



Physics of the Cosmos Newsletter

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Program Manager's Perspective

Mansoor Ahmed, *PCOS Program Manager*

I am happy to report that the PCOS Program Office (PO) made great progress toward achieving our milestones this quarter.

Our team began the important work of exploring the future of PCOS science with the initiation of the X-ray astronomy and gravitational wave mission studies. In October, the PCOS Program released Requests for Information (RFI) about potential mission concepts and technologies that address some or all of the key science objectives of the LISA and IXO missions as defined by the "New Worlds, New Horizons in Astronomy and Astrophysics" decadal survey. The RFI responses are posted on the "Studies" pages of the PCOS website (<http://pcos.gsfc.nasa.gov/studies/>).

The Community Science Teams that will work with the Program Office have been identified. The study teams are preparing for the community workshops that will be held later this month. The progress and planning for each are described in more detail by the study managers and study scientists in the articles that follow.

These studies are major elements of what we intend to be an ongoing conversation with the science communities about possible mechanisms for achieving these priority science objectives. I encourage you to participate through the workshops, contact with the study team, and the PCOS website's "Studies" pages.

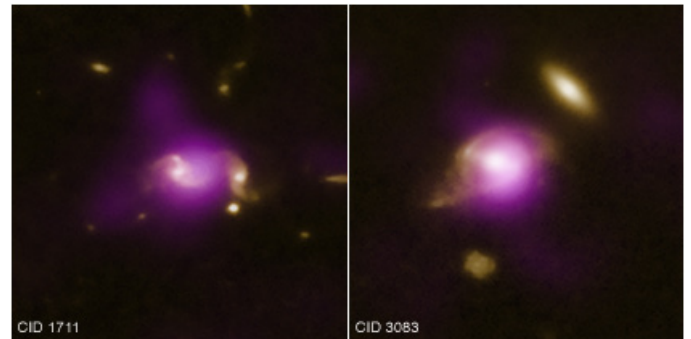
One important goal for the PCOS PO is to improve the transparency of the Program's technology management process and provide the community a voice in that process. In drafting the first PCOS Program Annual Technology Report (PATR), we successfully took the first steps down that path.

The work of the PATR began when the PhysPAG performed a detailed analysis of the technology needed to enable future PCOS missions. Their work was vetted with the PCOS community and posted on the PhysPAG website (<http://pcos.gsfc.nasa.gov/physpag.php>). This analysis was the foundation of the Program's prioritization of technology needs. The PATR will be referenced

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Chandra Observations of CID 1711 and CID 3083: Close Encounters of the Galactic Kind



These two composite images show a sample of the pairs of galaxies that are undergoing close encounters in the survey. In these images, the data from NASA's Chandra X-ray Observatory are shown in purple and Hubble Space Telescope data are in gold.

Astronomers have used a large survey called the Cosmic Evolution Survey (COSMOS) to test a prediction that close encounters between galaxies can trigger the rapid growth of supermassive black holes. Key to this work was Chandra's unique ability to pinpoint actively growing black holes through the X-rays they generate.

The researchers looked at 562 galaxies in pairs ranging in distances from about 3 billion to 8 billion light years from Earth. They found that the galaxies in the early stages of an encounter with another were more likely than isolated, or "lonelier," galaxies to have actively growing black holes in their cores.

The authors of the study estimate that nearly one-fifth of all moderately active black holes are found in galaxies undergoing the early stages of an interaction.

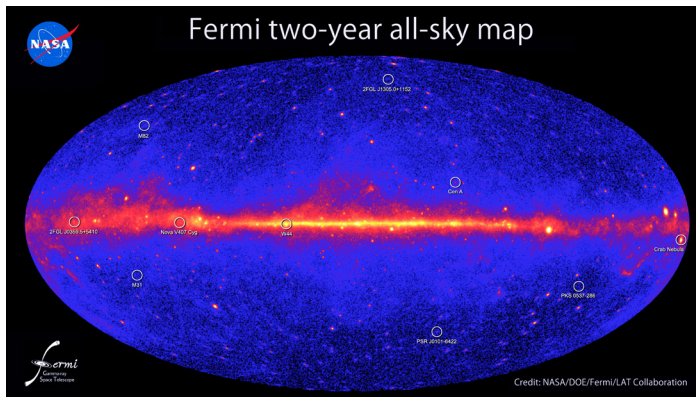
See full article at <http://chandra.harvard.edu/photo/2011/cid/>

by the Program over the upcoming year as calls for technology development proposals are drafted and investment decisions made.

I would like to thank the PhysPAG for helping us complete this work and for helping us demonstrate how important and constructive it is to have the community actively participate.

We in the Program Office look forward to working together with the community to build the future of PCOS science. The Program Office plans to send staff to several major conferences this spring and to support the PhysPAG meetings. If you have any questions or feedback about the work of the PCOS Program, please feel free to contact us, particularly as our paths cross at these forums.

Fermi's Latest Gamma-ray Census Highlights Cosmic Mysteries

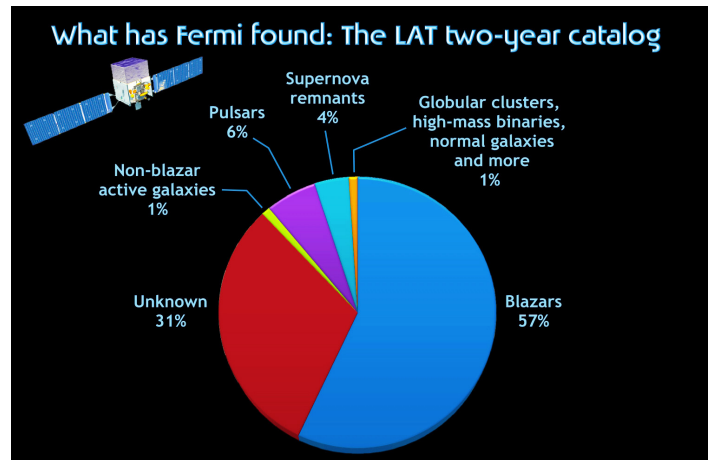


This all-sky image, constructed from two years of observations by NASA's Fermi Gamma-ray Space Telescope, shows how the sky appears at energies greater than 1 billion electron volts (1 GeV). Brighter colors indicate brighter gamma-ray sources. A diffuse glow fills the sky and is brightest along the plane of our galaxy (middle). (Credit: NASA/DOE/Fermi LAT Collaboration)

Every three hours, NASA's Fermi Gamma-ray Space Telescope scans the entire sky and deepens its portrait of the high-energy universe. Every year, the satellite's scientists reanalyze all of the data it has collected, exploiting updated analysis methods to tease out new sources. Earlier this year, the Fermi team released its second catalog of sources detected by the satellite's Large Area Telescope (LAT), producing an inventory of 1,873 objects shining with the highest-energy form of light.

"More than half of these sources are active galaxies, whose massive black holes are responsible for the gamma-ray emissions that the LAT detects," said Gino Tosti, an astrophysicist at the University of Perugia in Italy and currently a visiting scientist at SLAC National Accelerator Laboratory in Menlo Park, Calif. "What is perhaps the most intriguing aspect of our new catalog is the large number of sources not associated with objects detected at any other wavelength," he noted.

Indeed, if the Fermi catalog were a recipe, the two major ingredients would be active galaxies and pure mystery. See full story at http://www.nasa.gov/mission_pages/GLAST/news/gamma-ray-census.html



Active galaxies called blazars constitute the single largest source class in the second Fermi LAT catalog, but nearly a third of the sources are unassociated with objects at any other wavelength. Their natures are unknown. (Credit: NASA's Goddard Space Flight Center)

PCOS Science

Jean Cottam, *Outgoing PCOS Chief Scientist*

There is a great deal of activity under way both within the U.S. and in the larger, global science community toward realizing new missions that address Physics of the Cosmos science objectives.

In 2013, the Russians are scheduled to launch Spectrum-Roentgen-Gamma that will carry eROSITA, a joint German/Russian all-sky imaging experiment to address dark energy science by studying clusters of galaxies. ESA has just approved the Euclid mission for launch in 2019. Euclid will perform sensitive weak lensing and baryon acoustic oscillations measurements over 15,000 square degrees of the sky. In the U.S., the WFIRST Science Definition Team has completed their Interim Design Reference Mission report, which demonstrates a proof of concept mission that is compliant with the recommendations of the 2010 Decadal report.

A broad range of ground-based and suborbital experiments are studying the physics of Inflation with increased sensitivity to "B mode" polarization, the critical mode caused by inflationary gravitational waves. This community is actively pursuing technology development that would enable a dedicated space-based polarization mission. Such a mission is needed to fully characterize those "B modes" once they are detected. The PhysPAG's Inflation Probe Science Analysis Group (IPSAG) is coordinating these technology development plans.

The study of black holes proceeds through multiple techniques and platforms. The upcoming Explorer missions will all address

black hole science. Beginning with the 2012 launch of NuSTAR, then Astro-H and GEMS, the next Explorer missions will provide new capabilities that can probe the high-energy phenomena around black holes. ESA's revised L-class mission selection process continues with the completion of the internal technical and programmatic reviews of the mission concepts. The ATHENA mission, which replaces IXO, utilizes a total collecting area of 1 square meter divided between a wide-field imager and a microcalorimeter array. NGO, which replaces LISA, includes two interferometer arms that are each 1 Mkm long. Although simplified, these missions achieve significant fractions of the original missions' science goals but within ESA's cost caps. ESA will determine the schedule for down-selection between mission concepts at the February meeting of the Science Programme Committee. In parallel, the PCOS Program is considering concepts for possible U.S.-led missions. These might be complementary to an ESA-led mission or represent the next X-ray or gravitational wave mission if the ESA-led missions are not selected. The plans and early progress are described in the X-ray and Gravitational Wave Study articles below.

While budgetary and programmatic constraints have limited NASA's ability to implement the recommendations from the Astro 2010 Decadal report, there are exciting missions on the horizon that will significantly advance our understanding of PCOS science. We are working to identify creative ideas and alternatives within our constraints for the U.S. to make our unique contributions to this science.

News from the Astrophysics Division at NASA Headquarters

Jaya Bajpayee, *PCOS Program Executive*
Rita Sambruna, *PCOS Program Scientist*

Geoffrey Yoder, acting Astrophysics Division Director, has taken on leadership of the Division with a commitment to move forward on a course that maximizes the science output within the current budget of approximately \$670M. The astrophysics science objectives will be pursued in a manner consistent with the 2010 Decadal report recommendations.

Program Management Quarterly Dialogue:

In an effort to promote knowledge sharing among the Astrophysics Program Offices, particularly lessons learned and best practices, the Division has begun a quarterly meeting with the Physics of the Cosmos, Cosmic Origins, Exoplanet Exploration, Explorers, and the SOFIA Program Management. This leadership team will develop the overarching astrophysics programmatic strategies and optimize management of the programs. The Team had its kick-off meeting on November 8 at JPL.

Operating Missions Senior Review:

The six operating missions performing PCOS science—Chandra, XMM-Newton, Fermi, Planck, Swift, and Suzaku—have been invited to submit proposals to the upcoming Operating Missions Senior Review, held every two years by the Astrophysics Division to evaluate the scientific productivity of missions that have completed prime operations. The Division will use the findings of the 2012 Senior Review to prioritize the operating missions, define an implementation approach to achieve astrophysics strategic objectives, provide programmatic direction to the missions for FY13 and FY14, and develop initial funding guidelines for FY15 and FY16.

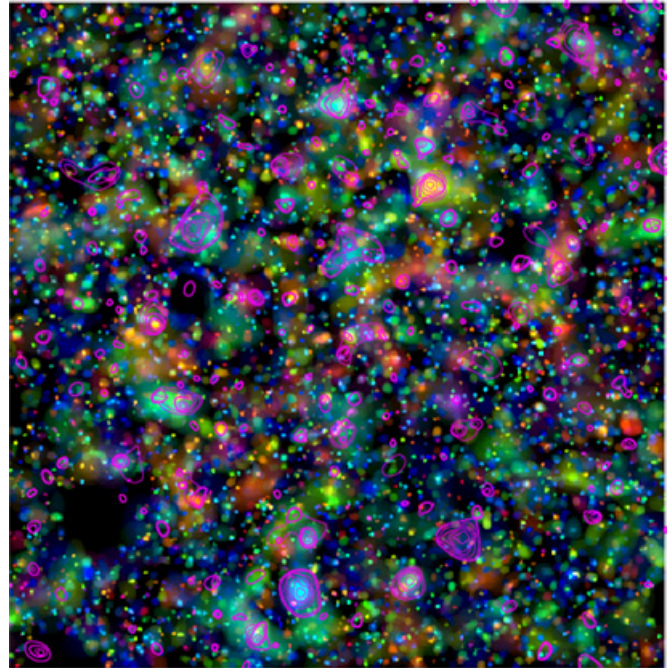
Explorer News:

The Division is making progress in addressing the 2010 Decadal report recommendation that four Explorer missions and four Missions of Opportunity be selected by the end of the decade. In response to the recent Explorer Announcement of Opportunity (AO) for the September 2011 selection, NASA received 15 Astrophysics Explorer mission proposals and 11 Astrophysics Missions of Opportunity proposals. Two Explorers and two Missions of Opportunity were selected for evaluation as potential future missions. Of these, the Neutron star Interior Composition Explorer (NICER), led by Dr. Keith Gendreau from NASA/GSFC, will directly address PCOS science. If selected for implementation, NICER will place an X-ray timing instrument on the International Space Station (ISS) to explore the exotic states of matter within neutron stars and reveal their interior and surface compositions.

International Partners:

The European Space Agency (ESA) has selected the Solar Orbiter and Euclid as the medium-class missions M1 and M2, respectively, for launch in 2017 and 2019. Planetary Transit and Oscillation of Stars (PLATO) will continue in the competitive process for M3. Other candidates for the M3 competition are the Exoplanet Characterization Observatory (EChO), Large Observatory For X-ray Timing (LOFT), MarcoPolo-R (sample return from a primitive near-Earth asteroid) and Space-Time Explorer and Quantum Equivalence Principle Space Test (STE-QUEST).

XMM-Newton traces dark matter in faint, distant galaxy groups



This image shows the galaxy density in the COSMOS field, with colours representing the redshift of the galaxies (ranging from redshift of 0.2 (depicted in blue) to 1 (depicted in red). The X-ray contours (in pink) show the extended X-ray emission as observed by XMM-Newton.

Dark matter is a mysterious, invisible constituent of the Universe which only reveals itself through its gravitational influence. Understanding its nature is one of the key open questions in modern cosmology. In one of the approaches used to address this question astronomers use the relationship between mass and luminosity that has been found for clusters of galaxies which links their X-ray emissions, an indication of the mass of the ordinary (baryonic) matter alone, and their total masses (baryonic plus dark matter) as determined by gravitational lensing.

To date the relationship could only be established for nearby clusters. Work by an international collaboration, including the Max Planck Institute for Extraterrestrial Physics (MPE), the Laboratory of Astrophysics of Marseilles (LAM), and Lawrence Berkeley National Laboratory (Berkeley Lab), has made major progress in extending the relationship to more distant and smaller structures than was previously possible.

See full story at <http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=46322>

Astrophysics Subcommittee:

The last face-to-face meeting of the Astrophysics Subcommittee was held October 19–20, 2011, at NASA Headquarters. The meeting featured a presentation by Dr. Steven Ritz, Chair, PCOS Program Analysis Group, on its activities. A follow-up meeting was held via webex/telecon on November 21, 2011. Agendas and reports of all meetings are posted on <http://science.nasa.gov/science-committee/subcommittees/nac-astrophysics-subcommittee/>.

Personnel Changes:

Dr. Thierry Lanz will be assuming a new post as Director of the newly-formed Lagrange laboratory at l'Observatoire de la Côte d'Azur in Nice, France, starting January 2012. Thierry managed the Astrophysics Theory, Fundamental Physics, and Astrophysics Archival Research Programs. We thank Thierry for his many years of contributions to the Division and the community, and wish him good luck in his future endeavors.

Dr. Billy Lightsey has joined the Division on a detail appointment from Marshall Space Flight Center (MSFC) to assist in managing the operating missions. Dr. Glenn Wahlgren has joined on an Intergovernmental Personnel Act (IPA) assignment from Catholic University. He will serve as the Program Scientist for Laboratory Astrophysics and Deputy Program Scientist for SOFIA. Dr. Phil Stahl has joined on a detail appointment from MSFC to assist in overseeing the Science Mission Directorate's Technology Program.

There are additional PCOS-related re-assignments within the Division. Dr. Richard Griffiths is the new Program Scientist for GEMS. Dr. Hashima Hasan will manage the Astrophysics archives and Dr. Linda Sparke the Theory and Fundamental Physics programs after Dr. Thierry Lanz leaves NASA. Drs. Hashima Hasan, Ilana Harrus, and Lisa Wainio form the newly created communication team.

Finally, Jean Cottam, who has served as the Chief Scientist for the PCOS Program Office for the past two years, is leaving NASA for a position at the National Science Foundation. Ann Hornschemeier will be the new Chief Scientist. Ann has served as a deputy project scientist for the International X-ray Observatory, is an expert in X-ray binary populations and galaxy evolution and is just finishing her term as an officer on the American Astronomical Society's High Energy Astrophysics Division executive committee. Please welcome her onboard!

PhysPAG Report

Steve Ritz, *Chair of the Executive Committee*

Most of the PhysPAG effort during the summer and fall focused on inputs to the technology roadmaps being developed by the PCOS program office. The Technology SAG (TechSAG: <http://pcos.gsfc.nasa.gov/sags/techsag.php>), led by Roger Brissenden, refined and expanded the tables of technology drivers for meeting PCOS science goals. The TechSAG posted and received community feedback on a draft assessment, which was then passed by the Astrophysics Subcommittee of the NASA Advisory Council. The Inflation Probe SAG (IPSAG: <http://pcos.gsfc.nasa.gov/sags/ip-sag.php>), led by Shaul Hanany, worked coherently with the TechSAG to develop technology needs for a future Inflation Probe mission. A proposal for a new Gamma-ray SAG is being developed by Liz Hays and Julie McEnery.

Our next face-to-face meeting will be held on Sunday, January 8, 2012, at the AAS meeting in Austin, TX. All are welcome to attend this full-day meeting. The agenda will be posted on the PCOS website. In addition to moving forward on the above topics, two Special Focus sessions will address X-ray and Gravitational Wave opportunities in a changing international landscape. Representatives from NASA HQ will be on hand to answer questions. We will also have a special AAS session on January 10, 2012, summarizing the activities of all the PAGs (PhysPAG, Cosmic Origins COPAG, and Exoplanets ExoPAG). Please join us!



Next meeting of the PhysPAG
January 8, 2012 9:00 AM - 5:00 PM
AAS Meeting, Austin, Texas
Special Session: Reports from NASA's PAGs
January 10, 2012 10:00 AM - 11:30 AM

The Physics of the Cosmos Program Analysis Group (PhysPAG) provides important conduits for information exchange across Physics of the Cosmos (PCOS) subfields in the community and with the PCOS Program Office at NASA Goddard and HQ. PhysPAG is open to the entire community, and everyone is encouraged to participate. Visit the webpage at <http://pcos.gsfc.nasa.gov/physpag.php>. Here you can find news, links to the presentations from recent meetings, and sign up to receive announcements. Some of our recent reports to the Astrophysics Subcommittee can be found here: <http://science.nasa.gov/science-committee/subcommittees/nac-astrophysics-subcommittee/>.

The current members of the PhysPAG Executive Committee are Jason Rhodes (JPL), Shaul Hanany (University of Minnesota), Roger Brissenden (Harvard-Smithsonian CfA), Liz Hays (GSFC), Guido Mueller (University of Florida), and Steve Ritz (UCSC).

You can sign up for the PhysPAG mailing list at: <http://pcos.gsfc.nasa.gov/physpag/announce.php>

X-ray Astronomy Mission Concept Study

Rob Petre, *Study Scientist*

Gerry Daelemans, *Study Manager*

PCOS has initiated a concept study of missions that would fulfill some or all of the scientific objectives of the International X-ray Observatory (IXO) at lower cost. Specifically, the study will assess the range of IXO objectives that can be achieved at a variety of cost points, ranging from \$300M to \$2B. The study results will be presented to NASA Headquarters in June 2012, and subsequently to the Committee for Astronomy and Astrophysics (CAA) as input for its deliberations about implementation of the recommendations of the 2010 Decadal Survey.

The initial step in this process was the release of a Request for Information (RFI), soliciting from the community white papers about mission concepts and enabling technology. A total of 29 responses were received. Approximately half of these describe mission concepts. The other half of the responses described enabling technology or programmatic strategies. All RFI responses have been posted on the X-ray Astronomy Mission study page of the PCOS Program Office website (<http://pcos.gsfc.nasa.gov/studies/x-ray-mission-rfis.php>).

In parallel with the RFI process, NASA solicited applications for membership in the Community Science Team (CST), which will provide scientific guidance over the course of the study. The CST is chaired by Joel Bregman (University of Michigan) and includes Mark Bautz (Massachusetts Institute of Technology), David Burrows (Pennsylvania State University), Webster Cash (University of Colorado at Boulder), Christine Jones (Harvard Smithsonian Center for Astrophysics), Stephen Murray (Johns Hopkins University), Paul Plucinsky (CfA), Brian Ramsey (NASA's Marshall

Space Flight Center), Ron Remillard (MIT), and Colleen Wilson-Hodge (MSFC).

Over the next few weeks the responses will be analyzed by the members of the study team: the supporting science and engineering teams and the CST. The study team will host an open workshop to promote discussion of the concepts and technology. The workshop will be held December 14–15 at the Maritime Institute, Linthicum, MD, located very near the Baltimore Washington International airport. Every RFI respondent will have an opportunity to make a presentation during this workshop. We invite all interested members of the community to attend this workshop and participate in these discussions. More information about the workshop, including a link for registration, can be found on the X-ray Astronomy Mission study page of the PCOS website (<http://pcos.gsfc.nasa.gov/studies/x-ray-mission.php>).

Based on the RFI responses and community input received during the workshop, the study team will develop up to three mission concepts, representing a range of cost points, using one of NASA's mission design laboratories to validate feasibility and cost. The outcome of these design lab runs provides the technical input for the report to HQ and the CAA.

Please contact us at robert.petre-1@nasa.gov or gerard.j.daelemans@nasa.gov if you have questions or comments.

Gravitational Wave Mission Concept Study

Tuck Stebbins, *Study Scientist*

Ken Anderson, *Study Manager*

The PCOS Program is developing alternative plans to address the high priority LISA science objectives described in the 2010 Astrophysics Decadal Survey report. The PCOS Program will work with the gravitational astrophysics community to develop concepts at multiple cost points for presentation to the NRC's Committee on Astronomy and Astrophysics (CAA) this summer.

As the first part of this effort, a Request for Information (RFI) was issued to the community on September 27, 2011, with responses due on November 10. The RFI solicited whitepapers with new mission concepts, instruments and/or technologies to achieve the LISA science objectives. 17 responses were received. These include 12 mission concepts, 3 instrument concepts, and 2 technologies. The whitepapers can be downloaded from the gravitational wave mission study page of the PCOS website (<http://pcos.gsfc.nasa.gov/studies/gravitational-wave-mission-rfis.php>).

On October 7th, a call for the Community Science Team (CST) was issued, with applications due October 25th. The CST will be co-chaired by Rainer Weiss (Massachusetts Institute of Technology) and Ned Wright (University of California, Los Angeles), and includes Peter Bender (JILA/University of Colorado), Joan Centrella (GSFC), Neil Cornish (Montana State, Bozeman), Jens Gundlach (University of Washington), Ron Hellings (Montana State, Bozeman), Guido Mueller (University of Florida), Holger Mueller (University of California, Berkeley), and Tom Prince (California Institute of Technology). A Core Science Team and Core Engineering Team is in place to provide science and engineering support to the program office. The Core Team members come from JPL and GSFC.

In conjunction with this study, the PCOS Program Office is hosting a gravitational-wave mission concepts workshop held on De-

Meet the Einstein Fellows: Tony Mroczkowski

Galaxy clusters are the largest gravitationally bound objects in the universe, and can therefore be used as both astrophysical laboratories and as probes of cosmology. Tony Mroczkowski is interested in developing the next generation of tools for observing the Sunyaev-Zel'dovich (SZ) effect from galaxy clusters,



a redshift-independent distortion of the Cosmic Microwave Background (CMB) proportional to the integral of pressure through a cluster. The SZ effect probes properties that are highly complementary to those probed through Chandra X-ray observations. In particular, Tony is working to image the SZ effect at high resolution, where cluster astrophysics meets cosmology.

Tony Mroczkowski grew up in Houston, Texas, and studied in New York City, earning his B.S. in Engineering from the Cooper Union for the Advancement of Science and Art, and his Ph.D. in Astronomy from Columbia University. His first postdoctoral position was at the University of Pennsylvania, where he worked on instrumentation for BLAST-Pol, a sub-millimeter telescope with polarization capabilities designed to measure galactic star formation. He started his Einstein Postdoctoral Fellowship in July 2010, working with the 90-GHz 9" bolometer array MUSTANG, which operates from the 100-m Green Bank Telescope (GBT).

In August 2011, Tony moved to JPL/Caltech to work on detectors for next generation mm/submm instrumentation. There he hopes to help build a much more sensitive replacement for MUSTANG, which will make the GBT the most sensitive ground-based instrument for high-resolution studies of cluster astrophysics, particularly at high redshift.

Tony is also involved in developing multi-frequency instrumentation to probe the relativistic and kinetic SZ effects, which can be used to constrain the temperatures and proper motions of galaxy clusters. This includes a first-light instrument for the upcoming observatory Cornell Caltech Atacama Telescope, as well as future instruments for probing the CMB, finding high- z galaxies, and detecting the filamentary structure between galaxy clusters through radio observations.

ember 20–21 at the Maritime Institute in Linthicum, MD. The workshop will bring together the gravitational-wave and astrophysics communities with the CST and the Core Team to explore the concepts submitted in response to the RFI, and ultimately to select concepts at three different cost points to go forward for further refinement. The concepts selected will be used to map the trade space available for obtaining science return at various cost points. The workshop is NOT selecting designs to go forward into development or proposal, but only identifying the trade space alternatives. Information and registration for the workshop are also available on the gravitational wave study page of the PCOS website.

PCOS Organization

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The concepts selected at the workshop will be further developed by the core team and CST and then analyzed by Team-X, the concurrent design facility at JPL, in the spring of 2012. These studies will refine the concepts, identify key design drivers and provide preliminary cost assessments for each concept. This information will be used as part of a final report to the CAA for consideration in the summer of 2012. The recommendations from the CAA will subsequently be used to guide detailed development of scientific, technical, and cost information for future US gravitational-wave missions.

News from the Advanced Concepts and Technology Office

Thai Pham, *Chief Technologist*

The Physics of the Cosmos (PCOS) Program Office is happy to announce the release of our inaugural Program Annual Technology Report (PATR)! This report summarizes our annual technology development activities for the fiscal year (FY) 2011. The PATR provides a snapshot status of technology development funded by the Program in FY11, includes the community-derived technology needs as provided by the PhysPAG's Technology Science Analysis Group, and describes the Technology Management Board (TMB) prioritization and investment recommendations.

The recommendations provided in the PATR, along with other inputs, will be referenced by the PCOS Program over the coming year as the calls for technology development proposals are drafted and investment decisions are made. The PATR and this process are intended to improve the transparency and relevance of technology investments, provide the community a voice in the process, ensure open competition for funding, and leverage the technology investments of external organizations by defining a need and a customer.

We appreciate the hard work of the TechSAG and broader PCOS community in developing the matrix of technology needs for this year, and we look forward to working together again next year. Comments from the community are invited at every stage, and

Upcoming Events

January 8, 2012	3rd Meeting of the PhysPAG, Austin, TX http://pcos.gsfc.nasa.gov/physpag.php
January 8-12	American Astronomical Society Meeting, Austin, TX http://aas.org/meetings/aas219
January 20	Fermi Cycle 5 Proposal submission deadline http://fermi.gsfc.nasa.gov/ssc/proposals/
February 13-17	"Astrophysics from Radio to Submillimeter Wavelengths, Planck View and Other Experiments: Temperature and Polarization", Bologna, Italy http://www.iasfbo.inaf.it/events/planck-2012/
February 13-17	Science with a Wide-Field Infrared Telescope in Space and The 16th International Conference on Gravitational Microlensing Pasadena, CA http://www.nasa.gov/mission_pages/GLAST/news/cygnus-cocoon.html
March TBD	Chandra Cycle 14 Proposal submission deadline
March 31- April 3	American Physical Society Meeting, Atlanta, GA http://www.aps.org/meetings/april/index.cfm
May 7-11	Fermi/Swift Joint Conference: Gamma-Ray Bursts 2012, Munich, Germany http://www.mpe.mpg.de/events/GRB2012/
May 21-23	XMM-Newton Science Workshop 2012 "Galaxy Clusters as Giant Cosmic Laboratories", ESAC, Madrid, Spain http://xmm.esac.esa.int/external/xmm_science/workshops/2012_science/

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specific technology needs inputs are requested at the start of each summer to begin the prioritization cycle again. Please download a copy of the PATR from the PCOS website at: <http://pcos.gsfc.nasa.gov/technology/>