NASA Facts

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Goddard Space Flight Center
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Imager for Magnetopause-to-Aurora Global Exploration (IMAGE): Exploring Earth's Inner Magnetosphere

Recent observations of the Sun reveal that it is very active and dynamic star. New findings from an international fleet of space missions indicate that coronal mass ejections, or CME's, which are carried to Earth by the solar wind, cause many of the disturbances in the Earth's magnetosphere. These disturbances, called geomagnetic storms, can produce beautiful auroras as seen in Canada and the Northern United States. These storms can sometimes cause power outages and affect orbiting spacecraft. As our society grows more dependent upon spacecraft-based technology, it is increasingly important for scientists to learn more about such disturbances.

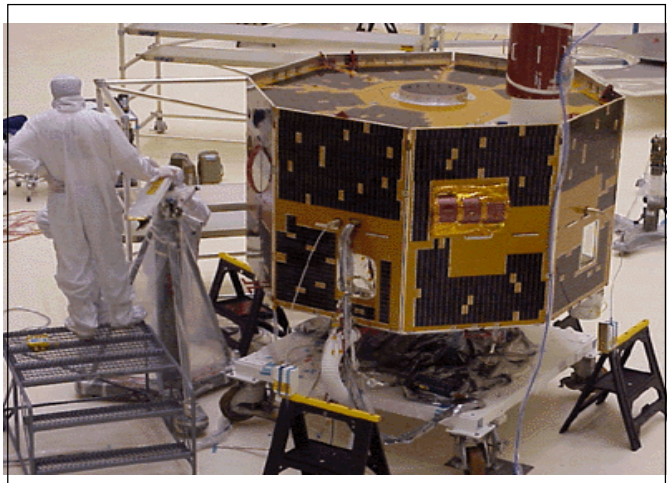


IMAGE spacecraft undergoing integration and testing in the spring of 1999. (Photo coutesy of Lockheed Martin Missiles & Space)

NASA's Imager for Magnetopause-to-Aurora Global Exploration (IMAGE) will allow scientists to study the global response of Earth's magnetosphere to changes in the solar wind during its two-year mission in space. The half-ton satellite, carrying some of the most sophisticated imaging instruments ever flown in near-Earth orbit, will help researchers understand and predict space storms, which can affect space systems, power grids and communications.

IMAGE will use energetic neutral atom imaging, conventional photon imaging, ultraviolet wavelengths and radio sounding to obtain global images of the principal plasma regions and boundaries of Earth's inner magnetosphere.

IMAGE was selected in 1996 as NASA's first Medium-class Explorer Mission (MIDEX) under the Agency's Explorers Program. The goal of NASA's Explorers Program is to accomplish frequent, high-quality space science investigations while reducing mission expense through innovative, streamlined management approaches, control of design, development and operating costs, and use of new technology.

The principal institution for IMAGE is

the Southwest Research Institute (SwRI) of San Antonio, Texas, which has overall responsibility for science, instrumentation, spacecraft and data analysis. The spacecraft was built and the instruments integrated and tested at the Lockheed Martin Missiles and Space Division at Sunneyvale, Calif., under an agreement with SwRI.

IMAGE Scientific Objectives

The IMAGE spacecraft is designed to address three broad science questions. Scientists will use data produced by IMAGE to:

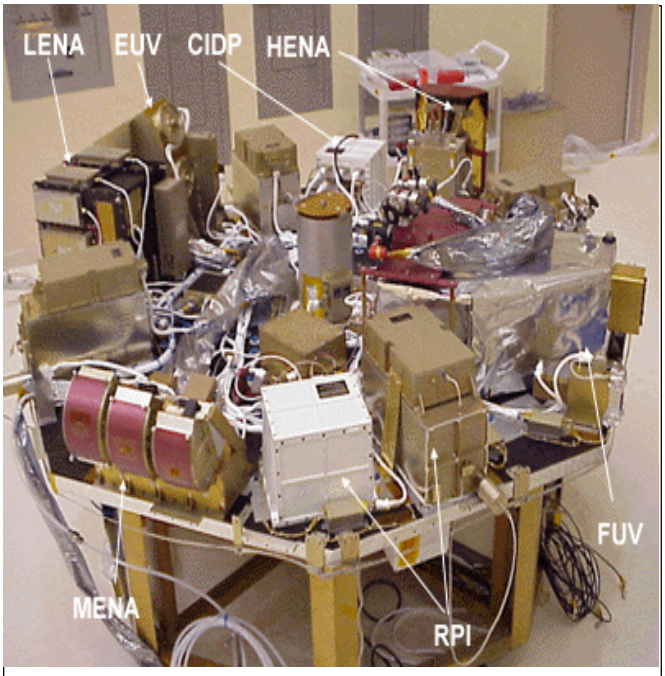
* determine the dominant mechanisms for injecting plasma into the magnetosphere on the time scales of geomagnetic storms and substorms;

* discover the directly driven response of the magnetosphere to changes in the solar wind; and

* decide how and where magnetospheric plasmas are energized, transported and lost during geomagnetic storms and magnetospheric substorms.

Much of the research in this area to date has only produced fragmented and incomplete data, gathered from measurements made by a single spacecraft at single, isolated points in space. Instruments onboard IMAGE will make remote measurements of particle populations within the entire magnetosphere, allowing scientists to view, for the first time, the 'big picture' rather than limited local measurements at far-flung points in space.

The IMAGE mission also coincides with solar maximum, a period of intense solar activity occuring every 11 years. During this period the magnetosphere will frequently be in a highly disturbed, highly dynamic state as a result of buffeting by coronal mass ejections -- eruptions of large amounts of ionized matter from the Sun into space. By observing the geosphere environment under such extreme conditions, IMAGE is expected to yield significant new insights into the geoeffectiveness of interplanetary disturbances and the nature of the magnetosphere's dynamic response.



Photograph of the IMAGE instrument payload. (Photo coutesy of Lockheed Martin Missiles & Space)

NASA will provide real-time data from IMAGE to the National Oceanic and Atmospheric Administration's Space Environment Center, Space Weather Operations (SWO) branch. The SWO is the national and world center for disturbances affecting people and equipment operating in the space environment. The agency will use the data gathered by IMAGE, together with data from other satellites and ground-based observatories to provide forecasts and warnings of solar and geomagnetic activity to government, industry and private sector officials.

Scientific Payload

The IMAGE science payload consists of several different types of imaging instruments and a central instrument data processor.

A suite of three neutral atom imagers, known as LENA, MENA and HENA (for low-, medium- and high-energy neutral atom),

provide energy- and composition-resolved images with a time resolution of typically two minutes. These imagers will detect energetic neutral atoms (ENAs) produced by charge exchange reactions between geocoronal neutral hydrogen and the "hot" plasmas of the ring current and inner plasma sheet. They also will detect ENAs from upward flowing ionospheric ions and ENAs associated with coronal mass ejections.

The far-ultraviolet (FUV) imaging system onboard IMAGE provides narrow-band imaging of far-ultraviolet auroral emissions excited by precipitating protons, wide-band imaging of auroral band emissions from molecular nitrogen and measurements of geocoronal Lyman alpha emissions.

The extreme ultraviolet (EUV) imager images extreme ultraviolet emissions from singly ionized helium in the Earth's plasmasphere, which is the high-altitude extension of the ionosphere consisting of "cold" (low-energy) plasma.

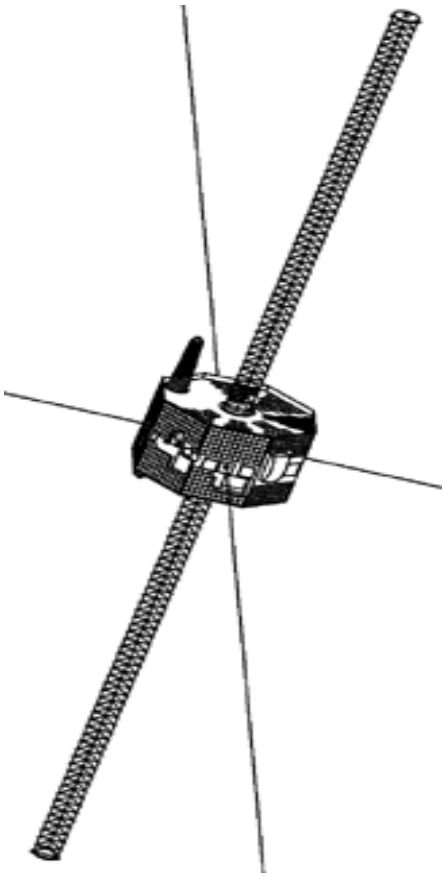
The radio plasma imager (RPI) will use radio signals to "sound" the magnetopause, plasmapause, cusp and ionosphere. And the central instrument data processor (CIDP) acquires, compresses, stores and formats science data from the imagers, monitors the status and health of the spacecraft and interfaces with the spacecraft control unit.

Design Features

The octagon-shaped IMAGE spacecraft is 7.4 feet (2.25 meters) in diameter by 4.9 feet (1.52 meters) high and weighs 1,089 pounds (494 kilograms), including its instrument payload. Arrays of high-efficiency, dual-junction gallium-arsenide solar cells attached to the spacecraft's eight sides and two end panels provide power to the scientific instruments and subsystems. During eclipses, power to the spacecraft will be supplied by a nickel-cadmium battery.

Instruments onboard the IMAGE spacecraft are located on the payload deck. Subsystems for electrical power, communications, command and data handling and attitude determination and control are mounted in four bays below the payload deck. Cutouts in the side panels secure the instrument apertures, deployers for the RPI radial antennas and radiators used for thermal control. When fully extended, the RPI antennas parallel to the spacecraft's spin axis will measure 66 feet (20 meters) tip-to-tip. The RPI's four thin radial antennas, positioned 90 degrees apart, will be deployed in the spin plane. Upon deployment, the opposing beryllium-copper antennas will extend 1,640 feet (500 meters) tip-to-tip, which makes IMAGE 180 feet (55 meters) longer than the height of the Empire State Building.

IMAGE has three antennas for S-band



Line drawing of the IMAGE spacecraft with its RPI antennas fully deployed.

communication with ground stations. Downlink of stored science, engineering and housekeeping data will occur once during each 14.5-hour orbit. Uplink of data will normally occur once a week. IMAGE also will continuously transmit real-time data at 44 kilobits per second.

IMAGE's Open Data Set

An important aspect of the IMAGE program is its open data set. Within 24 hours of data acquisition, images from each instrument and an orbital plot will be available on the Internet. The complete set of science data, along with a full set of data processing and analysis software, will be available online from the National Space Science Data Center at Goddard, granting the space science community equal access to the data.

Launch and Orbit

The IMAGE spacecraft is scheduled for launch March 2, 2000 from Vandenberg AFB, Calif. aboard a Boeing Delta II 7326 launch vehicle. After about 52 minutes in flight, the spacecraft will be inserted into an elliptical orbit about the Earth's poles. The satellite's 14.5-hour polar orbit has a 90 degree inclination with a 621 mile (1,000 kilometer) perigee altitude and a 28,503 mile (45,871 kilometer) apogee.

Polar orbits have the property that the plane of the satellite orbit rotates 30 degrees each month. Over the course of the IMAGE mission, such a rotation will allow the spacecraft to explore a number of geospace regions, providing scientists with further insights into how and why the near-Earth environment changes during solar and geomagnetic storms.

Although good magnetospheric imaging can be performed throughout the two-year mission from an apogee above the North Pole, the movement of apogee in latitude and local time during the mission will provide optimum conditions for certain investigations at different times throughout the day.

Mission Management

Goddard will manage the IMAGE mission for NASA's Office of Space Science, Washington, D.C. The IMAGE management team consists of:
James L. Burch, Principal Investigator, Southwest Research Institute, San Antonio, Texas;
Frank Volpe, Project Manager, Goddard Space Flight Center; and
Thomas E. Moore, Project Scientist, Goddard Space Flight Center.

Education and Public Outreach

IMAGE was the first Space science mission to formally include an education and public outreach program in their proposal to NASA, specifically setting aside a budget for such activities. This outreach function is called the “Public Outreach, Education, Teaching and Reaching Youth,” or POETRY. Dr. Bill Taylor of Goddard is the director of POETRY and Dr. Sten Odenwald of Goddard manages the program. Since 1996, POETRY has provided a wealth of educational resources, along with an award-winning web site, which serves the needs of educators and the community.

To find out more about POETRY, visit their website at:

http://image.gsfc.nasa.gov/poetry/

Mission Web Sites

More information about the IMAGE spacecraft and mission is available on the following web sites:

http://pluto.space.swri.edu/IMAGE/
http://image.gsfc.nasa.gov/