral blood lymphocytes is a useful in vivo marker of space radiation induced damage. Moreover, if radiation induced chromosome translocations persist in peripheral blood lymphocytes for many years, as has been assumed, they could potentially be used to measure retrospective doses or prolonged low dose rate exposures. However, as more data becomes available, evidence suggests that the yield of translocations may decline with time after exposure, at least in the case of space radiation exposures. We present our latest follow-up measurements of chromosome aberrations in astronauts blood lymphocytes assessed by FISH painting and collected a various times beginning directly after return from space to several years after flight. For most individuals the analysis of individual time-courses for translocations revealed a temporal decline of yields with different half-lives. Since the level of stable aberrations depends on the interplay between natural loss of circulating T-lymphocytes and replenishment from the stem or progenitor cells, the differences in the rates of decay could be explained by inter-individual variation in lymphocyte turn over. Biodosimetry estimates derived from cytogenetic analysis of samples collected a few days after return to earth lie within the range expected from physical dosimetry. However, a temporal decline in yields may indicate complications with the use of stable aberrations for retrospective dose reconstruction, and the differences in the decay time may reflect individual variability in risk from space radiation exposure. In addition, limited data on multiple flights show a lack of correlation between time in space and translocation yields. Data from one crewmember who has participated in two separate long-duration space missions and has been followed up for over 10 years provides limited information on the effect of repeat flights and show a possible adaptive response to space radiation exposure.
Author
Chromosome Aberrations; Extraterrestrial Radiation; Lymphocytes; Radiation Damage; Genes; Biological Effects; Physiological Effects; Radiation Effects

20080012531 NASA Johnson Space Center, Houston, TX, USA
Heavy Ion Carcinogenesis and Human Space Exploration
Cucinotta, Francis A.; Durante, Marco; [2008]; 33 pp.; In English; Original contains color and black and white illustrations; Copyright; Avail.: CASI: A03, Hardcopy

Prior to the human exploration of Mars or long duration stays on the Earth s moon, the risk of cancer and other diseases from space radiation must be accurately estimated and mitigated. Space radiation, comprised of energetic protons and heavy nuclei, has been show to produce distinct biological damage compared to radiation on Earth, leading to large uncertainties in the projection of cancer and other health risks, while obscuring evaluation of the effectiveness of possible countermeasures. Here, we describe how research in cancer radiobiology can support human missions to Mars and other planets.
Author
Space Exploration; Radiobiology; Risk; Extraterrestrial Radiation; Mars Missions; Cancer; Diseases

20080012542 NASA Johnson Space Center, Houston, TX, USA
M-BAND Analysis of Chromosome Aberration Induced by Fe-Ions in Human Epithelial Cells Cultured in 3-Dimensional Matrices
Hada, M.; Cucinotta, F. A.; Wu, H.; [2008]; 1 pp.; In English; 37th COSPAR Scientific Assembly, 13-20 Jul. 2008, Montreal, Canada; Copyright; Avail.: Other Sources; Abstract Only

Energetic heavy ions pose a great health risk to astronauts in extended ISS and future lunar and Mars missions. High-LET heavy ions are particularly effective in causing various biological effects, including cell inactivation, genetic mutations, cataracts and cancer induction. Most of these biological endpoints are closely related to chromosomal damage, which can be utilized as a biomarker for radiation insults. Previously, we had studied low- and high-LET radiation-induced chromosome aberrations in human epithelial cells cultured in 2-dimension (2D) using the multicolor banding fluorescence in situ

hybridization (mBAND) technique. However, it has been realized that the biological response to radiation insult in a 2D cellular environment in vitro can differ significantly from the response in 3-dimension (3D) or at the actual tissue level. In this study, we cultured human epithelial cells in 3D to provide a more suitable model for human tissue. Human mammary epithelia cells (CH184B5F5/M10) were grown in Matrigel to form 3D structures, and exposed to Fe-ions at NASA Space Radiation Laboratory (NSRL) at the Brookhaven National Laboratory or 137Cs-gamma radiation source at the University of Texas MD Anderson Cancer Center. After exposure, cells were allowed to repair for 16hr before dissociation and subcultued at low density in 2D. G2 and metaphase chromosomes in the first cell cycle were collected using a chemical-induced premature chromosome condensation (PCC) technique, and chromosome aberrations were analyzed using mBAND technique. With this technique, individually painted chromosomal bands on one chromosome allowed the identification of interchromosomal aberrations (translocation to unpainted chromosomes) and intrachromosomal aberrations (inversions and deletions within a single painted chromosome). Our data indicate a significant difference of the chromosome aberration yield between 2D and 3D cell cultures for gamma exposures, but not for Fe ion exposures. Therefore, the RBE for chromosome aberrations obtained in a 2D model may not represent accurately the RBE for tissues.
Author
Chromosome Aberrations; Heavy Ions; Cultured Cells; Two Dimensional Models; Physiological Responses; Relative Biological Effectiveness (RBE); Biological Effects

20080012544 Texas Univ. Health Science Center, Houston, TX, USA; NASA Johnson Space Center, Houston, TX, USA
Pharmacokinetics of Acetaminophen in Hind Limbs Unloaded Mice: A Model System Simulating the Effects of Low Gravity on Astronauts in Space
Peterson, Amanda; Risin, Semyon A.; Ramesh, Govindarajan T.; Dasgupta, Amitava; Risin, Diana; [2008]; 2 pp.; In English; 43rd Annual ACLPS Meeting, 5-7 Jun. 2008, Philadelphia, PA, USA; Copyright; Avail.: Other Sources; Abstract Only

The pharmacokinetics (PK) of medications administered to astronauts could be altered by the conditions in Space. Low gravity and free floating (and associated hemodynamic changes) could affect the absorption, distribution, metabolism and excretion of the drugs. Knowledge of these alterations is essential for adjusting the dosage and the regimen of drug administration in astronauts. Acquiring of such knowledge has inherent difficulties due to limited opportunities for experimenting in Space. One of the approaches is to use model systems that simulate some of the Space conditions on Earth. In this study we used hind limbs unloaded mice (HLU) to investigate the possible changes in PK of acetaminophen, a widely used analgesic with high probability of use by astronauts. The HLU is recognized as an appropriate model for simulating the effects of low gravity on hemodynamic parameters. Mice were tail suspended (n = 24) for 24-96 hours prior to introduction of acetaminophen (150 - 300 mg/kg). The drug (in aqueous solution containing 10% ethyl alcohol by volume) was given orally by a gavage procedure and after the administration of acetaminophen mice were additionally suspended for 30 min, 1 and 2 hours. Control mice (n = 24) received the same dose of acetaminophen and were kept freely all the time. Blood specimens were obtained either from retroorbital venous sinuses or from heart. Acetaminophen concentration was measured in plasma by the fluorescent polarization immunoassay and the AxSYM analyzer (Abbott Laboratories). In control mice peak acetaminophen concentration was achieved at 30 min. By 1 hour the concentration decreased to less than 50% of the peak level and at 2 hours the drug was almost undetectable in the serum. HLU for 24 hours significantly altered the acetaminophen pharmacokinetic: at 30 min the acetaminophen concentrations were significantly (both statistically and medically significant) lower than in control mice. The concentrations also reduced less significantly after 1 and 2 hours. At 2 hours approximately 20% of the drug still remained in the circulation. After 96 hrs of HLU the changes in acetaminophen PK were less prominent. These data indicate that short term HLU causes significant changes in acetaminophen PK most likely associated with HUL-related hemodynamic changes. However, after 96 hour these changes diminished. This suggests hemodynamic adaptation to the HUL conditions that possibly occurs also in real space conditions.
Author
Pharmacology; Hemodynamic Responses; Gravitational Effects; Aqueous Solutions; Plasmas (Physics); Microgravity; Metabolism; Immunoassay

20080012547 NASA Johnson Space Center, Houston, TX, USA
Kinematic and Electromyographic Evaluation of Locomotion on the Enhanced Zero-Gravity Locomotion Simulator: A Comparison of External Loading Mechanisms
DeWitt, John K.; Perusek, Gail P.; Bentley, Jason; Edwards, W. Brent; Lewandowski, Beth E.; Samorezov, Sergey; Savina, Mark C.; Hagan, R. Donald; January 2008; 40 pp.; In English; Original contains color and black and white illustrations
Report No.(s): NASA/TP-2007-214764; S-1014; Copyright; Avail.: CASI: A03, Hardcopy

Purpose: Determine how External Load (EL) type affects locomotion patterns and muscular activity on the enhanced

Zero-gravity Locomotion Simulator (eZLS) when using bungees or a linear motor subject loading device. Eight subjects were suspended on the eZLS while walking at 3 mph and running at 7 mph. The EL was provided by either bungees or a linear motor subject loading device (LM-SLD) at approximately 55% and 90% of body weight during the exercise. Joint kinematics, ground reaction forces (GRF), and electromyographical activity of lower body musculature were measured during each condition. Repeated measures analysis of variance were tested for differences between EL types within load levels on eZLS. There were few differences in locomotion patterns and muscular activity between loading mechanisms. GRF were greater with the LM-SLD than with bungees during eZLS locomotion. GRF magnitudes for both devices were lower than previously reported values obtained during upright locomotion in normal gravity, but similar to those found in actual microgravity. Greater GRF with the LM-SLD suggests that use of a constant-force SLD may be of potential benefit during treadmill exercise because locomotion patterns do not change, but subjects experience increased force magnitude and loading rates applied at the feet.
Author
Kinematics; Physical Exercise; Body Weight; Locomotion; Gravitation; Weightlessness; Analysis of Variance; Walking

20080012558 NASA Johnson Space Center, Houston, TX, USA
Different Levels of Eccentric Resistance during Eight Weeks of Training Affect Muscle Strength and Lean Tissue Mass
English, K. L.; Loehr, J. A.; Lee, S. M. C.; Laughlin, M. S.; Hagan, R. D.; [2008]; 2 pp.; In English; NSCA National Conference and Exhibition, 9-12 Jul. 2008, Las Vegas, NV, USA; No Copyright; Avail.: Other Sources; Abstract Only

Coupling concentric and eccentric muscle contractions appears to be important in the development of muscle strength and hypertrophy. The interim Resistive Exercise Device (iRED) currently used aboard the International Space Station does not seem to be as effective as free weight training in ambulatory subjects and has not completely protected against muscular deconditioning due to space flight. The lack of protection during space flight could be caused by iRED's proportionally lower eccentric resistance (60-70%) compared to concentric resistance. PURPOSE: To determine the effects of 8 wks of lower body resistive exercise training using five levels of eccentric resistance on muscle strength and lean tissue mass. METHODS: Forty untrained males (34.9 +/- 7 yrs, 80.9 +/- 9.8 kg, 178.2 +/- 7.1 cm; mean +/- SD) completed three 1-repetition maximum (1-RM) strength tests for both the supine leg press (LP) and supine heel raise (HR) prior to training; subjects were matched for LP strength and randomly assigned to one of five training groups. Concentric load (% 1-RM) was constant across groups during training, but each group trained with different levels of eccentric load (0%, 33%, 66%, 100%, or 138% of concentric). Subjects trained 3 d / wk for 8 wks using a periodized program for LP and HR based on percentages of the highest pre-training 1-RM. LP and HR 1-RM and leg lean mass (LLM; assessed by DEXA) were measured pre- and post-training. A two-way ANOVA was used to analyze all dependent measures. Tukey's post hoc tests were used to test significant main effects. Within group pre- to post-training changes were compared using paired t-tests with a Bonferroni adjustment. Statistical significance was set a priori at p 0.05. All data are expressed as mean +/- SE. RESULTS: LP 1-RM strength increased significantly in all groups pre- to post-training. The 138% group increase (20.1 +/- 3.7%) was significantly greater than the 0% (7.9 +/- 2.8%), 33% (7.7 +/- 4.6%), and 66% (7.5 +/- 4.3%) groups. All groups significantly increased HR strength pre- to posttraining (33%: 7.5 +/- 6.1%; 66%: 6.6 +/- 3.7%; 100%: 12.2 +/- 1.8%; 138%: 11.0 +/- 6.4%) except for the 0% (4.9 +/- 9.1%) group. There were no differences between groups. LLM increased significantly pre- to post-training in only the 138% group; there were no differences between groups. CONCLUSIONS: Eight wks of lower body resistive exercise training with eccentric overload resulted in greater increases in LP strength than training with eccentric loads of 66% or less. Post-training HR strength was not affected by eccentric training load, perhaps because of the predominance of Type I fibers typical in the gastrocnemius. Only 138% eccentric training significantly increased LLM. PRACTICAL APPLICATIONS: For athletes or others desiring to maximize muscle strength and hypertrophy gains, training with eccentric loads greater than 100% of concentric resistance will provide greater increases in muscle strength and lean tissue mass in some muscle groups. In a rehabilitation or geriatric exercise setting that places primary emphasis on program adherence and moderate strength gains, training with an eccentric underload may provide strength increases comparable to those of traditional 1:1 training but with less muscle soreness and physiologic insult to the patient, but this has yet to be proven.
Author
Deconditioning; Leg (Anatomy); Loads (Forces); Physical Exercise; Muscular Tonus

20080012559 Wyle Labs., Inc., Houston, TX, USA
Determining Exercise Strength Requirements for Astronaut Critical Mission Tasks: Reaching Under G-Load
Schaffner, Grant; Bentley, Jason; [2008]; 2 pp.; In English; NSCA National Conference and Exhibition, 9-12 Jul. 2008, Las Vegas, NV, USA; Copyright; Avail.: Other Sources; Abstract Only

The critical mission tasks assessments effort seeks to determine the physical performance requirements that astronauts

must meet in order to safely and successfully accomplish lunar exploration missions. These assessments will determine astronaut preflight strength, fitness, and flexibility requirements, and the extent to which exercise and other countermeasures must prevent the physical deconditioning associated with prolonged weightlessness. The purpose is to determine the flexibility and strength that crewmembers must possess in order to reach Crew Exploration Vehicle controls during maneuvers that result in sustained acceleration levels ranging from 3.7G to 7.8G. An industry standard multibody dynamics application was used to create human models representing a 5th percentile female, a 50th percentile male, and a 95th percentile male. The additional mass of a space suit sleeve was added to the reaching arm to account for the influence of the suit mass on the reaching effort. The human model was merged with computer models of a pilot seat and control panel for the Crew Exploration Vehicle. Three dimensional paths were created that guided the human models hand from a starting position alongside its thigh to three control targets: a joystick, a keyboard, and an overhead switch panel. The reaching motion to each target was repeated under four vehicle acceleration conditions: nominal ascent (3.7G), two ascent aborts (5.5G and 7.8G) and lunar reentry (4.6G). Elbow and shoulder joint angular excursions were analyzed to assess range of motion requirements. Mean and peak elbow and shoulder joint torques were determined and converted to equivalent resistive exercise loads to assess strength requirements. Angular excursions for the 50th and 95th percentile male models remained within joint range of motion limits. For the 5th percentile female, both the elbow and the shoulder exceeded range of motion limits during the overhead reach. Elbow joint torques ranged from 10 N-m (nominal ascent) to 60 N-m (ascent abort). Shoulder joint torques ranged from 65 N-m (nominal ascent) to 280 N-m (ascent abort). Maximal equivalent exercise loads reached 30 lb in tricep extension, 9 lb in bicep curl, 110 lb in unilateral pullover and unilateral bench press for nominal conditions (lunar reentry), and 188 lb in unilateral pullover and unilateral bench press. The location of the pilot seat was found to be inadequately located to allow a 5th percentile female to reach the switches on the overhead panel. Elbow strength requirements were found to be well within population norms. Shoulder strength was found to be a limiting factor. Reaching under nominal ascent and lunar reentry conditions was found to require near maximal shoulder strength. Reaching under ascent abort conditions requires shoulder strength well beyond population norms. Pilot seats must adjust to accomodate a 5th percentile female. Exercise countermeasures must maintain maximal pullover and bench press strength to allow pilots to reach and operate controls during lunar reentry. Reaching will not be possible during ascent abort conditions. Flight controls should be built into armrests or flight control must be accomplished by autonomous systems during acceleration exceeding 4.6G.
Author (revised)
Physical Exercise; Muscular Strength; Aerospace Medicine; Astronauts; Weightlessness; Autonomy

20080012582 NASA Johnson Space Center, Houston, TX, USA; Wyle Life Sciences, Inc., Houston, TX, USA
Strategies for Walking on a Laterally Oscillating Treadmill
Peters, Brian T.; Brady, Rachel A.; Bloomberg, Jacob, J.; [2008]; 2 pp.; In English; North American Congress on Biomechanics (NACOB), 5-9 Aug. 2008, Ann Arbor, MI, USA; Original contains color illustrations
Contract(s)/Grant(s): NCC9-58; No Copyright; Avail.: CASI: A01, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012582

Most people use a variety of gait patterns each day. These changes can come about by voluntary actions, such as a decision to walk faster when running late. They can also be a result of both conscious and subconscious changes made to account for variation in the environmental conditions. Many factors can play a role in determining the optimal gait patterns, but the relative importance of each could vary between subjects. A goal of this study was to investigate whether subjects used consistent gait strategies when walking on an unstable support surface.
Author
Gait; Treadmills; Walking; Lateral Oscillation

20080012588 Universities Space Research Association, Houston, TX, USA
Risk Assessment of Acute Mountain Sickness in the Crew Exploration Vehicle
Conkin, Johnny; January 2008; 114 pp.; In English; Original contains black and white illustrations
Contract(s)/Grant(s): NNJ06HG25A
Report No.(s): NASA/TP-2008-214759; S-1009; No Copyright; Avail.: CASI: A06, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012588

To limit the risk of fire and reduce the risk of decompression sickness and prebreathe time to support frequent activities on the moon and Mars, a hypobaric and mildly hypoxic living environment is considered for the Crew Exploration Vehicle, Lunar Surface Access Module, and long-term surface habitats. Superimposed on physiological adjustments to living in a hypobaric hypoxia (HH) environment are those associated with adaptation to microgravity (micro-G). Outward manifestations of physiological adaptations may present as signs and symptoms of Acute Mountain Sickness (AMS). The signs and symptoms

of AMS are undesirable, as they would impact crew health and performance. A literature review suggests that: (1) there is an absolute pressure effect per se on AMS, so the higher the altitude for a given computed hypoxic alveolar oxygen (O2) partial pressure (PAO2) the greater the AMS response; (2) about 25% of adults would experience AMS near 2,000 m altitude; (3) there is no direct evidence that HH synergizes with adaptive changes during simulated G to dramatically increase hematocrit and blood viscosity, and (4) only susceptible astronauts would develop mild and transient AMS with exposure to 8.0 psia (16,000 ft) while breathing 32% O2 and simultaneously adapting to micro-G.
Author
Decompression Sickness; Spacecrews; Extravehicular Activity; Aerospace Medicine; Altitude Sickness; Risk

20080012606 NASA Glenn Research Center, Cleveland, OH, USA
Risk Assessment of Bone Fracture During Space Exploration Missions to the Moon and Mars
Lewandowski, Beth E.; Myers, Jerry G.; Nelson, Emily S.; Licatta, Angelo; Griffin, Devon; [2007]; 20 pp.; In English; Space Systems Engineering and Risk Management Symposium, 26-29 Feb. 2008, Los Angeles, CA, USA; Original contains color illustrations
Contract(s)/Grant(s): WBS 444543.01.02.01; Copyright; Avail.: CASI: A03, Hardcopy

The possibility of a traumatic bone fracture in space is a concern due to the observed decrease in astronaut bone mineral density (BMD) during spaceflight and because of the physical demands of the mission. The Bone Fracture Risk Module (BFxRM) was developed to quantify the probability of fracture at the femoral neck and lumbar spine during space exploration missions. The BFxRM is scenario-based, providing predictions for specific activities or events during a particular space mission. The key elements of the BFxRM are the mission parameters, the biomechanical loading models, the bone loss and fracture models and the incidence rate of the activity or event. Uncertainties in the model parameters arise due to variations within the population and unknowns associated with the effects of the space environment. Consequently, parameter distributions were used in Monte Carlo simulations to obtain an estimate of fracture probability under real mission scenarios. The model predicts an increase in the probability of fracture as the mission length increases and fracture is more likely in the higher gravitational field of Mars than on the moon. The resulting probability predictions and sensitivity analyses of the BFxRM can be used as an engineering tool for mission operation and resource planning in order to mitigate the risk of bone fracture in space.
Author
Bone Demineralization; Fracturing; Bone Mineral Content; Biodynamics; Aerospace Environments; Probability Theory; Risk; Lumbar Region; Bones

20080013169 NASA Johnson Space Center, Houston, TX, USA
Effects of Long-duration Space Flight on Toe Clearance During Treadmill Walking
Miller, Chris; Peters, Brian; Brady, Rachel; Mulavara, Ajitkumar; Richards, Jason; Hayat, Matthew; Bloomberg, Jacob; [2008]; 3 pp.; In English; 2008 North American Congress on Biomechanics, 5-9 Aug. 2008, Ann Arbor, MI, USA; Original contains black and white illustrations; Copyright; Avail.: CASI: A01, Hardcopy

Upon returning from long-duration space flight, astronauts and cosmonauts must overcome physiologic and sensorimotor changes induced by prolonged exposure to microgravity as they readapt to a gravitational environment. Their compromised balance and coordination lead to an altered and more variable walking pattern (Bloomberg & Mulavara, 2003; McDonald, et al., 1996). Toe trajectory during the swing phase of locomotion has been identified as a precise motor control task (Karst, et al., 1999), thus providing an indication of the coordination of the lower limbs (Winter, 1992). Failure to achieve sufficient toe clearance may put the crew member at a greater risk of tripping and falling, especially if an emergency egress from the vehicle should be necessary upon landing. The purpose of this study was to determine the pre- to post-flight changes in toe clearance in crew members returning from long-duration missions and the recovery thereafter.
Author
Treadmills; Walking; Long Duration Space Flight; Feet (Anatomy); Aerospace Medicine

20080013257 Wyle Life Sciences, Inc., Houston, TX, USA; NASA Johnson Space Center, Houston, TX, USA
Effects of Different Lifting Cadences on Ground Reaction Forces during the Squat Exercise
Bentley, Jason R.; Amonette, William E.; Hagan, R. Donald; [2008]; 30 pp.; In English; Original contains black and white illustrations; Copyright; Avail.: CASI: A03, Hardcopy

The purpose of this investigation was to determine the effect of different cadences on the ground reaction force (GRF(sub R)) during the squat exercise. It is known that squats performed with greater acceleration will produce greater inertial forces;

however, it is not well understood how different squat cadences affect GRF(sub R). It was hypothesized that faster squat cadences will result in greater peak GRF(sub R). METHODS: Six male subjects (30.8+/-4.4 y, 179.5+/-8.9 cm, 88.8+/-13.3 kg) with previous squat experience performed three sets of three squats using three different cadences (FC = 1 sec descent/1 sec ascent; MC = 3 sec descent/1 sec ascent; SC = 4 sec descent/2 sec ascent) with barbell mass equal to body mass. Ground reaction force was used to calculate inertial force trajectories of the body plus barbell (FI(sub system)). Forces were normalized to body mass. RESULTS: Peak GRF(sub R) and peak FI(sub system) were significantly higher in FC squats compared to MC ($p=0.0002$) and SC ($p=0.0002$). Range of GRF(sub R) and FI(sub system) were also significantly higher in FC compared to MC ($p<0.05$), and MC were significantly higher than SC ($p<0.05$). DISCUSSION: Faster squat cadences result in significantly greater peak GRF(sub R) due to the inertia of the system. GRF(sub R) was more dependent upon decent cadence than on ascent cadence. PRACTICAL APPLICATION: This study demonstrates that faster squat cadences produce greater ground reaction forces. Therefore, the use of faster squat cadences might enhance strength and power adaptations to long-term resistance exercise training. Key Words: velocity, weight training, resistive exercise
Author
Physical Exercise; Trajectories; Loads (Forces); Inertia; Males

20080013295 NASA Johnson Space Center, Houston, TX, USA; Academy of Sciences (USSR), Moscow, Russian Federation
Vestibulo-cervico-ocular Responses and Tracking Eye Movements after Prolonged Exposure to Microgravity
Kornilova, Ludmila N.; Naumov Ivan A.; Azarov, Konstantin A.; Sagalovitch, Sergey V.; Reschke, Millard F.; [2008]; 25 pp.; In English; Copyright; Avail.: Other Sources

Spontaneous oculomotor activity, static torsional otolith-cervico-ocular reflex, dynamic vestibulo-cervico-ocular responses, vestibular reactivity, gaze fixation process, and smooth tracking were investigated in 15 Russian members of ISS crews within nine days of return from prolonged exposure to microgravity (126 to 195 days). The investigations were performed using videooculography (VOG) and electrooculography (EOG). The spontaneous oculomotor activity was found increased (spontaneous nystagmus, gaze nystagmus, square wave jerks); the otolith function suppressed (inversion, absence or reduction by half of the amplitude of torsional compensatory eye counter-rolling) during head inclination; the vestibular reactivity during active head yaw rotation at 0.125 Hz was elevated (an increased intensity of vestibular nystagmus). Amplitude and velocity of ocular tracking reduced significantly, time of tracking reactions increased, and gaze-holding ability degraded. The otoliths suppression was accompanied by an exaggerated vestibular reactivity. Structure of the ocular tracking was destroyed only in the cosmonauts who, in addition to the elevated vestibular reactivity, also displayed central changes in the vestibulo-oculomotor system.
Author
Eye Movements; Microgravity; Physiological Responses; Gravitational Physiology; Eye (Anatomy)

20080013330 NASA Johnson Space Center, Houston, TX, USA
NASA Standard Measures Overview
Meck, Janice V.; March 04, 2008; 12 pp.; In English; International Countermeasure Working Group, 4 Mar. 2008, Noordwijk, Norway; Original contains color illustrations; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080013330

Due to the limited in-flight resources available for human physiological research in the foreseeable future, NASA has increased its reliance on head-down bed rest. NASA has created the Bed Rest Project at the Johnson Space Center, which is implemented on the 6th floor of the Children's Hospital at UTMB. It has been conducted for three years. The overall objective of the Project is to use bed rest to develop and evaluate countermeasures for the ill effects of space flight before flight resources are requested for refinement and final testing.
Derived from text
Bed Rest; General Overviews; Physiology; NASA Programs; Aerospace Medicine

20080013331 NASA Johnson Space Center, Houston, TX, USA
Changes in Head Stability Control in Response to a Lateral Perturbation while Walking in Older Adults
Buccello, Regina R.; Cromwell, Ronita L.; Bloomberg, Jacob J.; [2008]; 1 pp.; In English; The Gerontological Society of America 61st Annual Meeting, 21-25 Nov. 2008, National Harbor, MD, USA; Copyright; Avail.: CASI: A01, Hardcopy

Falling is a main contributor of injury in older adults. The decline in sensory systems associated with aging limits information needed to successfully compensate for unexpected perturbations. Therefore, sensory changes result in older adults

having problems maintaining balance stability when experiencing an unexpected lateral perturbation (e.g. slip) in the environment. The goal of this study was to determine head stability movement strategies used by older adults when experiencing an unexpected lateral perturbation during walking. A total of 16 healthy adults, aged 66-81 years, walked across a foam pathway 6 times. One piece of the foam pathway covered a movable platform that translated to the left when the subject stepped on the foam. Three trials were randomized in which the platform shifted. Angular rate sensors were placed on the center of mass for the head and trunk segments to collect head and trunk movement in all three planes of motion. The predominant movement strategies for maintaining head stability were determined from the results of the cross-correlation analyses between the head and trunk segments. The Chi square test of independence was used to evaluate the movement pattern distributions of head-trunk coordination during perturbed and non-perturbed walking. When perturbed, head stabilization was significantly challenged in the yaw and roll planes of motion. Subjects demonstrated a movement pattern of the head leading the trunk in an effort to stabilize the head. The older adult subjects used this head stabilization movement pattern to compensate for sensory changes when experiencing the unexpected lateral perturbation.
Author
Head Movement; Walking; Perturbation; Cross Correlation; Statistical Tests; Center of Mass; Adults; Stability

20080013332 Wyle Life Sciences, Inc., Houston, TX, USA; NASA Glenn Research Center, Cleveland, OH, USA
Gravitational Effects upon Locomotion Posture
DeWitt, John K.; Bentley, Jason R.; Edwards, W. Brent; Perusek, Gail P.; Samorezov, Sergey; [2008]; 3 pp.; In English; North American Congress on Biomechanics (NACOB), 5-9 Aug. 2008, Ann Arbor, MI, USA; Original contains color illustrations; Copyright; Avail.: CASI: A01, Hardcopy

Researchers use actual microgravity (AM) during parabolic flight and simulated microgravity (SM) obtained with horizontal suspension analogs to better understand the effect of gravity upon gait. In both environments, the gravitational force is replaced by an external load (EL) that returns the subject to the treadmill. However, when compared to normal gravity (N), researchers consistently find reduced ground reaction forces (GRF) and subtle kinematic differences (Schaffner et al., 2005). On the International Space Station, the EL is applied by elastic bungees attached to a waist and shoulder harness. While bungees can provide EL approaching body weight (BW), their force-length characteristics coupled with vertical oscillations of the body during gait result in a variable load. However, during locomotion in N, the EL is consistently equal to 100% body weight. Comparisons between AM and N have shown that during running, GRF are decreased in AM (Schaffner et al, 2005). Kinematic evaluations in the past have focussed on joint range of motion rather than joint posture at specific instances of the gait cycle. The reduced GRF in microgravity may be a result of differing hip, knee, and ankle positions during contact. The purpose of this investigation was to compare joint angles of the lower extremities during walking and running in AM, SM, and N. We hypothesized that in AM and SM, joints would be more flexed at heel strike (HS), mid-stance (MS) and toe-off (TO) than in N.
Author
Locomotion; Posture; Gravitational Effects; Microgravity; Body Weight; Parabolic Flight; Kinematics

53
BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

20080012537 NASA Johnson Space Center, Houston, TX, USA
Training Concept for Long Duration Space Mission
O'Keefe, William; [2008]; 1 pp.; In English; 59th International Astronautical Congress, 29 Sep. ? 3 Oct. 2008, Glasgow, Scotland, UK
Contract(s)/Grant(s): NNJ06VA01C; No Copyright; Avail.: CASI: A01, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012537

There has been papers about maintenance and psychological training for Long Duration Space Mission (LDSM). There are papers on the technology needed for LDSMs. Few are looking at how groundbased pre-mission training and on-board in-transit training must be melded into one training concept that leverages this technology. Even more importantly, fewer are looking at how we can certify crews pre-mission. This certification must ensure, before the crew launches, that they can handle any problem using on-board assets without a large ground support team.
Author
Education; Long Duration Space Flight; Psychological Effects; Space Psychology; Space Flight Training

54
MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human factors engineering, bionics, man-machine systems, life support, space suits and protective clothing. For related information see also *16 Space Transportation and Safety* and *52 Aerospace Medicine*.

20080012527 Mei Technology Corp., USA; NASA Johnson Space Center, Houston, TX, USA
Effects of Varying Surface Inclines and Suit Pressure: Implications on Space Suit Design
Clowers, Kurt; Clark, Timothy; Harvill, Lauren; Morency, Richard; Rajulu, Sudhakar; [2008]; 2 pp.; In English; Original contains color and black and white illustrations; Copyright; Avail.: CASI: A01, Hardcopy

Suited human performance studies in reduced gravity environments to date include limited observations from Apollo Lunar surface Extravehicular Activities (EVA) and from previous studies conducted in partial gravity simulation environments. The Constellation Program EVA Systems Project office has initiated tests to develop design requirements for the next generation Lunar EVA suit. Theses studies were conducted in the Space Vehicle Mock-Up Facility (SVMF) at Johnson Space Center from which the results provided recommendations for suit weight, mass, center of gravity, pressure, and suit kinematic constraints that optimize human performance in partial gravity environments.
Derived from text
Space Suits; Extravehicular Activity; Body Kinematics; Treadmills; Pressure Effects

20080012540 Jacobs Engineering Group, Inc., Houston, TX, USA; NASA Johnson Space Center, Houston, TX, USA
Ventilation Transport Trade Study for Future Space Suit Life Support Systems
Kempf, Robert; Vogel, Matthew; Paul, Heather L.; [2008]; 20 pp.; In English; 38th International Conference on Environmental Systems, 29 Jun.?2 Jul. 2008, San Francisco, CA, USA; Original contains color and black and white illustrations
Contract(s)/Grant(s): 903184.04.02.03.01; Copyright; Avail.: CASI: A03, Hardcopy

A new and advanced portable life support system (PLSS) for space suit surface exploration will require a durable, compact, and energy efficient system to transport the ventilation stream through the space suit. Current space suits used by NASA circulate the ventilation stream via a ball-bearing supported centrifugal fan. As NASA enters the design phase for the next generation PLSS, it is necessary to evaluate available technologies to determine what improvements can be made in mass, volume, power, and reliability for a ventilation transport system. Several air movement devices already designed for commercial, military, and space applications are optimized in these areas and could be adapted for EVA use. This paper summarizes the efforts to identify and compare the latest fan and bearing technologies to determine candidates for the next generation PLSS.
Author
Portable Life Support Systems; Space Suits; Technology Utilization; Tradeoffs; Transport Theory; Gas Transport; Ventilation Fans

20080012541 Jacobs Engineering Group, Inc., Houston, TX, USA; NASA Johnson Space Center, Houston, TX, USA
Further Testing of an Amine-based Pressure-Swing System for Carbon Dioxide and Humidity Control
Lin, Amy; Smith, Frederick; Sweterlitsch, Jeffrey; Nalette, Tim A.; Papale, William; [2008]; 15 pp.; In English; 38th International Conference on Environmental Systems, 29 Jun.-2 Jul. 2008, San Francisco, CA, USA; Original contains color illustrations
Contract(s)/Grant(s): NNJ04HF73A
Report No.(s): 08ICES-0184; Copyright; Avail.: CASI: A03, Hardcopy

In a crewed spacecraft environment, atmospheric carbon dioxide (CO2) and moisture control are crucial. Hamilton Sundstrand has developed a stable and efficient amine-based CO2 and water vapor sorbent, SA9T, that is well suited for use in a spacecraft environment. The sorbent is efficiently packaged in pressure-swing regenerable beds that are thermally linked to improve removal efficiency and minimize vehicle thermal loads. Flows are all controlled with a single spool valve. This technology has been baselined for the new Orion spacecraft. However, more data was needed on the operational characteristics of the package in a simulated spacecraft environment. A unit was therefore tested with simulated metabolic loads in a closed chamber at Johnson Space Center during the last third of 2006. Those test results were reported in a 2007 ICES paper. A second test article was incorporated for a third phase of testing, and that test article was modified to allow pressurized gas purge regeneration on the launch pad in addition to the standard vacuum regeneration in space. Metabolic rates and chamber volumes were also adjusted to reflect current programmatic standards. The third phase of tests was performed during the spring and summer of 2007. Tests were run with a range of operating conditions, varying: cycle time, vacuum pressure (or purge gas

flow rate), air flow rate, and crew activity levels. Results of this testing are presented and potential flight operational strategies discussed.
Author
Amines; Carbon Dioxide; Systems Engineering; Pressure Effects; Humidity; Control Systems Design; Manned Space Flight

20080012574 Lockheed Martin Space Operations, Houston, TX, USA; NASA Johnson Space Center, Houston, TX, USA
Wearability, Comfort and Field of View Findings from the Integrated Launch Suit Test
Harvey, Craig M.; Jones, Jeffrey A.; Whitmore, Mihriban; Gernhardt, Mike; January 2008; 54 pp.; In English; Original contains color and black and white illustrations
Report No.(s): NASA/TP-2007-214754; S-1004; Copyright; Avail.: CASI: A04, Hardcopy

The primary objective of the Launch Suit Test was to evaluate crewmember comfort in two planetary suit concepts during 1-g launch conditions similar to those to be experienced in the Crew Exploration Vehicle. This report addresses suit wear in a launch pad configuration; however, the overarching question is: 'Should planetary suits be further considered for launch/entry suits?' The test plan outlined four objectives: assess crewmember comfort in the Advanced Crew Escape Suit (ACES), Mark III and the Rear Entry ILC Dover Suit (REI-Suit) in a recumbent position (with helmet); determine the visibility envelope of crewmembers while in the ACES, Mark III, and REI-Suit in a recumbent position (with helmet); determine the ability of crewmembers to sit and stand from a recumbent position unassisted while in the ACES, Mark III, and REI-Suit (with helmet); and determine the reach envelope and motion capability for the ACES, Mark III, and REI-Suit in a recumbent position (with helmet). This report addresses objectives 1 through 3. The findings support further study of the planetary suit for use as a potential launch/entry suit.
Author
Wear; Comfort; Helmets; Field of View; Suits; Visibility

20080012587 NASA Johnson Space Center, Houston, TX, USA
The Challenges of Developing a Food System for a Mars Mission
Perchonok, Michele; [2008]; 30 pp.; In English; Original contains color illustrations; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012587

This viewgraph presents a review of the development of food systems for the use during a Mars Mission. It review some of the food delivery systems developed for all of the NASA space programs from Mercury, Gemini, and Apollo, to the Space Shuttle, International Space Station. The goals and objectives of the program are to: provide an adequate food system and develop a safe food system, that is nutritious and acceptable to astronauts, and to provide a food system that efficiently balances vehicle resources.
CASI
Mars Missions; Food Processing; Food Production (In Space); Space Flight Feeding; Space Rations; Diets; Nutrition; Food Intake; Eating

20080013202 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Structural Health System for Crew Habitats
Brandon, Erik; April 21, 2005; 48 pp.; In English; Society for the Advancement of Material and Process Engineering, 21 Apr. - 4 May 2005, Long Beach, CA, USA; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40641

This viewgraph presentation reviews the history of JPL, and its affilation with CalTech and NASA. It continues by examining some of the sensors, and systems to ensure structural health that JPL has developed. It also reviews some of the habitat designs that are being developed for the lunar base. With these crew habitats, there is a requirement to have embedded systems health monitoring, to alert the crew in time about adverse structural conditions. The use of sensing technologies and smart materials are being developed to assure mechanical flexibility, minimumally invasive, autonomous, and enhanced reliability.
CASI
Detection; Lunar Bases; Systems Health Monitoring; Component Reliability; Fault Detection; Lunar Based Equipment; Lunar Shelters; Life Support Systems

20080013347 NASA Marshall Space Flight Center, Huntsville, AL, USA
Life Support Technology Challenges for NASA's Constellation Program
Carrasquillo, Robyn; Bagdigian, Robert; Ewert, Michael; November 14, 2007; 23 pp.; In English; Technology Exchange Conference/NASA Constellation Program, 14-15 Nov. 2007, Galveston, TX, USA; Original contains color illustrations; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080013347

The presentation is for the ECLSS session of the Constellation Technology Exchange Conference and is to describe what new technology challenges the Constellation mission presents for the ECLSS, in order to communicate these needs with industry.
Author
Constellation Program; Life Support Systems; Environmental Control; Constellations

55
EXOBIOLOGY

Includes astrobiology; planetary biology; and extraterrestrial life. For the biological effects of aerospace environments on humans see *52 Aerospace Medicine*; on animals and plants see *51 Life Sciences*. For psychological and behavioral effects of aerospace environments see *53 Behavioral Sciences*.

20080013272 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Biologically Inspired Technology Using Electroactive Polymers (EAP)
Bar-Cohen, Yoseph; February 26, 2006; 6 pp.; In English; Smart Structures and Materials Symposium, 26 Feb. 2006, San Diego, CA, USA; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40643

Evolution allowed nature to introduce highly effective biological mechanisms that are incredible inspiration for innovation. Humans have always made efforts to imitate nature's inventions and we are increasingly making advances that it becomes significantly easier to imitate, copy, and adapt biological methods, processes and systems. This brought us to the ability to create technology that is far beyond the simple mimicking of nature. Having better tools to understand and to implement nature's principles we are now equipped like never before to be inspired by nature and to employ our tools in far superior ways. Effectively, by bio-inspiration we can have a better view and value of nature capability while studying its models to learn what can be extracted, copied or adapted. Using electroactive polymers (EAP) as artificial muscles is adding an important element to the development of biologically inspired technologies.
Author
Activity (Biology); Electroactive Polymers; Muscles

59
MATHEMATICAL AND COMPUTER SCIENCES (GENERAL)

Includes general topics and overviews related to mathematics and computer science. For specific topics in these areas see *categories 60 through 67*.

20080013193 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Reusable and Extensible High Level Data Distributions
Diaconescu, Roxana E.; Chamberlain, Bradford; James, Mark L.; Zima, Hans P.; May 4, 2005; 11 pp.; In English; Workshop on Patterns in High Performance Computing, 4-6 May 2005, Urbana-Champaign, IL, USA; Original contains black and white illustrations
Contract(s)/Grant(s): DARPA NBCH3039003; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40685

This paper presents a reusable design of a data distribution framework for data parallel high performance applications. We are implementing the design in the context of the Chapel high productivity programming language. Distributions in Chapel are a means to express locality in systems composed of large numbers of processor and memory components connected by a network. Since distributions have a great effect on,the performance of applications, it is important that the distribution strategy can be chosen by a user. At the same time, high productivity concerns require that the user is shielded from error-prone, tedious details such as communication and synchronization. We propose an approach to distributions that enables the user to refine a language-provided distribution type and adjust it to optimize the performance of the application.

Additionally, we conceal from the user low-level communication and synchronization details to increase productivity. To emphasize the generality of our distribution machinery, we present its abstract design in the form of a design pattern, which is independent of a concrete implementation. To illustrate the applicability of our distribution framework design, we outline the implementation of data distributions in terms of the Chapel language.
Author
Programming Languages; Memory (Computers); Computer Storage Devices; Productivity

20080013199 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Probabilistic Reasoning for Plan Robustness
Schaffer, Steve R.; Clement, Bradley J.; Chien, Steve A.; June 30, 2005; 6 pp.; In English; International Joint Conference on Artificial Intelligence (IJCAI), 30 Jun. 2005, Edinburgh, Scotland, UK; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40639

A planning system must reason about the uncertainty of continuous variables in order to accurately project the possible system state over time. A method is devised for directly reasoning about the uncertainty in continuous activity duration and resource usage for planning problems. By representing random variables as parametric distributions, computing projected system state can be simplified in some cases. Common approximation and novel methods are compared for over-constrained and lightly constrained domains. The system compares a few common approximation methods for an iterative repair planner. Results show improvements in robustness over the conventional non-probabilistic representation by reducing the number of constraint violations witnessed by execution. The improvement is more significant for larger problems and problems with higher resource subscription levels but diminishes as the system is allowed to accept higher risk levels.
Author
Robustness (Mathematics); Probability Theory; Random Variables; Approximation; Risk

20080013207 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Steps Towards the Standardization of a More Efficient Uplink Protocol and Code
Kazz, Greg J.; Greenberg, Edward; June 20, 2006; 6 pp.; In English; SpaceOps Conference, 20 Jun. 2006, Rome, Italy; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40698

In June 2004, NASA announced a new vision for the further exploration of the Moon and Mars. The vision includes a long-term human and robotic program to explore the solar system, starting with a return to the Moon that will ultimately enable future exploration of Mars and other destinations. Inherent in this endeavor is the need to transfer the communication technology developed for lunar missions to deep space whenever possible. Furthermore, greater data throughput on the uplink will be required for future nominal operations for the Exploration missions given their highly interactive nature and the need to send files in both directions. Therefore, it is prudent for standards bodies i.e., CCSDS to develop the underlying communication recommendations necessary to deliver greater data throughput to meet future agencies' needs.
Author
Uplinking; Protocol (Computers); Solar System; Standardization; Robotics

20080013215 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Autonomous Congestion Control in Delay-Tolerant Networks
Burleigh, Scott C.; Jennings, Esther H.; August 20, 2005; 9 pp.; In English; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40636

Congestion control is an important feature that directly affects network performance. Network congestion may cause loss of data or long delays. Although this problem has been studied extensively in the Internet, the solutions for Internet congestion control do not apply readily to challenged network environments such as Delay Tolerant Networks (DTN) where end-to-end connectivity may not exist continuously and latency can be high. In DTN, end-to-end rate control is not feasible. This calls for congestion control mechanisms where the decisions can be made autonomously with local information only. We use an economic pricing model and propose a rule-based congestion control mechanism where each router can autonomously decide on whether to accept a bundle (data) based on local information such as available storage and the value and risk of accepting the bundle (derived from historical statistics).
Author
Automatic Control; Computer Networks; Controllers; Losses; Internets

20080013270 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Accumulate Repeat Accumulate Coded Modulation

Abbasfar, Aliazam; Divsalar, Dariush; Yao, Kung; October 31, 2004; 5 pp.; In English; IEEE Military Communications Conference, 31 Oct. - 3 Nov. 2004, Monterey, CA, USA; Original contains black and white illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40695

In this paper we propose an innovative coded modulation scheme called 'Accumulate Repeat Accumulate Coded Modulation' (ARA coded modulation). This class of codes can be viewed as serial turbo-like codes, or as a subclass of Low Density Parity Check (LDPC) codes that are combined with high level modulation. Thus at the decoder belief propagation can be used for iterative decoding of ARA coded modulation on a graph, provided a demapper transforms the received in-phase and quadrature samples to reliability of the bits.

Author

Coding; Modulation; Quadratures; Decoders; Transformations (Mathematics)

20080013279 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

High Performance, Dependable Multiprocessor

Ramos, Jeremy; Samson, John R.; Troxel, Ian; Subramaniyan, Rajagopal; Jacobs, Adam; Greco, James; Cieslewski, Grzegorz; Curreri, John; Fischer, Michael; Grobelny, Eric; George, Alan; Aggarwal, Vikas; Patel, Minesh; Some, Raphael; March 4, 2006; 13 pp.; In English; IEEE Aerospace Conference, 4-11 Mar. 2006, Big Sky, MT, USA; Original contains black and white illustrations

Contract(s)/Grant(s): NASA NMP ST-8 NMO-710209

Report No.(s): Paper-151 1; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40674

With the ever increasing demand for higher bandwidth and processing capacity of today's space exploration, space science, and defense missions, the ability to efficiently apply commercial-off-the-shelf (COTS) processors for on-board computing is now a critical need. In response to this need, NASA's New Millennium Program office has commissioned the development of Dependable Multiprocessor (DM) technology for use in payload and robotic missions. The Dependable Multiprocessor technology is a COTS-based, power efficient, high performance, highly dependable, fault tolerant cluster computer. To date, Honeywell has successfully demonstrated a TRL4 prototype of the Dependable Multiprocessor [I], and is now working on the development of a TRLS prototype. For the present effort Honeywell has teamed up with the University of Florida's High-performance Computing and Simulation (HCS) Lab, and together the team has demonstrated major elements of the Dependable Multiprocessor TRLS system.

Author

Multiprocessing (Computers); Commercial Off-the-Shelf Products; Payloads; Robotics; Space Exploration; Technology Utilization; Fault Tolerance

61
COMPUTER PROGRAMMING AND SOFTWARE

Includes software engineering, computer programs, routines, algorithms, and specific applications, e.g., CAD/CAM. For computer software applied to specific applications, see also the associated category.

20080013209 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

A Roadmap for Using Agile Development in a Traditional Environment

Streiffert, Barbara A.; Starbird, Thomas; Grenander, Sven; June 19, 2006; 3 pp.; In English; SpaceOps, 19 Jun. 2006, Rome, Italy; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40680

One of the newer classes of software engineering techniques is called 'Agile Development'. In Agile Development software engineers take small implementation steps and, in some cases they program in pairs. In addition, they develop automatic tests prior to implementing their small functional piece. Agile Development focuses on rapid turnaround, incremental planning, customer involvement and continuous integration. Agile Development is not the traditional waterfall method or even a rapid prototyping method (although this methodology is closer to Agile Development). At Jet Propulsion Laboratory (JPL) a few groups have begun Agile Development software implementations. The difficulty with this approach becomes apparent when Agile Development is used in an organization that has specific criteria and requirements handed down

for how software development is to be performed. The work at the JPL is performed for the National Aeronautics and Space Agency (NASA). Both organizations have specific requirements, rules and procedure for developing software. This paper will discuss the some of the initial uses of the Agile Development methodology, the spread of this method and the current status of the successful incorporation into the current JPL development policies.
Author
Computer Programs; Software Engineering; Rapid Prototyping; Computer Programming; Environmental Engineering

62
COMPUTER SYSTEMS

Includes computer networks and distributed processing systems. For information systems see *82 Documentation and Information Science*. For computer systems applied to specific applications, see the associated category.

20080013335 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Science Opportunity Analyzer (SOA): Not Just Another Pretty Face
Polanskey, Carol A.; Streiiffert, Barbara; O'Reilly, Taifun; May 18, 2004; 20 pp.; In English; SpaceOps, 18 May 2004, Montreal, Canada; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40645

This viewgraph presentation reviews the Science Opportunity Analyzer (SOA). For the first time at JPL, the Cassini mission to Saturn is using distributed science operations for sequence generation. This means that scientist at other institutions has more responsibility to build the spacecraft sequence. Tools are required to support the sequence development. JPL tools required a complete configuration behind a firewall, and the tools that the user community had developed did not interface with the JPL tools. Therefore the SOA was created to bridge the gap between the remote scientists and the JPL operations teams. The presentation reviews the development of the SOA, and what was required of the system. The presentation reviews the functions that the SOA performed.
CASI
Sequencing; Coordination; Systems Engineering; Task Planning (Robotics); Scheduling; Mission Planning; Distributed Processing

64
NUMERICAL ANALYSIS

Includes iteration, differential and difference equations, and numerical approximation.

20080012501 NASA Langley Research Center, Hampton, VA, USA
Recent Progress in the Development of a Multi-Layer Green's Function Code for Ion Beam Transport
Tweed, John; Walker, Steven A.; Wilson, John W.; Tripathi, Ram K.; February 10, 2008; 9 pp.; In English; Space Technology and Applications International Forum (STAIF 2008), 10-14 Feb, 2998, Albuquerque, NM, USA; Original contains black and white illustrations
Contract(s)/Grant(s): WBS 732759.07.09; Copyright; Avail.: CASI: A02, Hardcopy

To meet the challenge of future deep space programs, an accurate and efficient engineering code for analyzing the shielding requirements against high-energy galactic heavy radiation is needed. To address this need, a new Green's function code capable of simulating high charge and energy ions with either laboratory or space boundary conditions is currently under development. The computational model consists of combinations of physical perturbation expansions based on the scales of atomic interaction, multiple scattering, and nuclear reactive processes with use of the Neumann-asymptotic expansions with non-perturbative corrections. The code contains energy loss due to straggling, nuclear attenuation, nuclear fragmentation with energy dispersion and downshifts. Previous reports show that the new code accurately models the transport of ion beams through a single slab of material. Current research efforts are focused on enabling the code to handle multiple layers of material and the present paper reports on progress made towards that end.
Author
Green's Functions; Ion Beams; Transport Theory; Radiation Shielding; Codes; Approximation

66
SYSTEMS ANALYSIS AND OPERATIONS RESEARCH

Includes mathematical modeling of systems; network analysis; mathematical programming; decision theory; and game theory.

20080013310 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Mars Reconnaissance Orbiter Mission: Systems Engineering Challenges on the Mars Reconnaissance Orbiter Mission
Havens, Glen G.; September 19, 2007; 12 pp.; In English; Space Conference and Exposition, 18-20 Sep. 2007, Long Beach, CA, USA; Original contains color illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40676

MRO project is a system of systems requiring system engineering team to architect, design, integrate, test, and operate these systems at each level of the project. The challenge of system engineering mission objectives into a single mission architecture that can be integrated tested, launched, and operated. Systems engineering must translate high-level requirements into integrated mission design. Systems engineering challenges were overcome utilizing a combination by creative designs built into MRO's flight and ground systems: a) Design of sophisticated spacecraft targeting and data management capabilities b) Establishment of a strong operations team organization; c) Implementation of robust operational processes; and d) Development of strategic ground tools. The MRO system has met the challenge of its driving requirements: a) MRO began its two-year primary science phase on November 7, 2006, and by July 2007, met it minimum requirement to collect 15 Tbits of data after only eight months of operations. Currently we have collected 22 Tbits. b) Based on current performance, mission data return could return 70 Tbits of data by the end of the primary science phase in 2008.
Author
Mars Reconnaissance Orbiter; Mars Missions; Systems Engineering; Mission Planning; Data Management

70
PHYSICS (GENERAL)

Includes general research topics related to mechanics, kinetics, magnetism, and electrodynamics. For specific areas of physics see *categories 71 through 77*. For related instrumentation see *35 Instrumentation and Photography*; for geophysics, astrophysics, or solar physics see *46 Geophysics, 90 Astrophysics*, or *92 Solar Physics*.

20080013289 NASA Marshall Space Flight Center, Huntsville, AL, USA
Global Simulation of Electromagnetic Ion Cyclotron Waves
Khazanov, G. V.; Gamayunov, K.; Gallagher, D. L.; Kozyra, J. U.; December 10, 2007; 1 pp.; In English; 2007 Fall Meeting of the American Geophysical Union, 10-14 Dec. 2007, San Francisco, CA, USA; No Copyright; Avail.: Other Sources; Abstract Only

It is well known that the effects of electromagnetic ion cyclotron (EMIC) waves on ring current (RC) ion and radiation belt (RB) electron dynamics strongly depend on such particle/wave characteristics as the phase-space distribution function, frequency, wave-normal angle, wave energy, and the form of wave spectral energy density. The consequence is that accurate modeling of EMIC waves and RC particles requires robust inclusion of the interdependent dynamics of wave growth/damping, wave propagation, and particles. Such a self-consistent model is being progressively developed by Khazanov et al. [2002 - 2007]. This model is based on a system of coupled kinetic equations for the RC and EMIC wave power spectral density along with the ray tracing equations. We will discuss the recent progress in understanding EMIC waves formation mechanisms in the inner magnetosphere. This problem remains unsettled in spite of many years of experimental and theoretical studies. Modern satellite observations by CRRES, Polar and Cluster still do not reveal the whole picture experimentally since they do not stay long enough in the generation region to give a full account of all the spatio-temporal structure of EMIC waves. The complete self-consistent theory taking into account all factors significant for EMIC waves generation remains to be developed. Several mechanisms are discussed with respect to formation of EMIC waves, among them are nonlinear modification of the ionospheric reflection by precipitating energetic protons, modulation of ion-cyclotron instability by long-period (Pc3/4) pulsations, reflection of waves from layers of heavy-ion gyroresonances, and nonlinearities of wave generation process. We show that each of these mechanisms have their attractive features and explains certain part experimental data but any of them, if taken alone, meets some difficulties when compared to observations. We conclude that development of a refined nonlinear theory and further correlated analysis of modern satellite and ground-based data is needed to solve this very intriguing problem.
Author
Ion Cyclotron Radiation; Radiation Belts; Simulation; Electrodynamics; Wave Propagation

71
ACOUSTICS

Includes sound generation, transmission, and attenuation. For noise pollution see *45 Environment Pollution*. For aircraft noise see also *02 Aerodynamics* and *07 Aircraft Propulsion and Power*.

20080012595 NASA Glenn Research Center, Cleveland, OH, USA
The Aeroacoustics of Turbulent Flows
Goldstein, M. E.; January 25, 2008; 14 pp.; In English; WSEAS Int. Conference, 25-27 Jan. 2008, Acapulco, Mexico; Original contains color and black and white illustrations
Contract(s)/Grant(s): WBS 984754.02.07.03.17.04; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012595

Aerodynamic noise prediction has been an important and challenging research area since James Lighthill first introduced his Acoustic Analogy Approach over fifty years ago. This talk attempts to provide a unified framework for the subsequent theoretical developments in this field. It assumes that there is no single approach that is optimal in all situations and uses the framework as a basis for discussing the strengths weaknesses of the various approaches to this topic. But the emphasis here will be on the important problem of predicting the noise from high speed air jets. Specific results will presented for round jets in the 0.5 to 1.4 Mach number range and compared with experimental data taken on the Glenn SHAR rig. It is demonstrated that nonparallel mean flow effects play an important role in predicting the noise at the supersonic Mach numbers. The results explain the failure of previous attempts based on the parallel flow Lilley model (which has served as the foundation for most jet noise analyses during past two decades).
Author
Aeroacoustics; Aerodynamic Noise; Jet Aircraft Noise; Noise Prediction; Turbulent Flow

20080012596 NASA Glenn Research Center, Cleveland, OH, USA
On Identifying the Sound Sources in a Turbulent Flow
Goldstein, M. E.; January 2008; 20 pp.; In English; Original contains black and white illustrations
Contract(s)/Grant(s): WBS 984754.02.07.03.17.04; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012596

A space-time filtering approach is used to divide an unbounded turbulent flow into its radiating and non-radiating components. The result is then used to clarify a number of issues including the possibility of identifying the sources of the sound in such flows. It is also used to investigate the efficacy of some of the more recent computational approaches.
Author
Acoustics; Turbulent Flow; Mathematical Models; Flow Equations; Aeroacoustics; Space-Time Functions

20080012597 NASA Glenn Research Center, Cleveland, OH, USA
The Aeroacoustics of Slowly Diverging Supersonic Jets
Goldstein, M. E.; Leib, S. J.; January 2008; 73 pp.; In English; Original contains color and black and white illustrations
Contract(s)/Grant(s): WBS 984754.02.07.03.17.04; Copyright; Avail.: CASI: A04, Hardcopy

This paper is concerned with utilizing the acoustic analogy approach to predict the sound from unheated supersonic jets. Previous attempts have been unsuccessful at making such predictions over the Mach number range of practical interest. The present paper, therefore, focuses on implementing the necessary refinements needed to accomplish this objective. The important effects influencing peak supersonic noise turn out to be source convection, mean flow refraction, mean flow amplification, and source non-compactness. It appears that the last two effects have not been adequately dealt with in the literature. The first of these because the usual parallel flow models produce most of the amplification in the so called critical layer where the solution becomes singular and, therefore, causes the predicted sound field to become infinite as well. We deal with this by introducing a new weakly non parallel flow analysis that eliminates the critical layer singularity. This has a strong effect on the shape of the peak noise spectrum. The last effect places severe demands on the source models at the higher Mach numbers because the retarded time variations significantly increase the sensitivity of the radiated sound to the source structure in this case. A highly refined (non-separable) source model is, therefore, introduced in this paper.
Author
Aeroacoustics; Supersonic Jet Flow; Mathematical Models; Analogies; Gas Jets

20080013210 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Real Time Phase Noise Meter Based on a Digital Signal Processor

Angrisani, Leopoldo; D'Arco, Mauro; Greenhall, Charles A.; Schiano Lo Morille, Rosario; April 24, 2006; 6 pp.; In English; IEEE Intrumental and Measurement Technology Conference, 24 Apr. 2006, Sorrento, Italy; Original contains black and white illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40679

A digital signal-processing meter for phase noise measurement on sinusoidal signals is dealt with. It enlists a special hardware architecture, made up of a core digital signal processor connected to a data acquisition board, and takes advantage of a quadrature demodulation-based measurement scheme, already proposed by the authors. Thanks to an efficient measurement process and an optimized implementation of its fundamental stages, the proposed meter succeeds in exploiting all hardware resources in such an effective way as to gain high performance and real-time operation. For input frequencies up to some hundreds of kilohertz, the meter is capable both of updating phase noise power spectrum while seamlessly capturing the analyzed signal into its memory, and granting as good frequency resolution as few units of hertz.

Author

Signal Processing; Digital Systems; Noise Measurement; Real Time Operation; Noise Meters; Data Acquisition

20080013319 NASA Marshall Space Flight Center, Huntsville, AL, USA

CFD Computation of Broadband Fan Interaction Noise

Grace, Sheryl M.; Sondak, Douglas L.; Dorney, Daniel J.; November 10, 2007; 6 pp.; In English; 2007 ASME International Mechanical Engineering Congress and Exposition (IMECE 07), 10-16 Nov. 2007, Seattle, WA, USA; Original contains color and black and white illustrations

Report No.(s): IMECE2007-43779; Copyright; Avail.: Other Sources

In this study, a 3-D, unsteady, Reynolds Averaged Navier Stokes CFD code coupled to an acoustic calculation is used to predict the contribution of the exit guide vanes to broadband fan noise. The configuration investigated is that corresponding to the NASA Source Diagnostic Test (SDT) 22-in fan rig. Then an acoustic model introduced by Nallasamy which is based on 2-D strip theory is used to compute the broadband rotor-stator interaction noise. One configuration from the SDT matrix is considered here: the fan speed correlating to approach, and outlet guide vane count designed for cut-off of the blade passage frequency. Thus, in the chosen configuration, there are 22 rotor blades and 54 stator blades. The stators are located 2.5 tip chords downstream of the rotor trailing edge. The RANS computations are used to obtain the spectra of the unsteady surface pressure on the exit guide vanes. This surface pressure is then integrated together with the Green's function for and infinite cylindrical duct to obtain the acoustic field. The results from this investigation validate the use of the CFD code along with the acoustic model for broadband fan noise predictions. The validation enables future investigations such as the determination of rotor tip clearance and stator solidity effects on fan rotor-stator interaction noise.

Author

Broadband; Computational Fluid Dynamics; Interactional Aerodynamics; Rotor Aerodynamics; Aeroacoustics; Turbomachinery; Fan Blades

72
ATOMIC AND MOLECULAR PHYSICS

Includes atomic and molecular structure, electron properties, and atomic and molecular spectra. For elementary particle physics see *73 Nuclear Physics*.

20080013301 Huo Consulting, LLC, Los Altos, CA, USA

Electron-impact Excitation and Ionization in Air

Huo, Winifred M.; [2008]; 16 pp.; In English; Original contains color and black and white illustrations

Contract(s)/Grant(s): NNA07BA89C

Report No.(s): AIAA Paper 2008-1207-266; No Copyright; Avail.: CASI: A03, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080013301

Electron-impact ionization of N and N2 and radiative recombination of N(+) and O(+) with electrons are studied in order to provide state-of-the-art data for CFD and radiation simulations in an ionized hypersonic flow. The electron-impact ionization rate coefficients of N are determined assuming Boltzmann equilibrium among the three lowest states, 4S0, 2D0, and 2P0. They are significantly smaller that the rate data employed in the Park model, but are in reasonable agreement with the Losev model. For N2, the calculated rate coefficients are larger than the Losev model below 25,000 K. The study of the

radiative recombination of N(+) and O(+) shows that more than 93% of the radiation from this process is emitted in the 50-120 nm range. Due to the continuous nature of the radiation from recombination, it contributes a significant portion of the radiative heat load in the VUV region.
Author
Electron Impact; Excitation; Ionization; Nitrogen; Oxygen; Hypersonic Flow; Radiative Recombination; Atmospheric Entry Simulation; Computational Fluid Dynamics

73
NUCLEAR PHYSICS

Includes nuclear particles; and reactor theory. For space radiation see *93 Space Radiation*. For atomic and molecular physics see *72 Atomic and Molecular Physics*. For elementary particle physics see *77 Physics of Elementary Particles and Fields*. For nuclear astrophysics see *90 Astrophysics*.

20080013211 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
MEMS-Based Force-Detected Nuclear Magnetic Resonance (FDNMR) Spectrometer
Lee, Choonsup; Butler, Mark C.; Elgammal, Ramez A.; George, Thomas; Hunt, Brian; Weitekamp, Daniel P.; April 19, 2006; 6 pp.; In English; SPIE Micro (MEMS) and Nanotechnologies for Space Applications, 19 Apr. 2006, Orlando, FL, USA; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40678

Nuclear Magnetic Resonance (NMR) spectroscopy allows assignment of molecular structure by acquiring the energy spectrum of nuclear spins in a molecule, and by interpreting the symmetry and positions of resonance lines in the spectrum. As such, NMR has become one of the most versatile and ubiquitous spectroscopic methods. Despite these tremendous successes, NMR experiments suffer from inherent low sensitivity due to the relatively low energy of photons in the radio frequency (rt) region of the electromagnetic spectrum. Here, we describe a high-resolution spectroscopy in samples with diameters in the micron range and below. We have reported design and fabrication of force-detected nuclear magnetic resonance (FDNMR).
Author
Nuclear Magnetic Resonance; Microelectromechanical Systems; Spectrometers; Frequency Distribution; Electromagnetic Spectra; Energy Spectra; Nuclear Spin; Molecular Structure

74
OPTICS

Includes light phenomena and the theory of optical devices; for specific optical devices see also *35 Instrumentation and Photography*. For lasers see *36 Lasers and Masers*.

20080013275 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Recent Progress in x3-Related Optical Process Experimental Technique. Raman Lasing
Matsko, A. B.; Savchenkov, Anatoliy A.; Strekalov, Dmitry; Maleki, Lute; February 28, 2006; 3 pp.; In English; Advanced Solid-State Photonics (ASSP), 28 Feb. 2006, Tahoe, NV, USA; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40663

We describe theoretically and verify experimentally a simple technique for analyzing conversion efficiency and threshold of ail-resonant intracavity Raman lasers. The method is based on a dependence of the ring-down time of the pump cavity mode on the energy, accumulated in the cavity.
Author
Raman Lasers; Energy Conversion Efficiency; Downtime; Cavities; Accumulations

20080013277 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Calligraphic Poling for WGM Resonators
Mohageg, Makan; Strekalov, Dmitry; Savchenkov, Anatoliy; Matsko, Andrey; Ilchenko, Vladimir; Maleki, Lute; January 21, 2007; 13 pp.; In English; Photonics West, 21-27 Jan. 2006, San Jose, CA, USA; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40688

By engineering the geometry of a nonlinear optical crystal, the effective efficiency of all nonlinear optical oscillations can

be increased dramatically. Specifically, sphere and disk shaped crystal resonators have been used to demonstrate nonlinear optical oscillations at sub-milliwatt input power when cs light propagates in a Whispering Gallery Mode (WGM) of such a resonant cavity. in terms of both device production and experimentation in quantum optics, some nonlinear optical effects with naturally high efficiency can occult the desired nonlinear scattering process. the structure to the crystal resonator. In this paper, I will discuss a new method for generating poling structures in ferroelectric crystal resonators called calligraphic poling. The details of the poling apparatus, experimental results and speculation on future applications will be discussed.
Author
Whispering Gallery Modes; Ferroelectricity; Nonlinear Optics; Cavity Resonators; Quantum Optics

20080013307 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Polarization Effects Aboard the Space Interferometry Mission
Levin, Jason; Young, Martin; Dubovitsky, Serge; Dorsky, Leonard; April 17, 2006; 10 pp.; In English; SPIE Defense and Security Symposium, 17-21 Apr. 2006, Orlando, FL, USA; Original contains color and black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40664

For precision displacement measurements, laser metrology is currently one of the most accurate measurements. Often, the measurement is located some distance away from the laser source, and as a result, stringent requirements are placed on the laser delivery system with respect to the state of polarization. Such is the case with the fiber distribution assembly (FDA) that is slated to fly aboard the Space Interferometry Mission (ESA) next decade. This system utilizes a concatenated array of couplers, polarizers and lengthy runs of polarization-maintaining (PM) fiber to distribute linearly-polarized light from a single laser to fourteen different optical metrology measurement points throughout the spacecraft. Optical power fluctuations at the point of measurement can be traced back to the polarization extinction ration (PER) of the concatenated components, in conjunction with the rate of change in phase difference of the light along the slow and fast axes of the PM fiber.
Author
Optical Measurement; Laser Outputs; Metrology; Polarized Light; Displacement Measurement; Interferometry

76
SOLID-STATE PHYSICS

Includes condensed matter physics, crystallography, and superconductivity. For related information see also *33 Electronics and Electrical Engineering*; and *36 Lasers and Masers*.

20080013164 NASA Marshall Space Flight Center, Huntsville, AL, USA
Solution Growth and Characterization of Single Crystals on Earth and in Microgravity
Aggarwal, M. D.; Currie, J. R.; Penn, B. G.; Batra, A. K.; Lal, R. B.; December 2007; 80 pp.; In English; Original contains black and white illustrations
Contract(s)/Grant(s): W9113M-04-C-0005; NNG06GC58A
Report No.(s): NASA/TM-2007-215187; M-1211; Copyright; Avail.: CASI: A05, Hardcopy

Crystal growth has been of interest to physicists and engineers for a long time because of their unique properties. Single crystals are utilized in such diverse applications as pharmaceuticals, computers, infrared detectors, frequency measurements, piezoelectric devices, a variety of high-technology devices, and sensors. Solution crystal growth is one of the important techniques to grow a variety of crystals when the material decomposes at the melting point and a suitable solvent is available to make a saturated solution at a desired temperature. In this Technical Memorandum (TM) an attempt is made to give the fundamentals of growing crystals from solution including improved designs of various crystallizers. Since the same solution crystal growth technique could not be used in microgravity, the authors proposed a new cooled-sting technique to grow crystals in space. The authors experience from conducting two Space Shuttle solution crystal growth experiments are also detailed in this TM and the complexity of solution growth experiments to grow crystals in space are also discussed. These happen to be some of the early experiments performed in space, and various lessons learned are described. A brief discussion of protein crystal growth that shares basic principles of the solution growth technique is given, along with some flight hardware information for growth in microgravity.
Author
Microgravity; Protein Crystal Growth; Single Crystals; Characterization; Earth (Planet); Solutions

80
SOCIAL AND INFORMATION SCIENCES (GENERAL)

Includes general research topics related to sociology; educational programs and curricula. For specific topics in these areas see *categories 81 through 85*.

20080012458 NASA Dryden Flight Research Center, Edwards, CA, USA
The First 'A' in NASA: Motivations for a Career in Aerospace Engineering
Cole, Jennifer; January 24, 2008; 8 pp.; In English; Original contains color and black and white illustrations; No Copyright; Avail.: CASI: A02, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012458

This document offers a poster presentation highlighting reasons to pursue a career in aerospace engineering. These motivations are correlated with NASA's overall mission of scientific discovery and space exploration.
CASI
Aerospace Engineering; Occupation

81
ADMINISTRATION AND MANAGEMENT

Includes management planning and research.

20080013348 NASA Marshall Space Flight Center, Huntsville, AL, USA
Mission Risk Reduction Regulatory Change Management
Scroggins, Sharon; November 07, 2007; 7 pp.; In English; NASA and The Portugese Center for Pollution Prevention, 7-9 Nov. 2007, Peniche, Portugal; No Copyright; Avail.: CASI: A02, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080013348

NASA Headquarters Environmental Management Division supports NASA's mission to pioneer the future in space exploration, scientific discovery, and aeronautics research by integrating environmental considerations into programs and projects early-on, thereby proactively reducing NASA's exposure to institutional, programmatic and operational risk. As part of this effort, NASA established the Principal Center for Regulatory Risk Analysis and Communication (RRAC PC) as a resource for detecting, analyzing, and communicating environmental regulatory risks to the NASA stakeholder community. The RRAC PC focuses on detecting emerging environmental regulations and other operational change drivers that may pose risks to NASA programs and facilities, and effectively communicating the potential risks. For example, regulatory change may restrict how and where certain activities or operations may be conducted. Regulatory change can also directly affect the ability to use certain materials by mandating a production phase-out or restricting usage applications of certain materials. Regulatory change can result in significant adverse impacts to NASA programs and facilities due to NASA's stringent performance requirements for materials and components related to human-rated space vehicles. Even if a regulation does not directly affect NASA operations, U.S. and international regulations can pose program risks indirectly through requirements levied on manufacturers and vendors of components and materials. For example, manufacturers can change their formulations to comply with new regulatory requirements. Such changes can require time-consuming and costly requalification certification for use in human spaceflight programs. The RRAC PC has implemented a system for proactively managing regulatory change to minimize potential adverse impacts to NASA programs and facilities. This presentation highlights the process utilized by the RRACPC to communicate regulatory change and the associated potential risks within NASA, as well as the process for communicating and cooperating with other government agencies and industry partners, both domestic and international, to ensure mission success.
Author
Space Exploration; Environment Management; NASA Programs; Space Flight; Regulations; Detection; Communicating

82
DOCUMENTATION AND INFORMATION SCIENCE

Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography. For computer program documentation see *61 Computer Programming and Software*.

20080013370 NASA Langley Research Center, Hampton, VA, USA
A Proposal for a Thesaurus for Web Services in Solar Radiation
Gschwind, Benoit; Menard, Lionel; Ranchin, Thierry; Wald, Lucien; Stackhouse, Paul W., Jr.; [2007]; 8 pp.; In English; ENVIRONINFO 2007: Environmental Informatics and Systems Research, 12-14 Sep. 2007, Warsaw, Poland
Contract(s)/Grant(s): WBS 389018.02.12.01.73; Copyright; Avail.: Other Sources

Metadata are necessary to discover, describe and exchange any type of information, resource and service at a large scale. A significant amount of effort has been made in the field of geography and environment to establish standards. Efforts still remain to address more specific domains such as renewable energies. This communication focuses on solar energy and more specifically on aspects in solar radiation that relate to geography and meteorology. A thesaurus in solar radiation is proposed for the keys elements in solar radiation namely time, space and radiation types. The importance of time-series in solar radiation is outlined and attributes of the key elements are discussed. An XML schema for encoding metadata is proposed. The exploitation of such a schema in web services is discussed. This proposal is a first attempt at establishing a thesaurus for describing data and applications in solar radiation.
Author
Metadata; Thesauri; Web Services; Solar Energy; Solar Radiation; Document Markup Languages; Information Management

88
SPACE SCIENCES (GENERAL)

Includes general research topics related to the natural space sciences. For specific topics in space sciences see *categories 89 through 93*.

20080012515 Wisconsin Univ., Madison, WI, USA; NASA Johnson Space Center, Houston, TX, USA
Oxygen Isotope Systematics of Chondrules from the Least Equilibrated H Chondrite
Kita, N. T.; Kimura, M.; Ushikubo, T.; Valley, J. W.; Nyquist, L. E.; March 10, 2008; 2 pp.; In English; 39th Lunar and Planetary Science Conference, 10-14 Mar. 2008, League City, TX, USA; Original contains color and black and white illustrations; Copyright; Avail.: CASI: A01, Hardcopy

Oxygen isotope compositions of bulk chondrules and their mineral separates in type 3 ordinary chondrites (UOC) show several % variability in the oxygen three isotope diagram with slope of approx.0.7 [1]. In contrast, ion microprobe analyses of olivine and pyroxene phenocrysts in ferromagnesian chondrules from LL 3.0-3.1 chondrites show mass dependent isotopic fractionation as large as 5% among type I (FeO-poor) chondrules, while type II (FeO-rich) chondrules show a narrow range (less than or equal to 1%) of compositions [2]. The .Delta(exp 17)O (=delta(exp 17)O-0.52xdelta(exp 18)O) values of olivine and pyroxene in these chondrules show a peak at approx.0.7% that are systematically lower than those of bulk chondrule analyses as well as the bulk LL chondrites [2]. Further analyses of glass in Semarkona chondrules show .17O values as high as +5% with highly fractionated d18O (max +18%), implying O-16-poor glass in chondrules were altered as a result of hydration in the parent body at low temperature [3]. Thus, chondrules in LL3.0-3.1 chondrites do not provide any direct evidence of oxygen isotope exchange between solid precursor and O-16-depleted gas during chondrule melting events. To compare the difference and/or similarity between chondrules from LL and H chondrites, we initiated systematic investigations of oxygen isotopes in chondrules from Yamato 793408 (H3.2), one of the least equilibrated H chondrite [4]. In our preliminary study of 4 chondrules, we reported distinct oxygen isotope ratios from dusty olivine and refractory forsterite (RF) grains compared to their host chondrules and confirmed their relict origins [5].
Derived from text
Chondrites; Isotope Separation; Meteoritic Composition; Oxygen Isotopes; Depletion; Chondrule; Petrology; Forsterite; Iron Oxides

20080012520 NASA Johnson Space Center, Houston, TX, USA
Characterization of the Catalog Fengyun-1C Fragments and Their Long-term Effect on the LEO Environment
Liou, J.-C.; Johnson, N. L.; [2008]; 1 pp.; In English; 37th COSPAR Scientific Assembly, 13-20Jul. 2008, Montreal, Canada; Copyright; Avail.: Other Sources; Abstract Only

The intentional breakup of Fengyun-1C on 11 January 2007 created the most severe orbital debris cloud in history. More

than 2500 large fragments were identified and tracked by the U.S. Space Surveillance Network by the end of the year. The altitude where the event occurred was probably the worst location for a major breakup in the low Earth orbit (LEO) region, since it was already highly populated with operational satellites and debris generated from previous breakups. The addition of so many fragments not only poses a realistic threat to operational satellites in the region, but also increases the instability (i.e., collision cascade effect) of the debris population there. Preliminary analysis of the large Fengyun-1C fragments indicates that their size and area-to-mass ratio (A/M) distributions are very different from those of other known events. About half of the fragments appear to be composed of light-weight materials and more than 100 of them have A/M values exceeding 1 square meter per kilogram, consistent with thermal blanket pieces. In addition, the orbital elements of the fragments suggest nontrivial velocity gain by the fragment cloud during the impact. These important characteristics were incorporated into a numerical simulation to assess the long-term impact of the Fengyun-1C fragments to the LEO debris environment. The main objectives of the simulation were to evaluate (1) the collision probabilities between the Fengyun-1C fragments and the rest of the catalog population and (2) the collision activities and population growth in the region in the next 100 years.
Author
Low Earth Orbits; Orbital Elements; Space Debris; Fragments; Characterization

20080012522 NASA Johnson Space Center, Houston, TX, USA
Statistical Estimation of Orbital Debris Populations with a Spectrum of Object Size
Xu, Y. -l; Horstman, M.; Krisko, P. H.; Liou, J. -C; Matney, M.; Stansbery, E. G.; Stokely, C. L.; Whitlock, D.; [2008]; 2 pp.; In English; 37th COSPAR Scientific Assembly, 13-20 Jul. 2008, Montreal, Canada; Copyright; Avail.: CASI: A01, Hardcopy

Orbital debris is a real concern for the safe operations of satellites. In general, the hazard of debris impact is a function of the size and spatial distributions of the debris populations. To describe and characterize the debris environment as reliably as possible, the current NASA Orbital Debris Engineering Model (ORDEM2000) is being upgraded to a new version based on new and better quality data. The data-driven ORDEM model covers a wide range of object sizes from 10 microns to greater than 1 meter. This paper reviews the statistical process for the estimation of the debris populations in the new ORDEM upgrade, and discusses the representation of large-size (greater than or equal to 1 m and greater than or equal to 10 cm) populations by SSN catalog objects and the validation of the statistical approach. Also, it presents results for the populations with sizes of greater than or equal to 3.3 cm, greater than or equal to 1 cm, greater than or equal to 100 micrometers, and greater than or equal to 10 micrometers. The orbital debris populations used in the new version of ORDEM are inferred from data based upon appropriate reference (or benchmark) populations instead of the binning of the multi-dimensional orbital-element space. This paper describes all of the major steps used in the population-inference procedure for each size-range. Detailed discussions on data analysis, parameter definition, the correlation between parameters and data, and uncertainty assessment are included.
Author
Orbital Elements; Space Debris; Statistical Analysis; Populations; Estimating

20080012524 NASA Johnson Space Center, Houston, TX, USA
The Effect of a Potentially Low Solar Cycle #24 on Orbital Lifetimes of Fengyun 1-C Debris
Whitlock, David; Johnson, Nicholas; Matney, Mark; Krisko, Paula; [2008]; 1 pp.; In English; 37th COSPAR Scientific Assembly, 13-20 Jul. 2008, Montreal, Canada; Copyright; Avail.: Other Sources; Abstract Only

The magnitude of Solar Cycle #24 will have a non-trivial impact on the lifetimes of debris pieces that resulted from the intentional hypervelocity impact of the Fengyun 1-C satellite in January 2007. Recent solar flux measurements indicate Solar Cycle #24 has begun in the last few months, and will continue until approximately 2019. While there have been differing opinions on whether the intensity of this solar cycle will be higher or lower than usual, the Space Weather Prediction Center within the National Oceanic Atmospheric Administration (NOAA/SWPC) has recently forecast unusually low solar activity, which would result in longer orbital lifetimes. Using models for both the breakup of Fengyun 1-C and the propagation of the resultant debris cloud, the Orbital Debris Program Office at NASA Johnson Space Center conducted a study to better understand the impact of the solar cycle on lifetimes for pieces as small as 1 mm. Using a modified collision breakup model and PROP3D propagation software, the orbits of nearly 2 million objects 1 mm and larger were propagated for up to 200 years. By comparing a normal solar cycle with that of the NOAA/SWPC forecast low cycle, the effect of the solar flux on the lifetimes of the debris pieces is evaluated. The modeling of the low solar cycle shows an additional debris count of 12% for pieces larger than 10 cm by 2019 when compared to the resultant debris count using a normal cycle. The difference becomes more exaggerated (over 15%) for debris count in the smaller size regimes. However, in 50 years, the models predict the differences in debris count from differing models of Solar Cycle #24 to be less than 10% for all size regimes, with less variance

in the smaller sizes. Understanding the longevity of the debris cloud will affect collision probabilities for both operational spacecraft and large derelict objects over the next century and beyond.
Author
Hypervelocity Impact; Solar Cycles; Space Debris; Space Weather

20080012585 NASA Johnson Space Center, Houston, TX, USA
The Solid Rocket Motor Slag Population: Results of a Radar-Based Regressive Statistical Evaluation
Horstman, Matthew F.; Xu, Yu-Lin; [2008]; 1 pp.; In English; 37th COSPAR Scientific Assembly, 13-20 Jul. 2008, Montreal, Canada; Copyright; Avail.: Other Sources; Abstract Only

Solid rocket motor (SRM) slag has been identified as a potential source of man-made orbital debris. The possibility that SRMs (in addition to generating dust particles in the sub-millimeter range) may generate particles up to centimeters in size has caused concern regarding their contribution to the debris environment. Returned surfaces from space do not have sufficient area or exposure time to provide a clear picture of the SRM millimeter and centimeter debris population. Currently, radar observation is probably the only way to collect data showing the debris contribution from SRMs. Such observation is used to sample the debris environment, but it is difficult to obtain accurate orbital elements for the detected debris objects. NASA has developed several models to describe the different orbital debris populations, based on assumed debris production mechanisms to create clouds of debris objects that can be propagated in time. The NASA model, LEGEND (LEO-to-GEO Environment Debris), functions as a time-tested debris model for most debris sources. However, the current LEGEND model does not include contributions from the SRM population. An SRM model has recently been developed by NASA, based on purely theoretical details of SRM production and known SRM launches, but verification with hard data is needed. Because the detections of individual SRM objects cannot be deterministically separated from the total debris observed by radar, the validation of the SRM model can only be done by combining it with the LEGEND breakup model and comparing it with data. By applying observational constraints, the degree of SRM slag contribution to the environment may be estimated. This serves as an observationally sound method from which to calibrate a purely theoretical model into something more realistic. For this study, we use the populations observed by the Haystack radar from 1996 to present. For the SRM debris, we use a historical database of SRM launches, propellant masses, and estimated locations and times of tailoff to produce and propagate the SRM debris clouds. Comparisons with radar data from the ensuing years were made, and the SRM model was altered with respect to size and mass production of slag particles to reflect the populations estimated from the data. The result is a model SRM population that fits within the bounds of the observed environment and estimates of the production and contribution of SRM debris to the environment.
Author
Radar Data; Slags; Solid Propellant Rocket Engines; Statistical Analysis; Regression Analysis; Space Debris

20080013192 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
New Approach for Efficient Diagnosis of Large and Complex Space Systems
Fijany, Amir; Vatan, Farrokh; June 9, 2005; 6 pp.; In English; 2nd International Conference on Recent Advances in Space Technologies, 9 Mar. 2005, Istanbul, Turkey; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40624

We propose a novel algorithmic approach and present a new algorithm for solving the diagnosis problem. We report the results of the performance of the new algorithm and compare them with the traditional and standard algorithms. These results show the strong performance of our new algorithm with several orders of magnitude improvement over the traditional approach.
Author
Complex Systems; Aerospace Systems; Algorithms; Diagnosis

20080013212 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
New Horizons Risk Communication Strategy, Planning, Implementation, and Lessons Learned
Dawson, Sandra A.; June 25, 2006; 7 pp.; In English; 4th International Energy Conversion Engineering Conference, 26-29 Jun. 2006, San Diego, CA, USA; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40677

This paper discusses the risk communication goals, strategy, planning process and product development for the New

Horizons mission, including lessons from the Cassini mission that were applied in that effort, and presents lessons learned from the New Horizons effort that could be applicable to future missions.
Author
Risk; Product Development; New Horizons Mission; Cassini Mission

20080013216 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Mass Efficiencies for Common Large-Scale Precision Space Structures
Williams, R. Brett; Agnes, Gregory S.; April 18, 2005; 9 pp.; In English; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40635

This paper presents a mass-based trade study for large-scale deployable triangular trusses, where the longerons can be monocoque tubes, isogrid tubes, or coilable longeron trusses. Such structures are typically used to support heavy reflectors, solar panels, or other instruments, and are subject to thermal gradients that can vary a great deal based on orbital altitude, location in orbit, and self-shadowing. While multi layer insulation (MLI) blankets are commonly used to minimize the magnitude of these thermal disturbances, they subject the truss to a nonstructural mass penalty. This paper investigates the impact of these add-on thermal protection layers on selecting the lightest precision structure for a given loading scenario.
Author
Spacecraft Structures; Large Space Structures; Efficiency; Thermal Protection; Trusses; Longerons

20080013227 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Temporal Investment Strategy to Enable JPL Future Space Missions
Lincoln, William P.; Hua, Hook; Weisbin, Charles R.; July 17, 2006; 6 pp.; In English; 2nd International Conference on Space Mission Challenges for Information Technology (SMC-IT), 17 Jul. 2006, Pasadena, CA, USA; Original contains color and black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40652

The Jet Propulsion Laboratory (JPL) formulates and conducts deep space missions for NASA (the National Aeronautics and Space Administration). The Chief Technologist of JPL has the responsibility for strategic planning of the laboratory's advanced technology program to assure that the required technological capabilities to enable future JPL deep space missions are ready as needed; as such he is responsible for the development of a Strategic Plan. As part of the planning effort, he has supported the development of a structured approach to technology prioritization based upon the work of the START (Strategic Assessment of Risk and Technology) team. A major innovation reported here is the addition of a temporal model that supports scheduling of technology development as a function of time. The JPL Strategic Technology Plan divides the required capabilities into 13 strategic themes. The results reported here represent the analysis of an initial seven.
Author
Technology Assessment; NASA Space Programs; Deep Space; Scheduling; Space Missions

20080013228 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Adjoint Sensitivity Analysis of Orbital Mechanics: Application to Computations of Observables' Partials with Respect to Harmonics of the Planetary Gravity Fields
Ustinov, Eugene A.; Sunseri, Richard F.; April 24, 2005; 18 pp.; In English; European Geosciences Union General Assembly, 24-29 Apr. 2005, Vienna, Austria; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40634

An approach is presented to the inversion of gravity fields based on evaluation of partials of observables with respect to gravity harmonics using the solution of adjoint problem of orbital dynamics of the spacecraft. Corresponding adjoint operator is derived directly from the linear operator of the linearized forward problem of orbital dynamics. The resulting adjoint problem is similar to the forward problem and can be solved by the same methods. For given highest degree N of gravity harmonics desired, this method involves integration of N adjoint solutions as compared to integration of N2 partials of the forward solution with respect to gravity harmonics in the conventional approach. Thus, for higher resolution gravity models, this approach becomes increasingly more effective in terms of computer resources as compared to the approach based on the solution of the forward problem of orbital dynamics.
Author
Sensitivity Analysis; Gravitational Fields; Harmonics; Nitrogen; Gravitation

20080013266 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

A Parametric Design Tool for Large Space Telescope Sunshields

Paine, Christopher G.; Bradford, Charles M.; Dragovan, Mark C.; Yorke, Harold W.; May 31, 2006; 8 pp.; In English; Astonomical Telescopes and Instrumentation Conference, 24-31 May 2006, Orlando, Fl, USA; Original contains color and black and white illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40705

In what follows, we describe the thermal-mechanical model, the thermo-optical properties assumed for the components, and the environment which influences the thermal performance. Following this, we present predictions of performance sensitivity to variation in some of the optical characteristics. Studies of the performance sensitivity are continuing, to inform the direction of technology investment for further development of capabilities for large space telescopes.

Author

Hubble Space Telescope; Optical Properties; Temperature Effects

20080013305 NASA Johnson Space Center, Houston, TX, USA

Curation, Spacecraft Recovery and Preliminary Examination for the Stardust Mission: A Perspective from the Curatorial Facility

Zolensky, Michael; Nakamura-Messenger, Keiko; Fletcher, Lisa; See, Thomas; [2008]; 39 pp.; In English; Original contains color and black and white illustrations; Copyright; Avail.: CASI: A03, Hardcopy

We briefly describe some of the challenges to the Stardust mission, curation and sample preliminary analysis, from the perspective of the Curation Office at the Johnson Space Center. Our goal is to inform persons planning future sample returns, so that they may learn from both our successes and challenges (and avoid some of our mistakes). The Curation office played a role in the mission from its inception, most critically assisting in the design and implementation of the spacecraft contamination control plan, and in planning and documenting the recovery of the spacecraft reentry capsule in Utah. A unique class 100 cleanroom was built to maintain the returned comet and interstellar samples in clean comfort, and to permit dissection and allocation of samples for analysis.

Author

Stardust Mission; Spacecraft Reentry; Spacecraft Contamination; Spacecraft Recovery; Dissection; Comets

20080013308 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Results of the JIMO Follow-on Destinations Parametric Studies

Noca, Muriel A.; Hack, Kurt J.; February 15, 2005; 9 pp.; In English; Space Technology and Applications International Forum (STAIF), 15-17 Feb. 2005, Albuquerque, NM, USA; Original contains black and white illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40631

NASA's proposed Jupiter Icy Moon Orbiter (JIMO) mission currently in conceptual development is to be the first one of a series of highly capable Nuclear Electric Propulsion (NEP) science driven missions. To understand the implications of a multi-mission capability requirement on the JIMO vehicle and mission, the NASA Prometheus Program initiated a set of parametric high-level studies to be followed by a series of more in-depth studies. The JIMO potential follow-on destinations identified include a Saturn system tour, a Neptune system tour, a Kuiper Belt Objects rendezvous, an Interstellar Precursor mission, a Multiple Asteroid Sample Return and a Comet Sample Return. This paper shows that the baseline JIMO reactor and design envelop can satisfy five out of six of the follow-on destinations. Flight time to these destinations can significantly be reduced by increasing the launch energy or/and by inserting gravity assists to the heliocentric phase.

Author

Nuclear Electric Propulsion; Mission Planning; Sample Return Missions; Asteroids; Comets; Jupiter (Planet)

20080013309 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

The Mars Reconnaissance Orbiter Mission Operations: Architecture and Approach

Jai, Benhan; Wenkert, Daniel; Halbrook, Tim; June 19, 2006; 10 pp.; In English; SpaceOps, 19 Jun. 2006, Rome, Italy; Original contains color illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40681

The Mars Reconnaissance Orbiter (MRO) was launched on August 12, 2005 by an Atlas V launch vehicle from Cape Canaveral Air Force Station. MRO will carry a rich set of science instruments to Mars and provide global, regional survey, and targeted observations. In addition, a set of engineering instruments providing optical navigation, Ka band

telecommunication and UHF relay services to future Mars missions are part of the MRO payload. During the mission, the MRO operations teams are presented with two major challenges - unprecedented high data rate and data volumes, and complex science planning and resource sharing. MRO has the capability to communicate with earth at a maximum of six Megabits per second (> 50 times any previous Mars missions). With the current Deep Space Network (DSN) contact schedule of 19 eight-hour tracks per week, the baseline mission plan is for MRO to return 34 Terabits of raw science data during the two year primary science phase. Each of the science instruments has its unique requirements for global mapping, regional survey, and targeted observations. Some instruments prefer nadir-only observations, while others require off-nadir observations (especially for stereo viewing). The requirements from these Mars viewing instruments presented a significant challenge for the operations team to design the complex science planning and resource sharing/allocation process. This paper describes what MRO project is implementing to solve these challenges.
Author
Mars Reconnaissance Orbiter; Mars Missions; Rates (Per Time); Extremely High Frequencies; Telecommunication; Payloads

20080013349 Teledyne Brown Engineering, Huntsville, AL, USA
Fabrication in Space - What Materials are Needed?
Good, J; November 14, 2007; 21 pp.; In English; ARCAM User's Group, 14-15 Nov. 2007, Simi Valley, Ca, USA; Original contains color and black and white illustrations
Contract(s)/Grant(s): NAS8-02060; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080013349

In order to sustain life on the moon, and especially on Mars, the inhabitants must be self-sufficient. As on Earth, electronic and mechanical systems will break down and must be repaired. It is not realistic to 'send' parts to the moon or Mars in an effort to replace failed ones or have spares for all components. It will be important to have spares on hand and even better would be to have the capability to fabricate parts in situ. The In Situ Fabrication and Repair (ISFR) team is working to develop the Arcam Electron Beam Melting (EBM) machine as the manufacturing process that will have the capability to produce repair parts, as well as new designs, and tooling on the lunar surface and eventually on Mars. What materials will be available for the inhabitants to use? What materials would be most useful? The EBM process is versatile and can handle a multitude of materials. These include titanium, stainless steels, aluminums, inconels, and copper alloys. Research has shown what parts have failed during past space missions and this data has been compiled and assessed. The EBM machine is fully capable of processing these materials of choice. Additionally, the long-term goal is to use the lunar regolith as a viable feedstock. Preliminary work has been performed to assess the feasibility of using raw lunar regolith as a material source or use a binder combined with the regolith to achieve a good melt.
Author
Space Missions; Spacecraft Construction Materials; Lunar Surface; Fabrication; Copper Alloys; Electron Beams

20080013351 NASA Marshall Space Flight Center, Huntsville, AL, USA
Using Space Weather Variability in Evaluating the Radiation Environment Design Specifications for NASA's Constellation Program
Coffey, Victoria N.; Blackwell, William C.; Minow, Joseph I.; Bruce, Margaret B.; Howard, James W.; December 10, 2007; 2 pp.; In English; 2007 American Geophysical Union Fall Meeting, 10-14 Dec. 2007, San Francisco, CA, USA; Original contains color and black and white illustrations; Copyright; Avail.: CASI: A01, Hardcopy

NASA's Constellation program, initiated to fulfill the Vision for Space Exploration, will create a new generation of vehicles for servicing low Earth orbit, the Moon, and beyond. Space radiation specifications for space system hardware are necessarily conservative to assure system robustness for a wide range of space environments. Spectral models of solar particle events and trapped radiation belt environments are used to develop the design requirements for estimating total ionizing radiation dose, displacement damage, and single event effects for Constellation hardware. We first describe the rationale using the spectra chosen to establish the total dose and single event design environmental specifications for Constellation systems. We then compare variability of the space environment to the spectral design models to evaluate their applicability as conservative design environments and potential vulnerabilities to extreme space weather events
Author
Constellation Program; Space Weather; Aerospace Environments; Low Earth Orbits; Radiation Damage; Ionizing Radiation; Extraterrestrial Radiation

89
ASTRONOMY

Includes observations of celestial bodies; astronomical instruments and techniques; radio, gamma-ray, x-ray, ultraviolet, and infrared astronomy; and astrometry.

20080013205 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Spitzer Observatory Operations -- Increasing Efficiency in Mission Operations
Scott, Charles P.; Kahr, Bolinda E.; Sarrel, Marc A.; May 25, 2006; 9 pp.; In English; SPIE Astronomical Telescopes and Instrumentation, 25 May 2006, Orlando, FL, USA; Original contains color illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40655

This paper explores the how's and why's of the Spitzer Mission Operations System's (MOS) success, efficiency, and affordability in comparison to other observatory-class missions. MOS exploits today's flight, ground, and operations capabilities, embraces automation, and balances both risk and cost. With operational efficiency as the primary goal, MOS maintains a strong control process by translating lessons learned into efficiency improvements, thereby enabling the MOS processes, teams, and procedures to rapidly evolve from concept (through thorough validation) into in-flight implementation. Operational teaming, planning, and execution are designed to enable re-use. Mission changes, unforeseen events, and continuous improvement have often times forced us to learn to fly anew. Collaborative spacecraft operations and remote science and instrument teams have become well integrated, and worked together to improve and optimize each human, machine, and software-system element.
Author
Ground Operational Support System; Flight Operations; Costs; Planning; Observatories

20080013220 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
SCIAMACHY and FTS CO2 Retrievals Using the OCO Retrieval Algorithm
Boesch, Hartmut; Buchwitz, M.; Sen, Bhaswar; Toon, Geoffrey C.; Washenfelder, Rebecca A.; Wennberg, Paul O.; September 25, 2005; 2 pp.; In English; 7th International Carbon Dioxide Conference, 25-30 Sep. 2005, Boulder, CO, USA; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40701

The Orbiting Carbon Observatory (OCO) mission will make the first global, space-based measurements of atmospheric C02 with the precision and coverage needed to characterize C02 sources and sinks on regional scales. OCO will make spectrally and spatially highly resolved measurements of reflected sunlight in the 02A -band and two near-infrared C02 bands. To test the OCO retrieval algorithm, SCIAMACHY and ground-based Fourier Transform Spectrometer (FTS) measurements at Park Falls, Wisconsin have been analyzed. Good agreement between SCIAMACHY and FTS C02 columns has been found with SCIAMACHY showing a much larger scatter than FTS measurements. Both SCIAMACHY and FTS overestimate the surface pressure by a few percent which significantly impacts retrieved C02 columns.
Author
Carbon Dioxide; Remote Sensing; Fourier Transformation; Algorithms; Observatories

20080013263 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
An Ultrasensitive Hot-Electron Bolometer for Low-Background SMM Applications
Olayaa, David; Wei, Jian; Pereverzev, Sergei; Karasik, Boris S.; Kawamura, Jonathan H.; McGrath, William R.; Sergeev, Andrei V.; Gershenson, Michael E.; May 24, 2006; 7 pp.; In English; SPIE Millimeter and Submillimeter Detectors and Instrumentation for Astronomy III, 24-31 May 2006, Orlando, Fl, USA; Original contains black and white illustrations
Contract(s)/Grant(s): NNG04GD55G; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40715

We are developing a hot-electron superconducting transition-edge sensor (TES) that is capable of counting THz photons and operates at T = 0.3K. The main driver for this work is moderate resolution spectroscopy (R approx. 1000) on the future space telescopes with cryogenically cooled (approx. 4 K) mirrors. The detectors for these telescopes must be background-limited with a noise equivalent power (NEP) approx. 10(exp -19)-10(exp -20) W/Hz(sup 1/2) over the range v = 0.3-10 THz. Above about 1 THz, the background photon arrival rate is expected to be approx. 10-100/s), and photon counting detectors may be preferable to an integrating type. We fabricated superconducting Ti nanosensors with a volume of approx. 3x10(exp -3) cubic microns on planar substrate and have measured the thermal conductance G to the thermal bath. A very low G = 4x10(exp -14) W/K, measured at 0.3 K, is due to the weak electron-phonon coupling in the material and the thermal isolation provided by superconducting Nb contacts. This low G corresponds to NEP(0.3K) = 3x10(exp -19) W/Hz(sup 1/2). This

Hot-Electron Direct Detector (HEDD) is expected to have a sufficient energy resolution for detecting individual photons with v > 0.3 THz at 0.3 K. With the sensor time constant of a few microseconds, the dynamic range is approx. 50 dB.
Author
Bolometers; Hot Electrons; Superconductivity; Thermal Conductivity; Dynamic Range; Spaceborne Telescopes; Photons

20080013265 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Science Promise and Conceptual Mission Design for SAFIR - the Single Aperture Far Infrared Observatory
Lester, Dan; Benford, Dominic; Yorke, Harold W.; Bradford, Charles. M.; Parrish, Keith; Stahl, H.; May 24, 2006; 15 pp.; In English; Astronomical Telescopes and Instrumentation, 24-30 May 2006, Orlando, FL, USA; Original contains color and black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40714

We report on completion of the SAFIR Vision Mission study, as organized by the NASA Science Mission Directorate. This study resulted in a focused baseline design for this large aperture space observatory that capitalizes on architectures being actively developed for JWST and other missions. Special opportunities for achieving thermal performance of this <10K telescope are reviewed, as well as efforts to understand capabilities and needs for focal plane instrument and I&T on this large (10m-class) telescope.
Author
Focal Plane Devices; Far Infrared Radiation; Observatories; Temperature Effects; Mission Planning

20080013268 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA; Lockheed Martin Corp., USA; Ball Aerospace and Technologies Corp., USA; Arizona Univ., AZ, USA
The Development and Mission of the Space Infrared Telescope Facility
Gallagher, David B.; Irace, William R.; Werner, Michael W.; June 21, 2004; 13 pp.; In English; SPIE Astronomical Telescopes and Instrumentation, 21 Jun. 2004, Glasgow, Scotland, UK; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40710

This paper provides an overview of the SIRTF mission, telescope, cryostat, instruments, spacecraft, orbit, operations and project management approach; and this paper serves as an introduction to the accompanying set of detailed papers about specific aspects of SIRTF.
Author
Space Infrared Telescope Facility; Spacecraft Orbits; Cryostats

20080013269 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
The Antarctic Planet Interferometer
Swain, Mark R.; Walker, Christopher K.; Traub, Wesley A.; Storey, John W.; CoudeduForesto, Vincent; Fossat, Eric; Vakili, Farrok; Stark, Anthony A.; Lloyd, James P.; Lawson, Peter R.; Burrows, Adam S.; Ireland, Michael; Millan-Gabet, Rafael; vanBelle, Gerard T.; Lane, Benjamin; Vasisht, Gautam; Travouillon, Tony; June 21, 2004; 10 pp.; In English; SPIE Astronomical Telescopes and Instrumentation2004, 21 Jun. 2004, Glasgow, Scotland, UK; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40706

The Antarctic Planet Interferometer is an instrument concept designed to detect and characterize extrasolar planets by exploiting the unique potential of the best accessible site on earth for thermal infrared interferometry. High-precision interferometric techniques under development for extrasolar planet detection and characterization (differential phase, nulling and astrometry) all benefit substantially from the slow, low-altitude turbulence, low water vapor content, and low temperature found on the Antarctic plateau. At the best of these locations, such as the Concordia base being developed at Dome C, an interferometer with two-meter diameter class apertures has the potential to deliver unique science for a variety of topics, including extrasolar planets, active galactic nuclei, young stellar objects, and protoplanetary disks.
Author
Antarctic Regions; Active Galactic Nuclei; Infrared Interferometers; Astrometry; Protoplanetary Disks; Extrasolar Planets

20080013274 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Pointing Control System Architecture for the Eclipse Mission

Kia, Tooraj; Brugarolas, Paul B.; Alexander, James W.; Li, Diane G.; February 5, 2006; 15 pp.; In English; 29th Annual American Astronautical Society Guidance and Control Conference, 4-8 Feb. 2006, Breckenridge, CO, USA; Original contains color and black and white illustrations

Report No.(s): AAS 06-073; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40669

This paper describes the high performance pointing control system used to point the Eclipse telescope. Eclipse is a new mission under study at Jet Propulsion Laboratory for a proposal as a discovery mission. Eclipse is a space telescope for high-contrast optical astronomy. It will be used to investigate the planetary bodies and environments. The main objective of the Eclipse mission is to study planets around nearby stars. Eclipse is designed to reveal planets or dust structures by reducing the scattered and diffracted light within a few arcseconds of a star to a level three orders of magnitude lower than any instrument on the Hubble Space Telescope (HST). Eclipse achieves this high contrast using a 1.8 meter diameter telescope, a coronagraphic system for control of diffracted light, and active wavefront correction using a Precision Deformable Mirror (DM) for the suppression of scattered light. The observatory will be launched into a Sun-synchronous 690 Km, 98.2(deg) Earth Orbit in 2012.

Author

Pointing Control Systems; Deformable Mirrors; Spaceborne Telescopes; Wave Fronts; Control Systems Design; Earth Orbits; Hubble Space Telescope

20080013280 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

The Least-Squares Calibration on the Micro-Arcsecond Metrology Test Bed

Zhai, Chengxing; Milman, Mark H.; Regehr, Martin W.; May 21, 2006; 20 pp.; In English; Astronomical Telescopes and Instrumentation, Probing the Universe from Ground and Space, 21-24 May 2006, Orlando, FL, USA; Original contains black and white illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40625

The Space Interferometry Mission (S1M) will measure optical path differences (OPDs) with an accuracy of tens of picometers, requiring precise calibration of the instrument. In this article, we present a calibration approach based on fitting star light interference fringes in the interferometer using a least-squares algorithm. The algorithm is first analyzed for the case of a monochromatic light source with a monochromatic fringe model. Using fringe data measured on the Micro-Arcsecond Metrology (MAM) testbed with a laser source, the error in the determination of the wavelength is shown to be less than 10pm. By using a quasi-monochromatic fringe model, the algorithm can be extended to the case of a white light source with a narrow detection bandwidth. In SIM, because of the finite bandwidth of each CCD pixel, the effect of the fringe envelope can not be neglected, especially for the larger optical path difference range favored for the wavelength calibration.

Author

Interferometry; Charge Coupled Devices; Metrology; Optical Paths; Space Missions; Bandwidth; Calibrating; Laser Outputs

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ASTROPHYSICS

Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.

20080012481 NASA Johnson Space Center, Houston, TX, USA

Carbonate in Comets: A Comparison of Comets 1P/Halley, 9P/Temple 1, and 81P/Wild 2

Flynn, G. J.; Leroux, H.; Tomeoka, K.; Tomioka, N.; Ohnishi, I.; Mikouchi, T.; Wirick, S.; Keller, L. P.; Jacobsen, C.; Sanford, S. A.; [2008]; 2 pp.; In English; 39th Lunar Planetary Science Conference, 10-14 Mar. 2008, League City, TX, USA; Original contains color and black and white illustrations

Contract(s)/Grant(s): NNX07AM85G; Copyright; Avail.: CASI: A01, Hardcopy

Comets are generally believed to have formed in a cold region, trapping in the cometary ices the original low-temperature condensate grains of our Solar System. These grains would have been preserved in cold-storage, at a temperature below the freezing point of CO2, for the last 4.5+ billion years. Carbonates are common in hydrous meteorites and hydrous interplanetary dust particles (IDPs), where they are believed to have formed by parent-body aqueous processing. Since simple models of cometary evolution involve no aqueous processing, carbonates were generally presumed not to occur in comets. However, Toppani et al. [1] have performed experiments that indicate carbonate can be formed by non-equilibrium

condensation in circumstellar environments where water is present as a vapor, not as a liquid. This suggests carbonate might have condensed in cold regions of the Solar Nebula, and might be present in comets.
Author
Carbonates; Low Temperature Environments; Halley's Comet; Wild 2 Comet; Meteorites; Astronomical Models

20080012482 NASA Johnson Space Center, Houston, TX, USA
Comparison of Carbon XANES Spectra from an Iron Sulfide from Comet Wild 2 with an Iron Sulfide Interplanetary Dust Particle
Wirick, S.; Flynn, G. J.; Keller, L. P.; Sanford, S. A.; Zolensky, M. E.; Messenger, Nakamura K.; Jacobsen, C.; [2008]; 2 pp.; In English; 39th Lunar and Planetary Science Conference, 10-14 Mar. 2008, League City, TX, USA; Original contains color and black and white illustrations
Contract(s)/Grant(s): NNXO7AM856; NNXO7AM78G; NNXO7AJ08G; NAG512884; No Copyright; Avail.: CASI: A01, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012482

Among one of the first particles removed from the aerogel collector from the Stardust sample return mission was an approx. 5 micron sized iron sulfide. The majority of the spectra from 5 different sections of this particle suggests the presence of aliphatic compounds. Due to the heat of capture in the aerogel we initially assumed these aliphatic compounds were not cometary but after comparing these results to a heated iron sulfide interplanetary dust particle (IDP) we believe our initial interpretation of these spectra was not correct. It has been suggested that ice coating on iron sulfides leads to aqueous alteration in IDP clusters which can then lead to the formation of complex organic compounds from unprocessed organics in the IDPs similar to unprocessed organics found in comets [1]. Iron sulfides have been demonstrated to not only transform halogenated aliphatic hydrocarbons but also enhance the bonding of rubber to steel [2,3]. Bromfield and Coville (1997) demonstrated using Xray photoelectron spectroscopy that 'the surface enhancement of segregated sulfur to the surface of sulfided precipitated iron catalysts facilitates the formation of a low-dimensional structure of extraordinary properties' [4]. It may be that the iron sulfide acts in some way to protect aliphatic compounds from alteration due to heat.
Derived from text
Sulfides; Iron; Complex Compounds; Aerogels; Wild 2 Comet; Interplanetary Dust

20080013170 NASA Johnson Space Center, Houston, TX, USA
The Pioneer Anomaly and a Rotating Godel Universe
Wilson, Thomas; Blome, Hans-Joachim; [2008]; 1 pp.; In English; 37th COSPAR Scientific Assembly, 13-20 Jul. 2008, Montreal, Canada; Copyright; Avail.: Other Sources; Abstract Only

The Pioneer Anomaly represents an intriguing problem for fundamental physics whose scope still seems to baffle the best of explanations. It involves one of the most precise fine-scale acceleration measurements possible in the space age as the Pioneer 10/11 spacecraft reached distances of 20-70 AU from the Sun. An anomalous acceleration directed back toward the Sun of approx. 8x10(exp -10) m/sq s was discovered. The problem will be summarized and an up-to-date overview of possible explanations for this surprising result will be given. It may even be possible that our cosmic environment such as expansion dynamics and/or dark energy could be influencing the behavior of planets and spacecrafts within our local solar system. Then a new possibility, that of a rotating Godel Universe, will be introduced and examined.
Author
Pioneer 10 Space Probe; Anomalies; Rotation; Universe; Dark Energy

20080013179 NASA Johnson Space Center, Houston, TX, USA
Dust in Cometary Comae: Present Understanding of the Structure and Composition of Dust Particles
Levasseur-Regourd, A. C.; Zolensky, M.; Lasue, J.; [2007]; 11 pp.; In English; Copyright; Avail.: CASI: A03, Hardcopy

In situ probing of a very few cometary comae has shown that dust particles present a low albedo and a low density, and that they consist of both rocky material and refractory organics. Remote observations of solar light scattered by cometary dust provide information on the properties of dust particles in the coma of a larger set of comets. The observations of the linear polarization in the coma indicate that the dust particles are irregular, with a size greater (on the average) than about one micron. Besides, they suggest, through numerical and experimental simulations, that both compact grains and fluffy aggregates (with a power law of the size distribution in the -2.6 to -3 range), and both rather transparent silicates and absorbing organics are present in the coma. Recent analysis of the cometary dust samples collected by the Stardust mission provide a unique ground

truth and confirm, for comet 81P/Wild 2, the results from remote sensing observations. Future space missions to comets should, in the next decade, lead to a more precise characterization of the structure and composition of cometary dust particles. Author

Stardust Mission; Cometary Atmospheres; Dust; Linear Polarization; Wild 2 Comet; Remote Sensing; Comets

20080013180 NASA Johnson Space Center, Houston, TX, USA

The Mineralogy of Comet Wild 2

Zolensky, Michael; [2007]; 2 pp.; In English; 2008 Conference on the Origin and Interior of the Earth, 20-24 Mar. 2008, Misasa, Japan; No Copyright; Avail.: CASI: A01, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080013180

The nature of cometary solids is of fundamental importance to our understanding of the early solar nebula and protoplanetary history. Samples of Comet Wild 2, provided by the Stardust Mission, have now been examined in terrestrial labs for two years, and are very surprising! Here we describe mainly the critical phases olivine, pyroxene and Fe-Ni sulfides in Wild 2 grains, as a guide to the general mineralogy of the returned comet samples.

Author

Comets; Mineralogy; Olivine; Pyroxenes; Solar Nebula; Wild 2 Comet

20080013198 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Bayesian Analysis of the Power Spectrum of the Cosmic Microwave Background

Jewell, Jeffrey B.; Eriksen, H. K.; O'Dwyer, I. J.; Wandelt, B. D.; April 21, 2005; 26 pp.; In English; Society for Industrial and Applied Mathematics (SIAM) International Conference on Data Mining, 21 Apr. 2005, Newport Beach, CA, USA; Original contains black and white illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40640

There is a wealth of cosmological information encoded in the spatial power spectrum of temperature anisotropies of the cosmic microwave background. The sky, when viewed in the microwave, is very uniform, with a nearly perfect blackbody spectrum at 2.7 degrees. Very small amplitude brightness fluctuations (to one part in a million!!) trace small density perturbations in the early universe (roughly 300,000 years after the Big Bang), which later grow through gravitational instability to the large-scale structure seen in redshift surveys... In this talk, I will discuss a Bayesian formulation of this problem; discuss a Gibbs sampling approach to numerically sampling from the Bayesian posterior, and the application of this approach to the first-year data from the Wilkinson Microwave Anisotropy Probe. I will also comment on recent algorithmic developments for this approach to be tractable for the even more massive data set to be returned from the Planck satellite. Author

Cosmic Microwave Background Radiation; Bayes Theorem; Gravitational Instability; Cosmology; Power Spectra; Anisotropy

20080013314 NASA Marshall Space Flight Center, Huntsville, AL, USA

Self-consistent Model of Magnetospheric Electric Field, RC and EMIC Waves

Gamayunov, K. V.; Khazanov, G. V.; Liemohn, M. W.; Fok, M.-C.; December 10, 2007; 1 pp.; In English; American Geophysical Union Fall Meeting, 10-14 Dec. 2007, San Francisco, CA, USA; Copyright; Avail.: Other Sources; Abstract Only

Electromagnetic ion cyclotron (EMIC) waves are an important magnetospheric emission, which is excited near the magnetic equator with frequencies below the proton gyro-frequency. The source of bee energy for wave growth is provided by temperature anisotropy of ring current (RC) ions, which develops naturally during inward convection from the plasma sheet These waves strongly affect the dynamic s of resonant RC ions, thermal electrons and ions, and the outer radiation belt relativistic electrons, leading to non-adiabatic particle heating and/or pitch-angle scattering and loss to the atmosphere. The rate of ion and electron scattering/heating is strongly controlled by the Wave power spectral and spatial distributions, but unfortunately, the currently available observational information regarding EMIC wave power spectral density is poor. So combinations of reliable data and theoretical models should be utilized in order to obtain the power spectral density of EMIC waves over the entire magnetosphere throughout the different storm phases. In this study, we present the simulation results, which are based on two coupled RC models that our group has developed. The first model deals with the large-scale magnetosphere-ionosphere electrodynamic coupling, and provides a self-consistent description of RC ions/electrons and the magnetospheric electric field. The second model is based on a coupled system of two kinetic equations, one equation describes the RC ion dynamics and another equation describes the power spectral density evolution of EMIC waves, and self-consistently treats a micro-scale electrodynamic coupling of RC and EMIC waves. So far, these two models have been

applied independently. However, the large-scale magnetosphere-ionosphere electrodynamics controls the convective patterns of both the RC ions and plasmasphere altering conditions for EMIC wave-particle interaction. In turn, the wave induced RC precipitation Changes the local field-aligned current distributions and the ionospheric conductances, which are crucial for a large-scale electrodynamics. The initial results from this new self-consistent model of the magnetospheric electric field, RC and EMIC waves will be shown in this presentation.
Author
Electromagnetic Radiation; Ion Cyclotron Radiation; Electric Fields; Magnetosphere-Ionosphere Coupling; Electron Scattering; Wave-Particle Interactions; Ion Scattering

20080013317 NASA Marshall Space Flight Center, Huntsville, AL, USA
High Performance Simulations of Accretion Disk Dynamics and Jet Formations Around Kerr Black Holes
Nishikawa, Ken-Ichi; Mizuno, Yosuke; Watson, Michael; October 10, 2007; 1 pp.; In English; International Conference for High Performance Computing, Networking, Storage and Analysis, 10-16 Nov. 2007, Reno, NV, USA; No Copyright; Avail.: Other Sources; Abstract Only

We investigate jet formation in black-hole systems using 3-D General Relativistic Particle-In-Cell (GRPIC) and 3-D GRMHD simulations. GRPIC simulations, which allow charge separations in a collisionless plasma, do not need to invoke the frozen condition as in GRMHD simulations. 3-D GRPIC simulations show that jets are launched from Kerr black holes as in 3-D GRMHD simulations, but jet formation in the two cases may not be identical. Comparative study of black hole systems with GRPIC and GRMHD simulations with the inclusion of radiate transfer will further clarify the mechanisms that drive the evolution of disk-jet systems.
Author
Accretion Disks; Black Holes (Astronomy); Relativistic Particles; Polarization (Charge Separation)

20080013341 NASA Marshall Space Flight Center, Huntsville, AL, USA
A Magnetohydrodynamic Boost for Relativistic Jets
Mizuno, Yosuke; Hardee, Philip; Hartmann, Dieter H.; Nishikawa, Ken-Ichi; Zhang, Bing; November 05, 2007; 1 pp.; In English; 2007 Gamma Ray Burst Conference, 5-9 Nov. 2007, Santa Fe, NM, USA; Copyright; Avail.: Other Sources; Abstract Only

We performed relativistic magnetohydrodynamic simulations of the hydrodynamic boosting mechanism for relativistic jets explored by Aloy & Rezzolla (2006) using the RAISHIN code. Simulation results show that the presence of a magnetic field changes the properties of the shock interface between the tenuous, overpressured jet (V^z j) flowing tangentially to a dense external medium. We find that magnetic fields can lead to more efficient acceleration of the jet, in comparison to the pure-hydrodynamic case. A 'poloidal' magnetic field (B^z), tangent to the interface and parallel to the jet flow, produces both a stronger outward moving shock and a stronger inward moving rarefaction wave. This leads to a large velocity component normal to the interface in addition to acceleration tangent to the interface, and the jet is thus accelerated to larger Lorentz factors than those obtained in the pure-hydrodynamic case. Likewise, a strong 'toroidal' magnetic field (B^y), tangent to the interface but perpendicular to the jet flow, also leads to stronger acceleration tangent to the shock interface relative to the pure-hydrodynamic case. Thus. the presence and relative orientation of a magnetic field in relativistic jets can significant modify the hydrodynamic boost mechanism studied by Aloy & Rezzolla (2006).
Author
Elastic Waves; Magnetohydrodynamics; Magnetic Fields; Jet Flow

20080013342 NASA Marshall Space Flight Center, Huntsville, AL, USA
Relativistic Particle-in-Cell Simulation Studies of Prompt and Early Afterglows Observed by GLAST
Mizuno, Y.; Nishikawa, K.-I.; Hardee, P.; Fishman, G. J.; Preece, R.; November 05, 2007; 1 pp.; In English; 2007 Gamma Ray Burst Conference, 5-9 Nov. 2007, Santa Fe, NM, USA; Copyright; Avail.: Other Sources; Abstract Only

Nonthermal radiation observed from astrophysical systems containing relativistic jets and shocks, e.g., gamma-ray bursts (GRBs), active galactic nuclei (AGNs), and Galactic microquasar systems usually have power-law emission spectra. Recent PIC simulations using injected relativistic electron-ion (electro-positron) jets show that acceleration occurs within the downstream jet. Shock acceleration is a ubiquitous phenomenon in astrophysical plasmas. Plasma waves and their associated instabilities (e.g., the Buneman instability, other two-streaming instability, and the Weibel instability) created in the shocks are responsible for particle (electron, positron, and ion) acceleration. The simulation results show that the Weibel instability is responsible for generating and amplifying highly nonuniform, small-scale magnetic fields. These magnetic fields contribute

to the electron's transverse deflection behind the jet head. The "'jitter' radiation from deflected electrons has different properties than synchrotron radiation which is calculated in a uniform magnetic field. This jitter radiation may be important to understanding the complex time evolution and/or spectral structure in gamma-ray bursts, relativistic jets, and supernova remnants.
Author
Gamma Ray Bursts; Emission Spectra; Active Galactic Nuclei; Supernova Remnants; Relativistic Particles; Quasars; Nonuniform Magnetic Fields; Synchrotron Radiation

20080013343 NASA Marshall Space Flight Center, Huntsville, AL, USA
Particle Acceleration, Magnetic Field Generation and Associated Emission in Collisionless Relativistic Jets
Nishikawa, K. I.; Ramirez-Ruiz, E.; Hardee, P.; Mizuno, Y.; Fishman. G. J.; November 07, 2007; 1 pp.; In English; Seventh European Workshop on Collisionless Shocks, 7-9 Nov. 2007, Paris, France; No Copyright; Avail.: Other Sources; Abstract Only

Nonthermal radiation observed from astrophysical systems containing relativistic jets and shocks, e.g., active galactic nuclei (AGNs), gamma-ray bursts (GRBs), and Galactic microquasar systems usually have power-law emission spectra. Recent PIC simulations using injected relativistic electron-ion (electro-positron) jets show that acceleration occurs within the downstream jet. Shock acceleration is a ubiquitous phenomenon in astrophysical plasmas. Plasma waves and their associated instabilities (e.g., the Buneman instability, other two-streaming instability, and the Weibel instability) created in the shocks are responsible for particle (electron, positron, and ion) acceleration. The simulation results show that the Weibel instability is responsible for generating and amplifying highly nonuniform, small-scale magnetic fields. These magnetic fields contribute to the electron's transverse deflection behind the jet head. The 'jitter' radiation from deflected electrons has different properties than synchrotron radiation which is calculated in a uniform magnetic field. This jitter radiation may be important to understanding the complex time evolution and/or spectral structure in gamma-ray bursts, relativistic jets, and supernova remnants.
Author
Particle Acceleration; Nonuniform Magnetic Fields; Emission Spectra; Synchrotron Radiation; Space Plasmas; Plasma Waves; Nonthermal Radiation

20080013352 NASA Marshall Space Flight Center, Huntsville, AL, USA
The Chandra X-ray Observatory: An Overview of Its Success
Weisskopf, Martin C.; November 14, 2007; 41 pp.; In English; Physics Department COlloquium at the University of the South, 14-15 Nov. 2007, Sewanee, TN, USA; Original contains black and white illustrations; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080013352

The Chandra X-Ray Observatory, the X-Ray component of NASA's Great Observatory Program has been an outstanding scientific and technical success. Designed for a three year lifespan, Chandra is now beginning its 8-th year of scientific operation. Some of the history of the Project, including a discussion of the design, development, and calibration of the X-Ray optics will be presented. Of course the highlights of several of the myriad discoveries will be shown concerning topics ranging from solar system objects to dark matter studies in clusters of galaxies.
Author
X Ray Astrophysics Facility; Galactic Clusters; X Ray Optics; Calibrating; Observatories

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LUNAR AND PLANETARY SCIENCE AND EXPLORATION

Includes planetology; selenology; meteorites; comets; and manned and unmanned planetary and lunar flights. For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance*.

20080012500 NASA Langley Research Center, Hampton, VA, USA
A Versatile Lifting Device for Lunar Surface Payload Handling, Inspection and Regolith Transport Operations
Doggett, William R.; Dorsey, John T.; Collins, Timothy J.; King, Bruce D.; Mikulas, Martin M., Jr.; February 10, 2008; 17 pp.; In English; Space Technology and Applications International Forum (STAIF 2008), 10-14 Feb. 2008, Albuquerque, NM, USA; Original contains color and black and white illustrations
Contract(s)/Grant(s): WBS 140765.04.02.02.01.04; Copyright; Avail.: CASI: A03, Hardcopy

Devices for lifting and transporting payloads and material are critical for efficient Earth-based construction operations.

Devices with similar functionality will be needed to support lunar-outpost construction, servicing, inspection, regolith excavation, grading and payload placement. Past studies have proposed that only a few carefully selected devices are required for a lunar outpost. One particular set of operations involves lifting and manipulating payloads in the 100 kg to 3,000 kg range, which are too large or massive to be handled by unassisted astronauts. This paper will review historical devices used for payload handling in space and on earth to derive a set of desirable features for a device that can be used on planetary surfaces. Next, an innovative concept for a lifting device is introduced, which includes many of the desirable features. The versatility of the device is discussed, including its application to lander unloading, servicing, inspection, regolith excavation and site preparation. Approximate rules, which can be used to size the device for specific payload mass and reach requirements, are provided. Finally, details of a test-bed implementation of the innovative concept, which will be used to validate the structural design and develop operational procedures, is provided.
Author
Inspection; Lunar Surface; Payloads; Regolith; Excavation; Handling Equipment; Remote Manipulator System

20080012503 NASA Glenn Research Center, Cleveland, OH, USA
Excavation on the Moon: Regolith Collection for Oxygen Production and Outpost Site Preparation
Caruso, John J.; Spina, Dan C.; Greer, Lawrence C.; John, Wentworth T.; Michele, Clem; Krasowski, Mike J.; Prokop, Norman F.; January 07, 2008; 4 pp.; In English; 4th Annual AIAA Conference, 7 Jan. 2008, Reno, NV, USA; Original contains color illustrations
Contract(s)/Grant(s): WBS 387498.04.01; No Copyright; Avail.: CASI: A01, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012503

The development of a robust regolith moving system for lunar and planetary processing and construction is critical to the NASA mission to the Moon and Mars. Oxygen production may require up to 200 metric tons of regolith collection per year; outpost site development may require several times this amount. This paper describes progress in the small vehicle implement development and small excavation system development. Cratos was developed as a platform for the ISRU project to evaluate the performance characteristics of a low center of gravity, small (0.75m x 0.75m x 0.3m), low-power, tracked vehicle performing excavation, load, haul, and dump operations required for lunar ISRU. It was tested on loose sand in a facility capable of producing level and inclined surfaces, and demonstrated the capability to pick up, carry, and dump sand, allowing it to accomplish the delivery of material to a site. Cratos has demonstrated the capability to pick up and deliver simulant to a bury an inflatable habitat, to supply an oxygen production plant, and to build a ramp.
Author
Moon; Oxygen Production; Regolith; Lunar Construction Equipment; Lunar Excavation Equipment; Lunar Roving Vehicles; Terraforming

20080012512 NASA Johnson Space Center, Houston, TX, USA
Preliminary Examination of the Interstellar Collector of Stardust
Westphal, A. J.; Allen, C.; Bastien, R.; Borg, J.; Brenker, F.; Bridges, J.; Brownlee, D. E.; Butterworth, A. L.; Floss, C.; Flynn, G.; Frank, D.; Gainsforth, Z.; Gruen, E.; Hoppe, P.; Kearsley, A.; Leroux, H.; Nittler, L. R.; Sandford, S. A.; Simionovici, A.; Stadermann, F.; Stroud, M.; Tsou, P.; Tyliczszak, T.; Warren, J.; Zolensky, M. E.; [March 10, 2008]; 2 pp.; In English; 39th Lunar and Planetary Science Conference, 10-14 Mar. 2008, League City, TX, USA; Copyright; Avail.: CASI: A01, Hardcopy

The findings of the Stardust spacecraft mission returned to earth in January 2006 are discussed. The spacecraft returned two unprecedented and independent extraterrestrial samples: the first sample of a comet and the first samples of contemporary interstellar dust. An important lesson from the cometary Preliminary Examination (PE) was that the Stardust cometary samples in aerogel presented a technical challenge. Captured particles often separate into multiple fragments, intimately mix with aerogel and are typically buried hundreds of microns to millimeters deep in the aerogel collectors. The interstellar dust samples are likely much more challenging since they are expected to be orders of magnitudes smaller in mass, and their fluence is two orders of magnitude smaller than that of the cometary particles. The goal of the Stardust Interstellar Preliminary Examination (ISPE) is to answer several broad questions, including: which features in the interstellar collector aerogel were generated by hypervelocity impact and how much morphological and trajectory information may be gained?; how well resolved are the trajectories of probable interstellar particles from those of interplanetary origin?; and, by comparison to impacts by known particle dimensions in laboratory experiments, what was the mass distribution of the impacting particles? To answer these questions, and others, non-destructive, sequential, non-invasive analyses of interstellar dust candidates extracted from the Stardust interstellar tray will be performed. The total duration of the ISPE will be three years and will differ from the Stardust

cometary PE in that data acquisition for the initial characterization stage will be prolonged and will continue simultaneously and parallel with data publications and release of the first samples for further investigation.
CASI
Aerogels; Cosmic Dust; Interstellar Matter; Stardust Mission; Comets

20080012514 Mainz Univ., Germany; NASA Johnson Space Center, Houston, TX, USA
The Miniaturized Moessbauer Spectrometers MIMOS II on MER: Four Years of Operation - A Summary
Fleischer, I.; Klingelhoefer, G.; Morris, R. V.; Rodionov, D.; Blumers, M.; Bernhardt, B.; Schroeder, C.; Ming, D. W.; Yen, A. S.; Cohen, B. A.; McCoy, T. J.; Mittlefehldt, D. W.; Schmidt, M. E.; Girones Lopez, J.; Studlek, G.; Brueckner, J.; Gellert, R.; d'Uston, C.; March 10, 2008; 2 pp.; In English; 39th Lunar and Planetary Science Conference, 10-14 Mar. 2008, League City, TX, USA; Original contains color illustrations; Copyright; Avail.: CASI: A01, Hardcopy

The two Miniaturized Moessbauer Spectrometers (MIMOS II) on board the two Mars Exploration Rovers Spirit and Opportunity have now been collecting important scientific data for more than four years. The spectrometers provide information about Fe-bearing mineral phases and determine Fe oxidation states. The total amount of targets analized exceeds 600, the total integration time exceeds 260 days for both rovers. Since landing, more than five half-lives of the Co-57 MB sources have past (intensity at the time of landing approx. 150 mCi). Current integration times are about 50 hours in order to achieve reasonable statistics as opposed to 8 hours at the beginning of the mission. In total, 13 different mineral phases were detected: Olivine, pyroxene, hematite, magnetite and nanophase ferric oxide were detected at both landing sites. At Gusev, ilmenite, goethite, a ferric sulfate phase and a yet unassigned phase (in the rock Fuzzy Smith) were detected. At Meridiani, jarosite, metallic iron in meteoritic samples (kamacite), troilite, and an unassigned ferric phase were detected. Jarosite and goethite are of special interest, as these minerals are indicators for water activity. In this abstract, an overview of Moessbauer results will be given, with a focus on data obtained since the last martian winter. The MER mission has proven that Moessbauer spectroscopy is a valuable tool for the in situ exploration of extraterrestrial bodies and for the study of Febearing samples. The experience gained through the MER mission makes MIMOS II a obvious choice for future missions to Mars and other targets. Currently, MIMOS II is on the scientific payload of two approved future missions: Phobos Grunt (Russian Space Agency; 2009) and ExoMars (European Space Agency; 2013).
Derived from text
Miniaturization; Mossbauer Effect; Mars Exploration; Mars Roving Vehicles; Spectrometers; Mineralogy

20080012516 NASA Johnson Space Center, Houston, TX, USA
Martian Chronology and Atmospheric Composition: In Situ Measurements versus Sample Return
Bogard, Donald D.; [2008]; 2 pp.; In English; Ground Truth from Mars: Science Payoff from a Sample Return Mission, 21-23 Apr. 2008, Albuquerque, NM, USA; Original contains color illustrations; No Copyright; Avail.: CASI: A01, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012516

I examine two significant issues of martian science from the point of view of in situ measurements by robotic spacecraft versus sample return and analysis in terrestrial labs. (1) To define martian history, ages of geological processes and surface features are required. Estimated ages from surface crater densities have limitations, and the ages measured for martian meteorites cannot be associated with specific martian locales. Whereas returned martian rocks could be accurately dated, some have suggested sending a robotic spacecraft to Mars to measure rock ages using the classical K- Ar-40 technique, considered the easiest to implement. (2) To understand the evolution of the martian atmosphere and its interactions with the surface, requires precise measurements of atmospheric composition. A significant amount of information has derived from measurements by Viking and of martian meteorites. Instrumentation on the Mars Science Lander (MSL) spacecraft to be launched in the near future promises to determine atmospheric composition even more precisely. If MSL is successful, which questions about atmospheric composition will remain and thus will require atmospheric sample return to answer?
Author
Atmospheric Composition; Chronology; In Situ Measurement; Planetary Geology; Sample Return Missions; Mars Atmosphere; SNC Meteorites

20080012517 Barrios Technology, Inc., Houston, TX, USA; NASA Johnson Space Center, Houston, TX, USA
Space Shuttle MMOD Threat Mitigation Techniques
Hyde, J. L.; Christiansen, E. L.; Lear, D. M.; Kerr, J. H.; [2008]; 1 pp.; In English; 59th International Astronautical Congress, 29 Sep. ? 3 Oct. 2008, Glasgow, UK; Copyright; Avail.: Other Sources; Abstract Only

Prior to each shuttle mission, threat assessments are performed to determine the risk of critical penetration, payload bay

door radiator tube leak and crew module window replacement from Micrometeoroid and Orbital Debris (MMOD). Mission parameters, such as vehicle attitude, exposure time and altitude are used as inputs for the analysis. Ballistic limit equations, based on hypervelocity impact testing of shuttle materials are used to estimate the critical particle diameters of the outer surfaces of the vehicle. The assessments are performed using the BUMPER computer code at the NASA/JSC Hypervelocity Impact Technology Facility (HITF). The most critical involves the calculation of Loss of Crew and Vehicle (LOCV) risk. An overview of significant MMOD impacts on the Payload Bay Door radiators, wing leading edge reinforced carbon-carbon (RCC) panels and crew module windows will be presented, along with a discussion of the techniques NASA has implemented to reduce the risk from MMOD impacts. This paper will describe on-orbit inspection of the RCC regions and the methods used discern hypervelocity impact damage. Impact damage contingency plans and on-orbit repair techniques will also be discussed. The wing leading edge impact detection system (WLEIDS) and it s role in the reduction of on-orbit risk reduction will be presented. Finally, an analysis of alternative shuttle flight attitudes on MMOD risk will be demonstrated.
Author
Micrometeoroids; Space Shuttle Missions; Space Debris; Risk; Hypervelocity Impact

20080012525 NASA Johnson Space Center, Houston, TX, USA
Mars Sample Return from Meridiani Planum
Mittlefehldt, David W.; [2008]; 2 pp.; In English; Truth from Mars: Science Payoff from a Sample Return Mission, 21-23 Apr. 2008, Albuquerque, NM, USA; Original contains black and white illustrations; No Copyright; Avail.: CASI: A01, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012525

The NASA Mars Exploration Program has four main goals: (i) determine if life ever arose there, (ii) understand the processes and history of its climate, (iii) determine the evolution of its surface and interior, and (iv) prepare for human exploration of Mars. These goals are embodied in the NASA Mars exploration strategy Follow the Water. Current Mars exploration tactics for lander missions build on knowledge gained by prior orbital investigations; the science rationale for choosing landing sites is based on the current best interpretation of the geology. A future Mars sample return mission will greatly exceed in cost typical lander missions because of the need to design for return to Earth and the infrastructure needed on Earth to curate and process the samples safely and cleanly. Because of this added cost burden, expectations for science return are higher. There must be some prospect that the returned samples will allow for testing higher level hypotheses relevant to NASA's goals. Site selection must be based on knowledge gained from prior in situ measurements to enhance the prospects for successfully meeting these goals. I will argue that Meridiani Planum should be that site.
Derived from text
Mars Exploration; Mars Sample Return Missions; Mars Surface; NASA Space Programs; Mineralogy

20080012539 NASA Johnson Space Center, Houston, TX, USA
Real-time Imaging Technology for the Return to the Moon
Epp, Chirold; March 03, 2008; 15 pp.; In English; Go for Lunar Landing: From Terminal Decent to Touchdown, 4-5 Mar. 2008, Tempe, AZ, USA; Original contains color and black and white illustrations
Contract(s)/Grant(s): 079749.01.10; Copyright; Avail.: CASI: A03, Hardcopy

This viewgraph presentation reviews realtime Autonomous Landing Hazard Avoidance Technology (ALHAT) technology for the return to the Moon. The topics inclde: 1) ALHAT Background; 2) Safe and Precise Landing; 3) ALHAT Mission Phases; 4) Terminal Descent Phase; 5) Lighting; 6) Lander Tolerance; 7) HDA Sensor Performance; and 8) HDA Terrain Sensors.
CASI
Imaging Techniques; Moon; Real Time Operation; Autonomy; Technology Utilization

20080012543 NASA Johnson Space Center, Houston, TX, USA
Planning for the Future, a Look from Apollo to the Present
Segrera, David; [2008]; 1 pp.; In English; 59th International Astronautical Congress, 29 Sep.?3 Oct. 2008, Glasgow, Scotland, UK; No Copyright; Avail.: Other Sources; Abstract Only

Future missions out of low Earth orbit, returning to the moon and Mars, will be some of the most complicated endeavors ever attempted by mankind. It will require the wealth of nations and the dedicated efforts of thousand of individuals working in a concerted effort to take man to the moon, Mars and beyond. These missions will require new equipment and new approaches to optimize our limited resources and time in space. This daily planning and optimization which currently is being

performed by scores of people in MCC Houston and around the world will need to adapt to the challenges faced far from Earth. By studying the processes, methodologies, and tools employed from Apollo, Skylab, Shuttle, ISS, and other programs such as NEEMO, we can learn from the past to plan for the future. This paper will explore the planning process used from Apollo onward and will discuss their relevancy in future applications.
Author
Low Earth Orbits; Space Missions; Moon; Mars (Planet); Space Shuttles

20080012545 Jacobs Technologies Engineering Science Contract Group (ESCG), Houston, TX, USA
Lunar Surface Habitat Configuration Assessment: Methodology and Observations
Carpenter, Amanda; March 03, 2008; 8 pp.; In English; Earth and Space Conference 2008: 11th International Conference on Engineering, Science, Construction, and Operations in Challenging Environments, 3-5 Mar. 2008, Long Beach, CA, USA; Original contains color and black and white illustrations; Copyright; Avail.: CASI: A02, Hardcopy

The Lunar Habitat Configuration Assessment evaluated the major habitat approaches that were conceptually developed during the Lunar Architecture Team II Study. The objective of the configuration assessment was to identify desired features, operational considerations, and risks to derive habitat requirements. This assessment only considered operations pertaining to the lunar surface and did not consider all habitat conceptual designs developed. To examine multiple architectures, the Habitation Focus Element Team defined several adequate concepts which warranted the need for a method to assess the various configurations. The fundamental requirement designed into each concept included the functional and operational capability to support a crew of four on a six-month lunar surface mission; however, other conceptual aspects were diverse in comparison. The methodology utilized for this assessment consisted of defining figure of merits, providing relevant information, and establishing a scoring system. In summary, the assessment considered the geometric configuration of each concept to determine the complexity of unloading, handling, mobility, leveling, aligning, mating to other elements, and the accessibility to the lunar surface. In theory, the assessment was designed to derive habitat requirements, potential technology development needs and identify risks associated with living and working on the lunar surface. Although the results were more subjective opposed to objective, the assessment provided insightful observations for further assessments and trade studies of lunar surface habitats. This overall methodology and resulting observations will be describe in detail and illustrative examples will be discussed.
Author
Habitats; Lunar Surface; Risk; Information Systems

20080012572 NASA Glenn Research Center, Cleveland, OH, USA
A Successful Infusion Process for Enabling Lunar Exploration Technologies
Over, Ann P.; Klem, Mark K.; Motil, Susan M.; January 2008; 15 pp.; In English; AIAA Space 2007 Conference and Exposition, 18-20 Sept. 2007, Long Beach, CA, USA; Original contains color illustrations
Contract(s)/Grant(s): WBS 825855.01.03.03
Report No.(s): NASA/TM-2008-215045; AIAA Paper 2007-6196; E-16228; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080012572

The NASA Vision for Space Exploration begins with a more reliable flight capability to the International Space Station and ends with sending humans to Mars. An important stepping stone on the path to Mars encompasses human missions to the Moon. There is little doubt throughout the stakeholder community that new technologies will be required to enable this Vision. However, there are many factors that influence the ability to successfully infuse any technology including the technical risk, requirement and development schedule maturity, and, funds available. This paper focuses on effective infusion processes that have been used recently for the technologies in development for the lunar exploration flight program, Constellation. Recent successes with Constellation customers are highlighted for the Exploration Technology Development Program (ETDP) Projects managed by NASA Glenn Research Center (GRC). Following an overview of the technical context of both the flight program and the technology capability mapping, the process is described for how to effectively build an integrated technology infusion plan. The process starts with a sound risk development plan and is completed with an integrated project plan, including content, schedule and cost. In reality, the available resources for this development are going to change over time, necessitating some level of iteration in the planning. However, the driving process is based on the initial risk assessment, which changes only when the overall architecture changes, enabling some level of stability in the process.
Author
Lunar Exploration; Constellation Program; Technology Utilization; Costs

20080012584 Jacobs Engineering Group, Inc., Houston, TX, USA; NASA Johnson Space Center, Houston, TX, USA
Lunar Outpost Life Support Trade Studies
Lange, Kevin E.; Anderson, Molly S.; Ewert, Michael K.; Barta, Daniel J.; [2008]; 1 pp.; In English; 37th COSPAR Scientific Assembly, 13-20 Jul. 2008, Montreal, Canada; Copyright; Avail.: Other Sources; Abstract Only

Engineering trade-off studies of life support system architecture and technology options were conducted for potential lunar surface mission scenarios within NASA's Constellation Program. The scenarios investigated are based largely on results of the NASA Lunar Architecture Team (LAT) Phase II study. In particular, the possibility of Hosted Sortie missions, the high cost of power during eclipse periods, and the potential to reduce life support consumables through scavenging, in-situ resources, and alternative EVA technologies were all examined. These trade studies were performed within the Systems Integration, Modeling and Analysis (SIMA) element of NASA's Exploration Life Support (ELS) technology development project. The tools and methodology used in the study are described briefly, followed by a discussion of mission scenarios, life support technology options and results presented in terms of equivalent system mass for various regenerative life support technologies and architectures. Three classes of repeated or extended lunar surface missions were investigated in this study along with several life support resource scenarios for each mission class. Individual mission durations of 14 days, 90 days and 180 days were considered with 10 missions assumed for each at a rate of 2 missions per year. The 14-day missions represent a class of Hosted Sortie missions where a pre-deployed and potentially mobile habitat provides life support for multiple crews at one or more locations. The 90-day and 180-day missions represent lunar outpost expeditions with a larger fixed habitat. The 180-day missions assume continuous human presence and must provide life support through eclipse periods of up to 122 hours while the 90-day missions are planned for best-case periods of nearly continuous sunlight. This paper investigates system optimization within the assumptions of each scenario and addresses how the scenario selected drives the life support system to different designs. Subsequently, these analysis results can be used to determine which technologies may be good choices throughout a broad range of architectures.
Author
Constellation Program; Life Support Systems; Lunar Surface; Tradeoffs; Systems Engineering; Optimization; Technology Utilization

20080013149 NASA Glenn Research Center, Cleveland, OH, USA
Piloted Ignition Delay of PMMA in Space Exploration Atmospheres
McAllister, Sara; Fernandez-Pello, Carlos; Urban, David; Ruff, Gary; [2007]; 19 pp.; In English; Proceedings of the 32nd International Symposium on Combustion, 3-8 Aug. 2008, Montreal, Canada
Contract(s)/Grant(s): WBS 526282.01.03.02.02.01; Copyright; Avail.: CASI: A03, Hardcopy

In order to reduce the risk of decompression sickness associated with extravehicular activity (EVA), NASA is designing the next generation of exploration vehicles and habitats with a different cabin environment than used previously. The proposed environment uses a total cabin pressure of 52.7 to 58.6 kPa with an oxygen concentration of 30 to 34% by volume and was chosen with material flammability in mind. Because materials may burn differently under these conditions and there is little information on how this new environment affects the flammability of the materials onboard, it is important to conduct material flammability experiments at the intended exploration atmosphere. One method to evaluate material flammability is by its ease of ignition. To this end, piloted ignition delay tests were conducted in the Forced Ignition and Spread Test (FIST) apparatus subject to this new environment. In these tests, polymethylmethacylate (PMMA) was exposed to a range of oxidizer flow velocities and externally applied heat fluxes. Tests were conducted for a baseline case of normal pressure and oxygen concentration, low pressure (58.6 kPa) with normal oxygen (21%), and low pressure with 32% oxygen concentration conditions to determine the individual effect of pressure and the combined effect of pressure and oxygen concentration on the ignition delay. It was found that reducing the pressure while keeping the oxygen concentration at 21% reduced the ignition time by 17% on average. Increasing the oxygen concentration at low pressures reduced the ignition time by an additional 10%. It was also noted that the critical heat flux for ignition decreases at exploration atmospheres. These results show that tests conducted in standard atmospheric conditions will underpredict the ignition of materials intended for use on spacecraft and that, at these conditions, materials are more susceptible to ignition than at current spacecraft atmospheres.
Author
Ignition; Space Exploration; Extravehicular Activity; Delay; Polymethyl Methacrylate; Spacecraft Cabin Atmospheres; Aerospace Vehicles

20080013154 NASA Johnson Space Center, Houston, TX, USA
Special, Unopened Lunar Samples: Is it Time to Examine Them?
Lofgren, Gary E.; Allton, Judith H.; [2007]; 2 pp.; In English; 39th Annual Lunar Planetary Conference, 10-14 Mar. 2008, League City, TX, USA; Original contains black and white illustrations; No Copyright; Avail.: CASI: A01, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080013154

During the last three missions to the Moon several samples were collected and immediately placed in a vacuum tight-containers. Three of these samples have never been opened and, together with 2 samples not placed in vacuum, are the only lunar samples that have not been examined. There were, however, samples collected immediately adjacent to many of these samples that have been studied. Because there was nothing notable about these samples, there was no compelling reason to open these samples, and it was decided that they be preserved for future studies. The purpose of this abstract is to remind the science community of their existence and to open a discussion as to whether this is an appropriate time to study one or more of these samples
Derived from text
Lunar Rocks; Lunar Soil; Moon; Samples

20080013155 NASA Johnson Space Center, Houston, TX, USA
Apollo 17 Lunar Sounder Data provide Insight into Aitken Crater's Subsurface Structure
Cooper, Bonnie L.; [2007]; 2 pp.; In English; 39th Lunar and Planetary Science Conference, 10-14 Mar. 2008, Houston, TX, USA; Original contains color and black and white illustrations; Copyright; Avail.: CASI: A01, Hardcopy

In preparation for the forthcoming avalanche of data from Lunar Reconnaissance Orbiter (LRO), we conducted a pilot study to demonstrate integration of multiple geophysical data sets. We applied methods of data integration that are used by the commercial mineral exploration industry to enhance the value of historical data sets and to provide a roadmap for future efforts.
Author
Data Integration; Multisensor Fusion; Lunar Flight; Lunar Surface; Selenology

20080013156 NASA Johnson Space Center, Houston, TX, USA
Space Plasma Ion Processing of the Lunar Soil: Modeling of Radiation-Damaged Rim Widths on Lunar Grains
Chamberlin, S.; Christoffersen, R.; Keller, L.; [2007]; 2 pp.; In English; 39th Lunar Planetary Science Conference, 10-14 Mar. 2008, League City, TX, USA; Copyright; Avail.: CASI: A01, Hardcopy

Chemically and microstructurally complex altered rims around grains in the finest size fraction (<20 micron) of the lunar regolith are the result of multi-stage processes involving both solar ion radiation damage and nanoscale deposition of impact or sputter-derived vapors. The formation of the rims is an important part of the space weathering process, and is closely linked to key changes in optical reflectance and other bulk properties of the lunar surface. Recent application of field-emission scanning transmission electron microscope techniques, including energy dispersive X-ray spectral imaging, is making it easier to unravel the 'nano-stratigraphy' of grain rims, and to delineate the portions of rims that represent Radiation-Amorphized (RA) host grain from overlying amorphous material that represents vapor/sputter deposits. For the portion of rims formed by host grain amorphization (henceforth called RA rims), we have been investigating the feasibility of using Monte Carlo-type ion-atom collision models, combined with experimental ion irradiation data, to derive predictive numerical models linking the width of RA rims to the grain s integrated solar ion radiation exposure time.
Derived from text
Ion Irradiation; Lunar Rocks; Lunar Surface; Radiation Damage; Regolith; Rims; Solar Radiation; Lunar Maria; Selenology

20080013157 NASA Johnson Space Center, Houston, TX, USA
Petrography and Origin of the Unique Achondrite GRA 06128 & 06129: Preliminary Results
Treiman, A. H.; Morris, R. V.; Kring, D. A.; Mittlefehldt, D. W.; Jones, J. H.; [2007]; 2 pp.; In English; 39th Lunar Planetary Science Conference, 10-14 Mar. 2008, League City, TX, USA; Original contains color and black and white illustrations; Copyright; Avail.: CASI: A01, Hardcopy

GRA 06128 and 06129 are paired achondrites with unique mineral proportions (75% oligoclase), mineral compositions, and oxygen isotope ratios. They appear to represent alkalic igneous rock from a hitherto unsampled differentiated parent body, modified significantly by thermal and shock metamorphism.
Author
Achondrites; Igneous Rocks; Petrography; Meteoritic Composition; Mineralogy

20080013163 NASA Marshall Space Flight Center, Huntsville, AL, USA

Optimization of Crew Shielding Requirement in Reactor-Powered Lunar Surface Missions

Barghouty, A. F.; November 2007; 28 pp.; In English; Original contains color illustrations

Report No.(s): NASA/TP-2007-215133; M-1208; No Copyright; Avail.: CASI: A03, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080013163

On the surface of the moon and not only during heightened solar activities the radiation environment is such that crew protection will be required for missions lasting in excess of six months. This study focuses on estimating the optimized crew shielding requirement for lunar surface missions with a nuclear option. Simple, transport-simulation based dose-depth relations of the three radiation sources (galactic, solar, and fission) are employed in a one-dimensional optimization scheme. The scheme is developed to estimate the total required mass of lunar regolith separating reactor from crew. The scheme was applied to both solar maximum and minimum conditions. It is shown that savings of up to 30% in regolith mass can be realized. It is argued, however, that inherent variation and uncertainty mainly in lunar regolith attenuation properties in addition to the radiation quality factor can easily defeat this and similar optimization schemes.

Author

Lunar Surface; Optimization; Flight Crews; Reactors; Space Missions; Radiation Shielding; Extraterrestrial Radiation

20080013171 NASA Johnson Space Center, Houston, TX, USA

A New Bond Albedo for Performing Orbital Debris Brightness to Size Transformations

Mulrooney, Mark K.; Matney, Mark J.; [2008]; 1 pp.; In English; 59th International Astronautical Congress, 29 Sept. - 3 Oct. 2008, England, UK; Copyright; Avail.: Other Sources; Abstract Only

We have developed a technique for estimating the intrinsic size distribution of orbital debris objects via optical measurements alone. The process is predicated on the empirically observed power-law size distribution of debris (as indicated by radar RCS measurements) and the log-normal probability distribution of optical albedos as ascertained from phase (Lambertian) and range-corrected telescopic brightness measurements. Since the observed distribution of optical brightness is the product integral of the size distribution of the parent [debris] population with the albedo probability distribution, it is a straightforward matter to transform a given distribution of optical brightness back to a size distribution by the appropriate choice of a single albedo value. This is true because the integration of a powerlaw with a log-normal distribution (Fredholm Integral of the First Kind) yields a Gaussian-blurred power-law distribution with identical power-law exponent. Application of a single albedo to this distribution recovers a simple power-law [in size] which is linearly offset from the original distribution by a constant whose value depends on the choice of the albedo. Significantly, there exists a unique Bond albedo which, when applied to an observed brightness distribution, yields zero offset and therefore recovers the original size distribution. For physically realistic powerlaws of negative slope, the proper choice of albedo recovers the parent size distribution by compensating for the observational bias caused by the large number of small objects that appear anomalously large (bright) - and thereby skew the small population upward by rising above the detection threshold - and the lower number of large objects that appear anomalously small (dim). Based on this comprehensive analysis, a value of 0.13 should be applied to all orbital debris albedo-based brightness-to-size transformations regardless of data source. Its prima fascia genesis, derived and constructed from the current RCS to size conversion methodology (SiBAM Size-Based Estimation Model) and optical data reduction standards, assures consistency in application with the prior canonical value of 0.1. Herein we present the empirical and mathematical arguments for this approach and by example apply it to a comprehensive set of photometric data acquired via NASA's Liquid Mirror Telescopes during the 2000-2001 observing season.

Author

Albedo; Brightness; Size Distribution; Space Debris; Optical Measurement

20080013181 NASA Johnson Space Center, Houston, TX, USA

Science on the Moon: The Wailing Wall of Space Exploration

Wilson, Thomas; [2008]; 2 pp.; In English; 37th COSPAR Scientific Assembly, 13-20 Jul. 2008, Montreal, Canada; No Copyright; Avail.: Other Sources; Abstract Only

Science on and from the Moon has important implications for expanding human knowledge and understanding, a prospect for the 21st Century that has been under discussion for at least the past 25 years. That having been said, however, there remain many issues of international versus national priorities, strategy, economy, and politics that come into play. The result is a very complex form of human behavior where science and exploration take center stage, but many other important human options are sacrificed. To renew this dialogue about the Moon, it seems we are already rushing pell-mell into it as has been done in the past. The U.S., Japan, China, India, and Russia either have sent or plan to send satellites and robotic landers there at this time. What does a return to the Moon mean, why are we doing this now, who should pay for it, and how? The only semblance

of such a human enterprise seems to be the LHC currently coming online at CERN. Can it be used as a model of international collaboration rather than a sports or military event focused on national competition? Who decides and what is the human sacrifice? There are compelling arguments for establishing science on the Moon as one of the primary goals for returning to the Moon and venturing beyond. A number of science endeavors will be summarized, beyond lunar and planetary science per se. These include fundamental physics experiments that are background-limited by the Earth's magnetic dipole moment and noise produced by its atmosphere and seismic interior. The Moon is an excellent platform for some forms of astronomy. Other candidate Moon-based experiments vary from neutrino and gravitational wave astronomy, particle astrophysics, and cosmic-ray calorimeters, to space physics and fundamental physics such as proton decay. The list goes on and includes placing humans in a hostile environment to study the long-term effects of space weather. The list is long, and even newer ideas will come from this COSPAR conference. However, whatever the list the issue of cooperation and binding collaboration remains. As observers of Moon and other space enterprises, we all know that a room full of 60 scientists will not agree on much of anything and there will probably be 60! please for more funding. People have special interests and little common sense (e.g., conflict between NSF- and NASA-funding roadmaps). Scientists are no exception. Nevertheless, CERN has done it on Earth! Can we do the same on the Moon? Some of the present generation of proposals for science from and on the Moon, plus new ones, will witness a place in space exploration's future. It is clear, however, that the world has not thought this through adequately, except for talk about an international space federation whatever that is. An outpost on the Moon with humans permanently living there much like Antarctica on Earth may be in our future. However, such planning is our collective international responsibility and not that of special-interest investigators from individual nations unless they intend to pay for it.

Author

Moon; Space Exploration; Earth-Moon System; Aerospace Sciences

20080013191 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

MEMS-Based Micro Instruments for In-Situ Planetary Exploration

George, Thomas; Urgiles, Eduardo R; Toda, Risaku; Wilcox, Jaroslava Z.; Douglas, Susanne; Lee, C-S.; Son, Kyung-Ah; Miller, D.; Myung, N.; Madsen, L.; Leskowitz, G.; El-Gammal, R.; Weitekamp, D.; May 9, 2005; 12 pp.; In English; SPIE Symposium on Microtechnologies for the New Millennium, 9-11 May 2005, Seville, Spain; Original contains black and white illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40628

NASA's planetary exploration strategy is primarily targeted to the detection of extant or extinct signs of life. Thus, the agency is moving towards more in-situ landed missions as evidenced by the recent, successful demonstration of twin Mars Exploration Rovers. Also, future robotic exploration platforms are expected to evolve towards sophisticated analytical laboratories composed of multi-instrument suites. MEMS technology is very attractive for in-situ planetary exploration because of the promise of a diverse and capable set of advanced, low mass and low-power devices and instruments. At JPL, we are exploiting this diversity of MEMS for the development of a new class of miniaturized instruments for planetary exploration. In particular, two examples of this approach are the development of an Electron Luminescence X-ray Spectrometer (ELXS), and a Force-Detected Nuclear Magnetic Resonance (FDNMR) Spectrometer.

Author

Microelectromechanical Systems; X Ray Spectrometers; Mars Exploration; Electron Spectroscopy; Roving Vehicles; Robotics; Miniaturization

20080013196 NASA Marshall Space Flight Center, Huntsville, AL, USA

Application of Risk within Net Present Value Calculations for Government Projects

Grandl, Paul R.; Youngblood, Alisha D.; Componation, Paul; Gholston, Sampson; [2007]; 16 pp.; In English; No Copyright; Avail.: CASI: A03, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080013196

In January 2004, President Bush announced a new vision for space exploration. This included retirement of the current Space Shuttle fleet by 2010 and the development of new set of launch vehicles. The President's vision did not include significant increases in the NASA budget, so these development programs need to be cost conscious. Current trade study procedures address factors such as performance, reliability, safety, manufacturing, maintainability, operations, and costs. It would be desirable, however, to have increased insight into the cost factors behind each of the proposed system architectures. This paper reports on a set of component trade studies completed on the upper stage engine for the new launch vehicles. Increased insight into architecture costs was developed by including a Net Present Value (NPV) method and applying a set of associated risks to the base parametric cost data. The use of the NPV method along with the risks was found to add fidelity

to the trade study and provide additional information to support the selection of a more robust design architecture.
Author
Risk; Space Exploration; Space Shuttles; Governments; Aerospace Engineering; Technology Assessment; Project Management

20080013214 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Mars Science Laboratory Focused Technology Program Overview
Udomkesmalee, Gabriel Souraphol; Hayati, Samad A.; March 20, 2005; 8 pp.; In English; IEEE Aerospace Conferece, 20 mar. 2005, Big Sky, MT, USA; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40648

This paper describes how the MSL-FT program functions to ensure that the needed technology is identified, developed, matured to TRL 6, and infused in the MSL mission, in a systematic fashion that will meet the mission's objectives innovatively and within budget. The paper describes the mission's technical and project challenges, and outlines the process, procedures, tools and people involved in meeting those challenges. The paper also discusses the technology certification process required to demonstrate that technology deliverables perform adequately and in a predictable fashion to successful infusion into the MSL Flight System.
Author
Mars Exploration; Planetary Geology; Systems Engineering; Mars Surface; Cost Reduction

20080013219 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Themis Visible Imaging of the South Polar Layered Deposits, Martian Southern Spring, 2003
Plaut, Jeffery J.; Christensen, P.; Bender, K.; Bell, J.; Cherednik, L.; Ivanov, A.; Kieffer, H.; McConnochie, T.; Richardson, M.; Titus, T.; October 13, 2003; 3 pp.; In English; 3rd International Conference on Mars Polar Science and Exploration, 13-17 Oct. 2003, Alberta, Canada; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40666

The polar layered deposits (PLD) of Mars have attracted considerable attention since their identification in Mariner 9 images, largely due to the possibility that these finely layered, volatile-rich deposits hold a record of recent eras in Martian climate history. The PLD have been a target of imaging and other sensors in the last several decades, but only recently has it been possible to obtain a moderately high resolution image map, using the visible sensor on 2001 Mars Odyssey's Thermal Emission Imaging System (THEMIS). We report here on the acquisition of a 36 meter/pixel contiguous single-band visible image data set of the south polar layered deposits (SPLD), obtained during early southern spring in 2003. The data will undoubtedly be applied to many problems in Mars polar studies.
Author
Imaging Techniques; Mars Environment; Mariner 9 Space Probe; Deposits; Planetary Geology; Thermal Emission; Mars Surface; Mars Photographs

20080013253 NASA Johnson Space Center, Houston, TX, USA
Aluminum Foils of the Stardust Interstellar Collector: The Challenge of Recognizing Micrometer-sized Impact Craters made by Interstellar Grains
Kearsley, A. T.; Westphal, A. J.; Burchell, M. J.; Zolensky, Michael E.; [2008]; 2 pp.; In English; 39th Lunar and Planetary Science Conference, 10-14 Mar. 2008, League City, TX, USA; Original contains color and black and white illustrations; Copyright; Avail.: CASI: A01, Hardcopy

Preliminary Examination (PE) of the Stardust cometary collector revealed material embedded in aerogel and on aluminium (Al) foil. Large numbers of sub-micrometer impact craters gave size, structural and compositional information. With experience of finding and analyzing the picogram to nanogram mass remains of cometary particles, are we now ready for PE of the Interstellar (IS) collector? Possible interstellar particle (ISP) tracks in the aerogel are being identified by the stardust\@home team. We are now assessing challenges facing PE of Al foils from the interstellar collector.
Derived from text
Aluminum; Composition (Property); Stardust Mission; Interstellar Matter; Impact

20080013254 NASA Johnson Space Center, Houston, TX, USA
Sm-Nd and Rb-Sr Isotopic Studies of Meteorite Kalahari 009: An Old VLT Mare Basalt
Shih, C.-Y.; Nyquist, L. E.; Reese, Y.; Bischoff, A.; January 12, 2008; 2 pp.; In English; 39th Lunar Planetary Conference, 10-14 Mar. 2008, League City, TX, USA; Original contains color illustrations; Copyright; Avail.: CASI: A01, Hardcopy

Lunar meteorite Kalahari 009 is a fragmental basaltic breccia containing various very-low-Ti (VLT) mare basalt clasts

embedded in a fine-grained matrix of similar composition. This meteorite and lunar meteorite Kalahari 008, an anorthositic breccia, were suggested to be paired mainly due to the presence of similar fayalitic olivines in fragments found in both meteorites. Thus, Kalahari 009 probably represents a VLT basalt that came from a locality near a mare-highland boundary region of the Moon, as compared to the typical VLT mare basalt samples collected at Mare Crisium during the Luna-24 mission. The concordant Sm-Nd and Ar-Ar ages of such a VLT basalt (24170) suggest that the extrusion of VLT basalts at Mare Crisium occurred 3.30 +/- 0.05 Ga ago. Previous age results for Kalahari 009 range from approximately 4.2 Ga by its Lu-Hf isochron age to 1.70-0.04 Ga of its Ar-Ar plateau age. However, recent in-situ U-Pb dating of phosphates in Kalahari 009 defined an old crystallization age of 4.35+/- 0.15 Ga. The authors suggested that Kalahari 009 represents a cryptomaria basalt. In this report, we present Sm-Nd and Rb-Sr isotopic results for Kalahari 009, discuss the relationship of its age and isotopic characteristics to those of other L-24 VLT mare basalts and other probable cryptomaria basalts represented by Apollo 14 aluminous mare basalts, and discuss its petrogenesis.
Derived from text
Basalt; Isotopes; Lunar Maria; Meteorites; Geochronology; Meteoritic Composition

20080013255 NASA Johnson Space Center, Houston, TX, USA
Mobile Element Studies in Rocks (RAT) from Columbia Hills/West Spur at Gusev
Rao, M. N.; Nyquist, L. E.; Sutton, S. R.; Garrison, D. H.; [2007]; 2 pp.; In English; 39th Lunar Planetary Science Conference, 10-14 Mar. 2008, League City, TX, USA; Copyright; Avail.: CASI: A01, Hardcopy

Using elemental abundances determined by SPIRIT APX spectrometer on rocks and soils at Gusev Plains and Columbia Hills/ West Spur regions, the Athena Team discussed the aqueous geochemical implications at these sites on Mars. They suggested that these rocks were exposed to variable degrees of aqueous alteration (low to high) at Gusev crater. Earlier, we developed analytical procedures for studying aqueous geochemical behavior of fluids on rocks at Meridiani. In the present study, we apply these methods to rocks at Columbia Hills/West Spur in order to understand the significance of the Gusev rock results in reference to aqueous geochemical processes on Mars . The data analysis procedure is based on treating SO3 (‘a’) and Cl (‘b’) as two variables and tracking the relationship between ‘a’ and ‘b’ when the fluids undergo evaporation. This process of evaporation leads to concentration changes in these two elements finally producing salt assemblages on Martian rocks. In some cases on plotting ‘a"/ ‘b’ versus ‘b’ in salt assemblages, they yield a hyperbolic distribution. The relationship is transformed into a straight line when ‘a"/‘b’ is again plotted against 1/‘b’ in the system. Earlier, we used this procedure in the case of Merdiani rock abrasion tool (RAT) rocks and in this study, we discuss the application of this procedure to Gusev rocks. This study shows that the Gusev Plains rocks were exposed to low SO3/Cl solutions (sulfate-poor) for short period of time (weak interaction), whereas solutions with high SO3/Cl ratios (sulfate-rich) seem to have pervasively interacted with Columbia Hills/ West Spur rocks (strong interaction) at Gusev crater. Our conclusions seem to be consistent with the Mossbauer results given for these rocks
Derived from text
Geochemistry; Mars Surface; Planetary Geology; Rocks; Water

20080013256 MEI Technologies, Inc., USA
Lunar and Mars Exploration: The Autonomy Factor
Rando, Cynthia M.; Schuh, Susan V.; [2008]; 6 pp.; In English; 38th International Conference on Environmental Systems, 29 Jun.-2 Jul. 2008, San Francisco, CA, USA; Copyright; Avail.: CASI: A02, Hardcopy

Long duration space flight crews have relied heavily on almost constant communication with ground control mission support. Ground control teams provide vehicle status and system monitoring, while offering near real time support for specific tasks, emergencies, and ensuring crew health and well being. With extended exploration goals to lunar and Mars outposts, real time communication with ground control teams and the ground s ability to conduct mission monitoring will be very limited compared to the resources provided to current International Space Station (ISS) crews. An operational shift toward more autonomy and a heavier reliance on the crew to monitor their vehicle and operations will be required for these future missions. NASA s future exploration endeavors and the subsequent increased autonomy will require a shift in crew skill composition, i.e. engineer, doctor, mission specialist etc. and lead to new training challenges and mission scenarios. Specifically, operational and design changes will be necessary in many areas including: Habitat Infrastructure and Support Systems, Crew Composition, Training, Procedures and Mission Planning. This paper will specifically address how to apply ISS lessons learned to further use ISS as a test bed to address decreased amounts of ground support to achieve full autonomous operations for lunar and Mars missions. Understanding these lessons learned and applying them to current operations will help to address

the future impacts of increased crew autonomy for the lunar and Mars outposts and pave the way for success in increasingly longer mission durations.
Author
Autonomy; Mars Missions; Lunar Bases; Support Systems; Ground Based Control; Flight Crews

20080013258 NASA Johnson Space Center, Houston, TX, USA
Detection of Abiotic Methane in Terrestrial Continental Hydrothermal Systems: Implications for Methane on Mars
Socki, Richard A.; Niles, Paul B.; Gibson, Everett K., Jr.; Romanek, Christopher S.; Zhang, Chuanlun L.; Bissada, Kadry K.; March 10, 2008; 2 pp.; In English; 39th Lunar and Planetary Science Conference, 10-14 Mar. 2008, League City, TX, USA; Copyright; Avail.: CASI: A01, Hardcopy

The recent detection of methane in the Martian atmosphere and the possibility that its origin could be attributed to biological activity, have highlighted the importance of understanding the mechanisms of methane formation and its usefulness as a biomarker. Much debate has centered on the source of the methane in hydrothermal fluids, whether it is formed biologically by microorganisms, diagenetically through the decomposition of sedimentary organic matter, or inorganically via reduction of CO2 at high temperatures. Ongoing research has now shown that much of the methane present in sea-floor hydrothermal systems is probably formed through inorganic CO2 reduction processes at very high temperatures (greater than 400 C). Experimental results have indicated that methane might form inorganically at temperatures lower still, however these results remain controversial. Currently, methane in continental hydrothermal systems is thought to be formed mainly through the breakdown of sedimentary organic matter and carbon isotope equilibrium between CO2 and CH4 is thought to be rarely present if at all. Based on isotopic measurements of CO2 and CH4 in two continental hydrothermal systems, we suggest that carbon isotope equilibration exists at temperatures as low as 155 C. This would indicate that methane is forming through abiotic CO2 reduction at lower temperatures than previously thought and could bolster arguments for an abiotic origin of the methane detected in the martian atmosphere.
Derived from text
Abiogenesis; Detection; Mars Atmosphere; Hydrothermal Systems; Mars Surface

20080013281 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Distributed Operations for the Mars Exploration Rover Mission with the Science Activity Planner
Wick, Justin V.; Callas, John L.; Norris, Jeffrey S.; Powell, Mark W.; Vona, Marsette A., III; March 5, 2005; 8 pp.; In English; IEEE Aerospace Conference, 5-12 Mar. 2005, Big Sky, MT, USA; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40627

Due to the length of the Mars Exploration Rover Mission, most scientists were unable to stay at the central operations facility at the Jet Propulsion Laboratory. This created a need for distributed operations software, in the form of the Distributed Science Activity Planner. The distributed architecture saved a considerable amount of money and increased the number of individuals who could be actively involved in the mission, contributing to its success.
Author
Mars Exploration; Roving Vehicles; Mission Planning; Bandwidth

20080013284 NASA Johnson Space Center, Houston, TX, USA
NASA's Decadal Planning Team Mars Mission Analysis Summary
Drake, Bret G., Editor; February 2007; 101 pp.; In English; Original contains color and black and white illustrations
Report No.(s): JSC-63725; No Copyright; Avail.: CASI: A06, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080013284

In June 1999 the NASA Administrator chartered an internal NASA task force, termed the Decadal Planning Team, to create new integrated vision and strategy for space exploration. The efforts of the Decadal Planning Team evolved into the Agency-wide team known as the NASA Exploration Team (NEXT). This team was also instructed to identify technology roadmaps to enable the science-driven exploration vision, established a cross-Enterprise, cross-Center systems engineering team with emphasis focused on revolutionary not evolutionary approaches. The strategy of the DPT and NEXT teams was to 'Go Anywhere, Anytime' by conquering key exploration hurdles of space transportation, crew health and safety, human/robotic partnerships, affordable abundant power, and advanced space systems performance. Early emphasis was placed on revolutionary exploration concepts such as rail gun and electromagnetic launchers, propellant depots, retrograde trajectories, nano structures, and gas core nuclear rockets to name a few. Many of these revolutionary concepts turned out to

be either not feasible for human exploration missions or well beyond expected technology readiness for near-term implementation. During the DPT and NEXT study cycles, several architectures were analyzed including missions to the Earth-Sun Libration Point (L2), the Earth-Moon Gateway and L1, the lunar surface, Mars (both short and long stays), one-year round trip Mars, and near-Earth asteroids. Common emphasis of these studies included utilization of the Earth-Moon Libration Point (L1) as a staging point for exploration activities, current (Shuttle) and near-term launch capabilities (EELV), advanced propulsion, and robust space power. Although there was much emphasis placed on utilization of existing launch capabilities, the team concluded that missions in near-Earth space are only marginally feasible and human missions to Mars were not feasible without a heavy lift launch capability. In addition, the team concluded that missions in Earth s neighborhood, such as to the Moon, can serve as stepping-stones toward further deep-space missions in terms of proving systems, technologies, and operational concepts. The material contained in this presentation was compiled to capture the work performed by the Mars Sub-Team of the DPT NEXT efforts in the late 1999-2001 timeframe.
Derived from text
Space Exploration; Interplanetary Flight; Interplanetary Spacecraft; Manned Mars Missions; NASA Space Programs; Mission Planning; Earth-Mars Trajectories; Mars Exploration

20080013313 NASA Marshall Space Flight Center, Huntsville, AL, USA
Laboratory Measurements of Charging of Apollo 17 Lunar Dust Grains by Low Energy Electrons
Abbas, Mian M.; Tankosic, Dragana; Spann, James F.; Dube, Michael J.; Gaskin, Jessica; December 10, 2007; 1 pp.; In English; 2007 Fall Meeting of the American Geophysical Union, 10-14 Dec. 2007, San Francisco, CA, USA; Copyright; Avail.: Other Sources; Abstract Only

It is well recognized that the charging properties of individual micron/sub-micron size dust grains by various processes are expected to be substantially different from the currently available measurements made on bulk materials. Solar UV radiation and the solar wind plasma charge micron size dust grains on the lunar surface with virtually no atmosphere. The electrostatically charged dust grains are believed to be levitated and transported long distances over the lunar terminator from the day to the night side. The current models do not fully explain the lunar dust phenomena and laboratory measurements are needed to experimentally determine the charging properties of lunar dust grains. An experimental facility has been developed in the Dusty Plasma Laboratory at NASA Marshall Space Flight Center MSFC for investigating the charging properties of individual micron/sub-micron size positively or negatively charged dust grains by levitating them in an electrodynamic balance in simulated space environments. In this paper, we present laboratory measurements on charging of Apollo 17 individual lunar dust grains by low energy electron beams in the 5-100 eV energy range. The measurements are made by levitating Apollo 17 dust grains of 0.2 to 10 micrometer diameters, in an electrodynamic balance and exposing them to mono-energetic electron beams. The charging rates and the equilibrium potentials produced by direct electron impact and by secondary electron emission processes are discussed.
Author
Electrostatic Charge; Lunar Dust; Aerospace Environments; Apollo 17 Flight; Electron Beams

20080013324 NASA Johnson Space Center, Houston, TX, USA
Mineralogy, Three Dimensional Structure, and Oxygen Isotope Ratios of Four Crystalline Particles from Comet 81P/Wild 2
Nakamura, T.; Noguchi, T.; Tsuchiyama, A.; Ushikubo, T.; Kita, N. T.; Valley, J. W.; Zolensky, M. E.; Kakazu, Y.; Sakamoto, K.; Mashio, E.; Uesugi, K.; Nakano, T.; [2008]; 2 pp.; In English; 39th Lunar and Planetary Sciences Conference, 10-14 Mar. 2008, League City, TX, USA; Copyright; Avail.: CASI: A01, Hardcopy

Preliminary examinations of small dust particles from comet 82P/Wild 2 revealed many expected and unexpected features. Among them the most striking feature is the presence of abundant crystalline material in the comet. Synchrotron radiation X-ray diffraction and microtomography are the most efficient methods to detect and describe bulk mineralogical features of crystalline cometary particles. In the present study, in addition to these two non-destructive techniques, electron microscopy and ion-probe mass spectrometry were carried out on the four crystalline particles.
Author
Isotope Ratios; Mineralogy; Oxygen Isotopes; Wild 2 Comet; Cometary Atmospheres; Cosmic Dust; Crystallinity; Crystal Structure

20080013325 NASA Johnson Space Center, Houston, TX, USA

What Can You Do with a Returned Sample of Martian Dust?

Zolensky, Michael E.; Nakamura-Messenger, K.; [2007]; 2 pp.; In English; Ground Truth from Mars: Science Payoff from Sample Return Mission, 20-23 Apr. 2008, Albuquerque, NM, USA; No Copyright; Avail.: CASI: A01, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080013325

A major issue that we managed to successfully address for the Stardust Mission was the magnitude and manner of preliminary examination (PET) of the returned samples, which totaled much less than 1 mg. Not since Apollo and Luna days had anyone faced this issue, and the lessons of Apollo PET were not extremely useful because of the very different sample masses in this case, and the incredible advances in analytical capabilities since the 1960s. This paper reviews some of the techniques for examination of small very rare samples that would be returned from Mars missions.

Derived from text

Stardust Mission; Sample Return Missions; Mars Surface; Nondestructive Tests; Nonintrusive Measurement

20080013327 NASA Johnson Space Center, Houston, TX, USA

2003 Mars Exploration Rover Mission: Robotic Field Geologists for a Mars Sample Return Mission

Ming, Douglas W.; [2008]; 2 pp.; In English; Ground Truth from Mars: Science Payoff, 21-23 Apr. 2008, Albuquerque, NM, USA; No Copyright; Avail.: CASI: A01, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080013327

The Mars Exploration Rover (MER) Spirit landed in Gusev crater on Jan. 4, 2004 and the rover Opportunity arrived on the plains of Meridiani Planum on Jan. 25, 2004. The rovers continue to return new discoveries after 4 continuous Earth years of operations on the surface of the red planet. Spirit has successfully traversed 7.5 km over the Gusev crater plains, ascended to the top of Husband Hill, and entered into the Inner Basin of the Columbia Hills. Opportunity has traveled nearly 12 km over flat plains of Meridiani and descended into several impact craters. Spirit and Opportunity carry an integrated suite of scientific instruments and tools called the Athena science payload. The Athena science payload consists of the 1) Panoramic Camera (Pancam) that provides high-resolution, color stereo imaging, 2) Miniature Thermal Emission Spectrometer (Mini-TES) that provides spectral cubes at mid-infrared wavelengths, 3) Microscopic Imager (MI) for close-up imaging, 4) Alpha Particle X-Ray Spectrometer (APXS) for elemental chemistry, 5) Moessbauer Spectrometer (MB) for the mineralogy of Fe-bearing materials, 6) Rock Abrasion Tool (RAT) for removing dusty and weathered surfaces and exposing fresh rock underneath, and 7) Magnetic Properties Experiment that allow the instruments to study the composition of magnetic martian materials [1]. The primary objective of the Athena science investigation is to explore two sites on the martian surface where water may once have been present, and to assess past environmental conditions at those sites and their suitability for life. The Athena science instruments have made numerous scientific discoveries over the 4 plus years of operations. The objectives of this paper are to 1) describe the major scientific discoveries of the MER robotic field geologists and 2) briefly summarize what major outstanding questions were not answered by MER that might be addressed by returning samples to our laboratories on Earth.

Author

Mars Sample Return Missions; Robotics; Mars Exploration; Geological Surveys; Mineralogy; Mars Landing Sites; Roving Vehicles

20080013333 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA

Development of a Microwave Facility for Processing Lunar Regolith

Barmatz, Martin B.; Hays, Charles C.; Meek, T. T.; February 6, 2006; 17 pp.; In English; Habitation Conference, 5-8 Feb. 2008, Orlando, Fl, USA; Original contains black and white illustrations; Copyright; Avail.: Other Sources

ONLINE: http://hdl.handle.net/2014/40665

This viewgraph presentation reviews in this Roadmap for Developing a Lunar Microwave Facility an approach to determine the source of the enhanced microwave heating of Lunar Regolith. A set of microwave heating studies were proposed for a specially designed realistic simulant to determine optimum processing parameters. Apollo lunar soil will be used to validate the heating features found for the simulant. We have also introduced several possible designs for a future lunar microwave processing facility. In the future when sufficient funds become available, a microwave facility for processing regolith on the lunar surface will be ready to be built

CASI

Heating; Lunar Rocks; Lunar Soil; Microwaves; Regolith; In Situ Resource Utilization; Lunar Construction Equipment; Lunar Resources

20080013345 NASA Marshall Space Flight Center, Huntsville, AL, USA

2007 Lunar Regolith Simulant Workshop Overview

McLemore, Carole A.; Fikes, John C.; Howell, Joe T.; November 11, 2007; 21 pp.; In English; JUSTSAP 17th Annual Symposium, 11-15 Nov. 2007, Waikoloa, HI, USA; Original contains black and white illustrations; No Copyright; Avail.: CASI: A03, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080013345

The National Aeronautics and Space Administration (NASA) vision has as a cornerstone, the establishment of an Outpost on the Moon. This Lunar Outpost will eventually provide the necessary planning, technology development, and training for a manned mission to Mars in the future. As part of the overall activity, NASA is conducting Earth-based research and advancing technologies to a Technology Readiness Level (TRL) 6 maturity under the Exploration Technology Development Program that will be incorporated into the Constellation Project as well as other projects. All aspects of the Lunar environment, including the Lunar regolith and its properties, are important in understanding the long-term impacts to hardware, scientific instruments, and humans prior to returning to the Moon and living on the Moon. With the goal of reducing risk to humans and hardware and increasing mission success on the Lunar surface, it is vital that terrestrial investigations including both development and verification testing have access to Lunar-like environments. The Marshall Space Flight Center (MSFC) is supporting this endeavor by developing, characterizing, and producing Lunar simulants in addition to analyzing existing simulants for appropriate applications. A Lunar Regolith Simulant Workshop was conducted by MSFC in Huntsville, Alabama, in October 2007. The purpose of the Workshop was to bring together simulant developers, simulant users, and program and project managers from ETDP and Constellation with the goals of understanding users' simulant needs and their applications. A status of current simulant developments such as the JSC-1A (Mare Type Simulant) and the NASA/U.S. Geological Survey Lunar Highlands-Type Pilot Simulant (NU-LHT-1 M) was provided. The method for evaluating simulants, performed via Figures of Merit (FoMs) algorithms, was presented and a demonstration was provided. The four FoM properties currently being assessed are: size, shape, density, and composition. Some of the Workshop findings include: simulant developers must understand simulant users' needs and applications; higher fidelity simulants are needed and needed in larger quantities now; simulants must be characterized to allow 'apples-to-apples' comparison of test results; simulant users should confer with simulant experts to assist them in the selection of simulants; safety precautions should be taken in the handling and use of simulants; shipping, storing, and preparation of simulants have important implications; and most importantly, close communications among the simulant community must be maintained and will be continued via telecoms, meetings, and an annual Lunar Regolith Simulant Workshop.

Author

Lunar Rocks; Regolith; Geological Surveys; NASA Programs; Lunar Surface; Manned Mars Missions; Accident Prevention; Lunar Environment; Simulation

20080013346 NASA Marshall Space Flight Center, Huntsville, AL, USA

2007 Lunar Regolith Simulant Workshop Overview

McLemore, Carole A.; Fikes, John C.; Howell, Joe T.; November 07, 2007; 21 pp.; In English; 2007 Lunar Regolith Simulant Workshop Overview, 10-12 Oct. 2007, Huntsville, AL, USA; Original contains black and white illustrations; No Copyright; Avail.: CASI: A03, Hardcopy

ONLINE: http://hdl.handle.net/2060/20080013346

The National Aeronautics and Space Administration (NASA) vision has as a cornerstone, the establishment of an Outpost on the Moon. This Lunar Outpost will eventually provide the necessary planning, technology development, and training for a manned mission to Mars in the future. As part of the overall activity, NASA is conducting Earth-based research and advancing technologies to a Technology Readiness Level (TRL) 6 maturity under the Exploration Technology Development Program that will be incorporated into the Constellation Project as well as other projects. All aspects of the Lunar environment, including the Lunar regolith and its properties, are important in understanding the long-term impacts to hardware, scientific instruments, and humans prior to returning to the Moon and living on the Moon. With the goal of reducing risk to humans and hardware and increasing mission success on the Lunar surface, it is vital that terrestrial investigations including both development and verification testing have access to Lunar-like environments. The Marshall Space Flight Center (MSFC) is supporting this endeavor by developing, characterizing, and producing Lunar simulants in addition to analyzing existing simulants for appropriate applications. A Lunar Regolith Simulant Workshop was conducted by MSFC in Huntsville, Alabama, in October 2007. The purpose of the Workshop was to bring together simulant developers, simulant users, and program and project managers from ETDP and Constellation with the goals of understanding users' simulant needs and their applications. A status of current simulant developments such as the JSC-1A (Mare Type Simulant) and the NASA/U.S. Geological Survey Lunar Highlands-Type Pilot Simulant (NU-LHT-1M) was provided. The method for evaluating simulants, performed via

Figures of Merit (FoMs) algorithms, was presented and a demonstration was provided. The four FoM properties currently being assessed are: size, shape, density, and composition. Some of the Workshop findings include: simulant developers must understand simulant users' needs and applications; higher fidelity simulants are needed and needed in larger quantities now; simulants must be characterized to allow 'apples-to-apples' comparison of test results; simulant users should confer with simulant experts to assist them in the selection of simulants; safety precautions should be taken in the handling and use of simulants; shipping, storing, and preparation of simulants have important implications; and most importantly, close communications among the simulant community must be maintained and will be continued via telecoms, meetings, and an annual Lunar Regolith Simulant Workshop.
Author
Manned Mars Missions; Lunar Rocks; Regolith; NASA Programs; Lunar Environment; Simulation; Geological Surveys; Lunar Bases; Accident Prevention

20080013362 NASA Langley Research Center, Hampton, VA, USA
Aeroheating Analysis for the Mars Reconnaissance Orbiter with Comparison to Flight Data
Liechty, Derek S.; January 2007; 15 pp.; In English; Original contains color and black and white illustrations; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080013362

The aeroheating environment of the Mars Reconnaissance Orbiter (MRO) has been analyzed using the direct simulation Monte Carlo and free-molecular techniques. The results of these analyses were used to develop an aeroheating database to be used for the preflight planning and the in-flight operations support for the aerobraking phase of the MRO mission. The aeroheating predictions calculated for the MRO include the heat transfer coefficient (CH) over a range of angles-of-attack, sideslip angles, and number densities. The effects of flow chemistry, surface temperature, and surface grid resolution were also investigated to determine the aeroheating database uncertainties. Flight heat flux data has been calculated from surface temperature sensor data returned to Earth from the MRO in orbit around Mars during the aerobraking phase of its mission. The heat flux data have been compared to the aeroheating database and agree favorably.
Author
Aerodynamic Heating; Mars Reconnaissance Orbiter; Monte Carlo Method; Aerobraking; Surface Geometry

20080013365 NASA Langley Research Center, Hampton, VA, USA
Mars Exploration Rovers Entry, Descent, and Landing Trajectory Analysis
Desai, Prasun N.; Knocke, Philip C.; January 2007; 20 pp.; In English; Original contains color and black and white illustrations
Contract(s)/Grant(s): WBS 439654.02.07.01.01; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080013365

In this study we present a novel method of land surface classification using surface-reflected GPS signals in combination with digital imagery. Two GPS-derived classification features are merged with visible image data to create terrain-moisture (TM) classes, defined here as visibly identifiable terrain or landcover classes containing a surface/soil moisture component. As compared to using surface imagery alone, classification accuracy is significantly improved for a number of visible classes when adding the GPS-based signal features. Since the strength of the reflected GPS signal is proportional to the amount of moisture in the surface, use of these GPS features provides information about the surface that is not obtainable using visible wavelengths alone. Application areas include hydrology, precision agriculture, and wetlands mapping.
Author
Mars Exploration; Roving Vehicles; Trajectory Analysis; Descent; Remote Sensing; Mars Landing; Image Classification

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SOLAR PHYSICS

Includes solar activity, solar flares, solar radiation and sunspots. For related information see *93 Space Radiation*.

20080013218 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Performance of High-Efficiency Advanced Triple-Junction Solar Panels for the LILT Mission Dawn
Fatemi, Navid S.; Sharma, Surya; Buitrago, Oscar; Sharps, Paul R.; Blok, Ron; Kroon, Martin; Jalink, Cees; Harris, Robin; Stella, Paul; Distefano, Sal; January 3, 2005; 4 pp.; In English; 31 Photovoltaic Specialists Conference and Exhibition, 3-7 Jan. 2005, Lake Buena Vista, FL, USA; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40632

NASA's Discovery Mission Dawn is designed to (LILT) conditions. operate within the solar system's Asteroid belt, where

the large distance from the sun creates a low-intensity, low-temperature (LILT) condition. To meet the mission power requirements under LlLT conditions, very high-efficiency multi-junction solar cells were selected to power the spacecraft to be built by Orbital Sciences Corporation (OSC) under contract with JPL. Emcore's InGaP/InGaAs/Ge advanced triple-junction (ATJ) solar cells, exhibiting an average air mass zero (AMO) efficiency of greater than 27.6% (one-sun, 28 C), were used to populate the solar panels [1]. The two solar array wings, to be built by Dutch Space, with 5 large- area panels each (total area of 36.4 sq. meters) are projected to produce between 10.3 kWe and 1.3 kWe of end-of life (EOL) power in the 1.0 to 3.0 AU range, respectively. The details of the solar panel design, testing and power analysis are presented.
Author
Design Analysis; Solar Cells; Solar Arrays; Structural Design; Indium Phosphides; Gallium Phosphides

20080013337 NASA Marshall Space Flight Center, Huntsville, AL, USA
Solar Sail Propulsion Technology at NASA
Johnson, Charles Les; November 08, 2007; 1 pp.; In English; Colloquium at Surrey University, 8-9 Nov. 2007, Surrey, UK; No Copyright; Avail.: Other Sources; Abstract Only

NASA's In-Space Propulsion Technology Program developed the first generation of solar sail propulsion systems sufficient to accomplish inner solar system science and exploration missions. These first generation solar sails, when operational, will range in size from 40 meters to well over 100 meters in diameter and have an area density of less than 13 grams per square meter. A rigorous, multi-year technology development effort culminated in 2005 with the testing of two different 20-m solar sail systems under thermal vacuum conditions. This effort provided a number of significant insights into the optimal design and expected performance of solar sails as well as an understanding of the methods and costs of building and using them. In addition, solar sail orbital analysis tools for mission design were developed and tested. Laboratory simulations of the effects of long-term space radiation exposure were also conducted on two candidate solar sail materials. Detailed radiation and charging environments were defined for mission trajectories outside the protection of the earth's magnetosphere, in the solar wind environment. These were used in other analytical tools to prove the adequacy of sail design features for accommodating the harsh space environment. The presentation will describe the status of solar sail propulsion within NASA, near-term solar sail mission applications, and near-term plans for further development.
Author
Solar Sails; Technology Utilization; Solar System; Space Missions; Aerospace Sciences; Spacecraft Propulsion

20080013350 NASA Marshall Space Flight Center, Huntsville, AL, USA
A Radiation Dosimeter Concept for the Lunar Surface Environment
Adams, James H.; Christl, Mark J.; Watts, John; Kuznetsov, Eugeny N.; Parnell, Thomas A.; Pendleton, Geoff N.; October 27, 2007; 4 pp.; In English; IEEE Nuclear Science Symposium, 27 Oct. - 3 Nov. 2007, Honolulu, HI, USA; Original contains black and white illustrations; Copyright; Avail.: CASI: A01, Hardcopy

A novel silicon detector configuration for radiation dose measurements in an environment where solar energetic particles are of most concern is described. The dosimeter would also measure the dose from galactic cosmic rays. In the lunar environment a large range in particle flux and ionization density must be measured and converted to dose equivalent. This could be accomplished with a thick (e.g. 2mm) silicon detector segmented into cubic volume elements 'voxels' followed by a second, thin monolithic silicon detector. The electronics needed to implement this detector concept include analog signal processors (ASIC) and a field programmable gate array (FPGA) for data accumulation and conversion to linear energy transfer (LET) spectra and to dose-equivalent (Sievert). Currently available commercial ASIC's and FPGA's are suitable for implementing the analog and digital systems.
Author
Dosimeters; Lunar Surface; Lunar Environment; Silicon; Energetic Particles; Galactic Cosmic Rays; Dosage; Particle Flux Density

20080013353 NASA Marshall Space Flight Center, Huntsville, AL, USA
Recent Plasma Observations Related to Magnetic Merging and the Low-Latitude Boundary Layer. Case Study by Polar, March 18, 2006
Chandler, M.; Avanov, L.; Craven, P.; Mozer, F.; Moore, T. E.; December 10, 2007; 25 pp.; In English; Fall American Geophysical Union 2007 Meeting, 10-14 Dec. 2007, San Francisco, CA, USA; Original contains color and black and white illustrations; No Copyright; Avail.: CASI: A03, Hardcopy
ONLINE: http://hdl.handle.net/2060/20080013353

We have begun an investigation of the nature of the low-latitude boundary layer in the mid-altitude cusp region using data

from the Polar spacecraft. Magnetosheath-like plasma is frequently observed deep (in terms of distance from the magnetopause and in invariant latitude) in the magnetosphere. One such case, taken during a long period of northward interplanetary magnetic field (IMP) on March 18, 2006, shows injected magnetosheath ions within the magnetosphere with velocity distributions resulting from two separate merging sites along the same field lines. Cold ionospheric ions were also observed counterstreaming along the field lines, evidence that these field lines were closed. Our results support the idea of double reconnection under northward IMP on the same group of field lines can provide a source for the LLBL. However, the flow direction of the accelerated magnetosheath ions antiparallel to the local magnetic field and given location of the spacecraft suggest that these two injection sites are located northward of the spacecraft position. Observed convection velocities of the magnetic field lines are inconsistent with those expected for double post-cusp reconnection in both hemispheres. These observations favor a scenario in which a group of newly closed field lines was created by a combination of high shear merging at high latitudes in the northern hemisphere and low shear merging at lower latitudes at the dayside magnetopause.
Author
Magnetosheath; Boundary Layers; Interplanetary Magnetic Fields; Magnetic Field Reconnection; Plasmas (Physics); Magnetopause; Double Cusps; Cold Plasmas

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SPACE RADIATION

Includes cosmic radiation; and inner and outer Earth radiation belts. For biological effects of radiation on plants and animals see *51 Life Sciences*; on human beings see 52 Aerospace Medicine. For theory see *73 Nuclear Physics*.

20080012447 NASA Johnson Space Center, Houston, TX, USA
Recent Low-Earth Orbit Radiation Measurements Using Passive Dosimeters during ISS Expeditions 13, 14 and 15
Gaza, R.; Zhou, D.; Semones, E.; Zapp, N.; [2008]; 1 pp.; In English; 37th COSPAR Scientific Assembly, 13-20 Jul. 2008, Montreal, Canada; Copyright; Avail.: Other Sources; Abstract Only

Current passive radiation measurements in low-Earth orbit (LEO) involve using a combination of thermally/optically stimulated luminescence detectors (TLDs/OSLDs) for the low-LET component (LET<10 keV/micron water) of the space radiation field and plastic nuclear track detectors (PNTDs) for the high-LET region (LET>10 keV/micron water), as per National Council on Radiation Protection recommendation (NCRP 132, 2004). This combination of radiation detectors has been successfully implemented at NASA Johnson Space Center for routine crewmember and ISS area monitoring using LiF:Mg,Ti, CaF2:Tm, Al2O3:C and CR-39 material. This paper will present in detail the measurement and data processing techniques employed for passive space radiation measurements by the Space Radiation Analysis Group (SRAG) at JSC. The paper will also summarize the absorbed dose, dose equivalent and quality factor results for the area monitoring during ISS Expeditions 13, 14 and 15.
Author
Extraterrestrial Radiation; Radiation Detectors; Luminescence; Radiation Measurement; Earth Orbital Environments

20080012586 NASA Johnson Space Center, Houston, TX, USA
Radiation Measured during ISS-Expedition 13 with Different Dosimeters
Zhou, D.; Semones, E.; Gaza, R.; Johnson, S.; Zapp, N.; Lee, K.; George, T.; [2008]; 1 pp.; In English; 37th COSPAR Scientific Assembly, 13-20 Jul. 2008, Montreal, Canada; No Copyright; Avail.: Other Sources; Abstract Only

Radiation in low Earth orbit (LEO) is mainly composed of Galactic Cosmic Rays (GCR), solar energetic particles and particles in SAA (South Atlantic Anomaly). The biological impact of space radiation to astronauts depends strongly on the particles linear energy transfer (LET) and is dominated by high LET radiation. It is important to measure the LET spectrum for the space radiation field and to investigate the influence of radiation on astronauts. At present, the preferred active dosimeters sensitive to all LET are the tissue equivalent proportional counter (TEPC) and silicon detectors in various configurations; the preferred passive dosimeters are thermoluminescence dosimeters (TLDs) and optically stimulated luminescence dosimeters (OSLDs) sensitive to low LET as well as CR-39 plastic nuclear track detectors (PNTDs) sensitive to high LET. The TEPC, CR-39 PNTDs, TLDs and OSLDs were used to investigate the radiation exposure for the ISS mission Expedition 13 (ISS-12S) in LEO. LET spectra and radiation quantities (fluence, absorbed dose, dose equivalent and quality factor) were measured for the space mission with different dosimeters. This paper introduces the operational principles for the

dosimeters, describes the method to combine the results measured by TLDs/OSLDs and CR-39 PNTDs, and presents the LET spectra and the radiation quantities measured. Keywords: space radiation; cosmic rays; active and passive dosimeters; LET spectra.
Author
Radiation Dosage; Extraterrestrial Radiation; International Space Station; Energetic Particles; Galactic Cosmic Rays; Linear Energy Transfer (LET); Radiation Distribution; Solar Physics; Dosimeters

20080013172 NASA Johnson Space Center, Houston, TX, USA
Space-radiation-induced Photon Luminescence of the Moon
Wilson, Thomas; Lee, Kerry; [2008]; 1 pp.; In English; 37th COSPAR Scientific Assembly, 13-20 Jul. 2008, Montreal, Canada; Copyright; Avail.: Other Sources; Abstract Only

We report on the results of a study of the photon luminescence of the Moon induced by Galactic Cosmic Rays (GCRs) and space radiation from the Sun, using the Monte Carlo program FLUKA. The model of the lunar surface is taken to be the chemical composition of soils found at various landing sites during the Apollo and Luna programs, averaged over all such sites to define a generic regolith for the present analysis. This then becomes the target that is bombarded by Galactic Cosmic Rays (GCRs) and Solar Energetic Particles (SEPs) above 1 keV in FLUKA to determine the photon fluence albedo produced by the Moon's surface when there is no sunlight and Earthshine. This is to be distinguished from the gamma-ray spectrum produced by the radioactive decay of radiogenic constituents lying in the surface and interior of the Moon. From the photon fluence we derive the spectrum which can be utilized to examine existing lunar spectral data and to design orbiting instrumentation for measuring various components of the space-radiation-induced photon luminescence present on the Moon.
Author
Extraterrestrial Radiation; Lunar Luminescence; Moon; Photons; Lunar Surface

20080013267 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA, USA
Optical Sources, Fibers and Photonic Subsystems
Johnston, Allan H.; July 19, 2004; 77 pp.; In English; IEEE Nuclear and Space Radiation Effects Conference, 19-20 Jun. 2004, Atlanta, GA, USA; Original contains black and white illustrations; Copyright; Avail.: Other Sources
ONLINE: http://hdl.handle.net/2014/40713

This section of the Short Course discusses radiation effects in photonic components, along with some examples of the radiation response of photonic subsystems. It begins with a review of some optical principles that are important in the discussions that follow.
Author
Radiation Effects; Optical Fibers; Optical Measuring Instruments; Radiation Absorption; Particle Energy; Photonics

Subject Term Index

Personal Author Index