CPS Plasma Page

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IMAGE Spacecraft Takes First Pictures of Plasma Surrounding Earth

Initial pictures from NASA's IMAGE (Imager for Magnetopause to Aurora Global Exploration) spacecraft are revealing for the first time the global ebb and flow of plasma (hot, electrified gas) around the Earth in response to the solar wind. Severe disturbances in this region controlled by the Earth's magnetic field (the magnetosphere) are capable of disrupting satellites, telephone and radio communications, and power systems.

"IMAGE is the first weather satellite for space storms," said Dr. James L. Burch, Principal Investigator for IMAGE at Southwest Research Institute. "This revolutionary spacecraft makes these invisible storms visible. In a sense, IMAGE allows us to view the Earth through plasma-colored glasses. We eagerly anticipate the arrival of severe solar weather associated with solar maximum, which we are now entering."

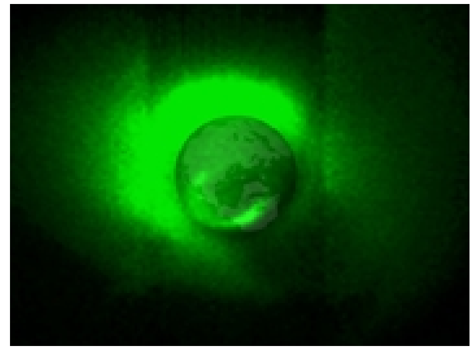
Previous spacecraft explored this turbulent region by detecting particles and fields as they passed through them. This technique limited their vision to small portions of this dynamic region, which extends beyond the Moon on the Earth's night side.

"The old way of tracking magnetic storms is like trying to understand severe thunderstorms in the Midwest by driving around with a rain gauge out the window," said Dr. Thomas Moore, IMAGE Project Scientist at NASA's Goddard Space Flight Center. "With IMAGE, we will see the big picture, just like entire storm systems appear on the evening news with weather satellites."

IMAGE contains a suite of three Neutral Atom Imaging instruments that record the glow of atoms coming from throughout the Earth's magnetic field. This reveals the shape and motion of the clouds of plasma that make up a magnetic storm.

The Far Ultraviolet Imaging instrument is collecting the first-ever images from space of the Earth's proton aurora. Unlike the aurora commonly known as northern or southern lights, caused by electrons striking and lighting up the atmosphere, the proton aurora is invisible to the naked eye. From the ground, it is visible only in far-ultraviolet wavelengths. It has never been viewed from space.

The Extreme Ultraviolet Imager is capturing the first global images of the plasmasphere, which is the tenuous extension of the Earth's electrically charged upper atmosphere, or ionosphere. The plasmasphere extends about 12,500 miles (20,000 kilometers) into space. Images from this region will provide a sensitive indicator of the onset of magnetic storm activity.



Ultraviolet image of the proton aurora during a small space storm

The Radio Plasma Imager instrument provides a three-dimensional view of the plasmasphere by sounding it with radio pulses, like an ultrasound image of the human body. To accomplish this, it uses the longest antennas ever deployed in space, longer than the height of the Empire State Building.

Images and information are available on the internet at: http://image.gsfc.nasa. gov/press_release/2000_05_31

For more information contact: Dr. E.V. Bell, II, edbell@gsfc.nasa.gov

Coalition's K-12 Education Work Supported by Award Recipient

Professor Mark Kushner of the University of Illinois surprised his audience at the IEEE International Conference on Plasma Science (ICOPS) 2000 when he donated the monetary portion of an award he was receiving to the Coalition for Plasma Science (CPS) education outreach efforts.

At the conference banquet Kushner received the Plasma Science and Applications Committee (PSAC) Award for his work in plasma modeling. Upon accepting his plaque and check for $2000, he addressed the room, explaining his belief that educating K-12 students about plasmas is essential for the future welfare of the field. He finished by announcing that to help in that effort he was donating the $2,000 award to the Coalition for Plasma Science to help with their K-12 educational activities.

The Coalition for Plasma Science is devoted to aiding the education of students and the general public about plasmas. The Coalition has produced lively graphic materials to show simply what plasmas are and how they are all around us - a part of nature and a part of many industrial processes people depend upon. CPS is also working on an education web site designed for teachers and by teachers. The site will feature selected plasma-related sites, categorized by topic, and evaluated against the National Science Standards. Teachers will be able to go to this site to discover how teaching about plasmas can fulfill their teaching requirements and fit into their curricula.

For further information contact: Dr. G.L. Rogoff, g.rogoff@ieee.org.

NASA Pursues Plasma Rocket

An agreement to collaborate on developing an advanced rocket technology that could cut in half the time required to reach Mars, opening the solar system to human exploration in the next decade, has been signed by NASA's Johnson Space Center, Houston, TX, and MSE Technology Applications Inc., Butte, MT. The technology could reduce astronauts' total exposure to space radiation and lessen time spent in weightlessness, perhaps minimizing bone and muscle mass loss and circulatory changes.

Called the Variable Specific Impulse Magnetoplasma Rocket (VASIMR), the technology has been under development at Johnson's Advanced Space Propulsion Laboratory. The laboratory director is Franklin Chang-Diaz, a NASA astronaut who holds a doctorate in applied plasma physics and fusion technology from the Massachusetts Institute of Technology, Cambridge. Chang-Diaz, who began working on the plasma rocket in 1979, said, "A precursor to fusion rockets, the VASIMR provides a power-rich, fast-propulsion architecture."

The VASIMR engine consists of three linked magnetic cells. The forward cell handles the main injection of propellant gas and its ionization. The central cell acts as an amplifier to further heat the plasma. The aft cell is a magnetic nozzle, which converts the energy of the fluid into directed flow.

Neutral gas, typically hydrogen, is injected at the forward cell and ionized. The resulting plasma is electromagnetically energized in the central cell by ion cyclotron resonance heating. In this process radio waves give their energy to the plasma, heating it in a manner similar to the way a microwave oven works. After heating, the plasma is magnetically exhausted at the aft cell to provide modulated thrust. The aft cell is a magnetic nozzle, which converts the energy of the plasma into velocity of the jet exhaust. This technology makes it possible to vary, or modulate, the plasma exhaust to maintain optimal propulsive efficiency. This feature is like an automobile's transmission, which adjusts the power of the engine, either for speed when driving on a level highway, or for torque over hilly terrain.

On a mission to Mars, such a rocket would continuously accelerate through the first half of its voyage, then reverse its attitude and slow down during the second half. The flight could take slightly over three months. A conventional chemical mission would take seven to eight months and involve long periods of unpowered drift en route. There are also potential applications for the technology in the commercial sector. A variable-exhaust plasma rocket would enhance the ability to position satellites in Earth’s orbit.

Several new technologies are being developed for the concept, Chang-Diaz said. They include magnets that are superconducting at space temperatures, compact power generation equipment, and compact and robust radio-frequency systems for plasma generation and heating.

Images associated with this release are available on the Internet at: http://spaceflight.nasa.gov/mars/technology/propulsion/aspl/

For further information contact Kelly Humphries, (kelly.o.humphries@jssc.nasa.gov).

General Atomics Organizes Second Internet Physics Olympiad

Members of the plasma physics community have a reputation for creating educational physics outreach programs to make science come alive for students in middle and high school. General Atomics in San Diego, home of the DIII-D plasma fusion experiment, has helped develop an annual Internet Physics Olympiad that allows high school students in the U.S. and Russia to collaborate in real time on physics problems, using streaming video and data links over the internet.

On April 27, 2000 at 7:30 pm PST the second annual Olympiad got underway. High school students from Seattle and San Diego were paired with their counterparts in the Russian cities of Novosibirsk and St. Petersburg. Each team of four Americans and four Russians was encouraged to get to know each other via computer in training sessions and before the games began by exchanging messages, questions and drawings.

When the competition began, teams had only 12 minutes to answer each of six questions. The third question proved too difficult for most teams to answer in the allotted time, and judges had to rule on how to score this, based on whether or not the team was on the right track.

Although the final scores were delayed about a week due to technical problems, the students seemed to feel that winning was secondary to connecting and collaborating with their peers across the sea. A Seattle high school senior is quoted in the Seattle Post Intelligencer Reporter as saying, “There is a lot of teamwork involved, and that’s more important than winning.”

San Diego students were proud to be a part of this event for the second year. High school teacher Dan Lavine noted, “We all had a great time, and all of my students begged me to inflict those problems on their classmates.”

Members of Team 7 from San Diego watch as questions appear on their computer screen during the Physics Olympiad.

Contact: Carol Danielson, danielso@fusion.gat.com

These brief summaries are drawn from several sources and are issued throughout the year. For more information please contact the source given at the end of each article or the editor: rivenberg@psfc.mit.edu; 617/253-8101