CPS Plasma Page

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Fusion in a Pop Can?

Plasma researchers at the Department of Energy's Los Alamos National Laboratory and the U.S. Air Force Research Laboratory in Albuquerque, N.M., are investigating a way to create fusion energy in a cylinder roughly the size of a soda can.

Magnetized Target Fusion (MTF) research shows the potential for producing smaller fusion energy sources at a cost that is far less than current approaches. Laboratory scientists presented the research at a recent American Physical Society - Division of Plasma Physics meeting in Canada.

"The primary benefit of MTF is that it requires simpler, smaller and considerably less expensive experimental systems than either magnetic or inertial fusion," said Los Alamos' Glen Wurden, who leads one of the MTF teams. "It is a qualitatively different approach to fusion with the potential for truly low-cost development. This means that fusion experiments and testing facilities might conceivable be built that cost in the tens of million dollar range, rather than in the billion dollar range."

In a process roughly analogous to that of a diesel engine, which compresses fuel to a state where it burns more readily, MTF uses a magnetized fusion fuel in the form of an electrically neutral, high-temperature ionized gas - plasma - that is preheated before being injected into a soda-can-sized aluminum cylinder.

The cylinder and its contents are then quickly compressed by driving a powerful electrical current through the wall of the cylinder. As the fast-moving solid metal wall compresses the fuel, it burns in a few millionths of a second at pressures that are millions of times greater than that of the Earth's atmosphere.

Within this mass of super-compressed, high-density plasma, scientists hope to produce tiny amounts of fusion energy — the same kind of energy that fuels the sun.

Fusion is a nuclear reaction combining, or fusing, the nuclei of light elements, such as helium, to form heavier elements. On the galactic scale, the fusion process in stars results in the release of huge amounts of energy. On Earth, fusion energy offers a potentially unlimited source of energy, but scientists have so far been unable to create fusion on a small, controllable basis. The MTF experiments could provide the basis for a technology that could change that.

Much of the science behind MTF was developed at Los Alamos long before the current project began and some was perfected through recent collaborations on pulsed power energy between Los Alamos and Russian scientists. Several components of MTF technology have already been tested at Shiva Star, the Air Force's pulsed power facility in Albuquerque, but considerable research lies ahead for Los Alamos scientists as they develop methods to heat and handle the plasma needed for MTF.

MTF is a collaboration between Los Alamos, the U.S. Air Force Research Laboratory and other laboratories with funding provided by the Department of Energy's Office of Fusion Energy Sciences.

For technical information on magnetized target fusion and fusion energy research at Los Alamos, see the Laboratory's web site at: http://fusionenergy.lanl.gov.

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Danielson Receives DOE Distinguished Associate Award

Carol Danielson (above left), CPS Steering Committee Member and Manager of Fusion Publications at General Atomics, was surprised on October 24 when Anne Davies, Associate Director of DOE's Office of Fusion Energy Sciences, presented her with the Department's Distinguished Associate Award. Danielson was attending a luncheon in Quebec City for local teachers taking part in the American Physical Society - Division of Plasma Physics Teachers Day, a day of plasma science training provided during the APS-DPP annual meeting. Danielson's role in structuring this outreach day and many other plasma education activities, including the U.S.-Russian Internet Physics Olympiad (Plasma Page, 9/00), was honored with this award. Signed by Energy Secretary Bill Richardson, the citation reads: "For your critical role in organizing and sustaining national and international education outreach activities as part of the U.S. fusion program." This is the first nontechnical Associates Award presented by DOE, and is the highest honor this agency can give to a civilian.

Danielson reports that some of the recent outreach has had unanticipated surprises. The Russian high school students who took part in this year's Physics Olympiad received their awards from Zhores Alferov, who has since been honored as one of the winners of the Nobel Prize in physics.

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NASA Investigates Plasmas Near and Far

The September Plasma Page reported on NASA's IMAGE spacecraft, which was revealing the ebb and flow of plasmas around the earth. Now NASA is searching for plasmas around Jupiter's moon, Ganymede.

When NASA's Galileo spacecraft zipped past Ganymede on December 28, 2000, the moon was deep inside Jupiter's shadow, giving scientists an excellent chance to examine faint glows that would be overwhelmed by sunlight at other times.

Scientists hope to record faint shimmering auroras on Ganymede, comparable to Earth's Northern Lights.

"The auroral glows we plan to observe occur because Ganymede has a very tenuous atmosphere of gases," said Dr. Torrence Johnson, Galileo project scientist at JPL. "When these gases are hit by electrons from Jupiter's radiation belts, they glow. It's similar to what goes on in a fluorescent light bulb when you turn on the electricity."

Studying Ganymede's auroras could provide information about the chemical makeup of gases in Ganymede's atmosphere and also about Ganymede's unique magnetic field.

When Galileo flew past Ganymede in 1996, instruments on the spacecraft detected plasma waves — a telltale sign of a magnetosphere around the moon. That discovery marked Ganymede as not only the largest moon in our solar system, but also the only one known with its own internally-generated magnetic field.

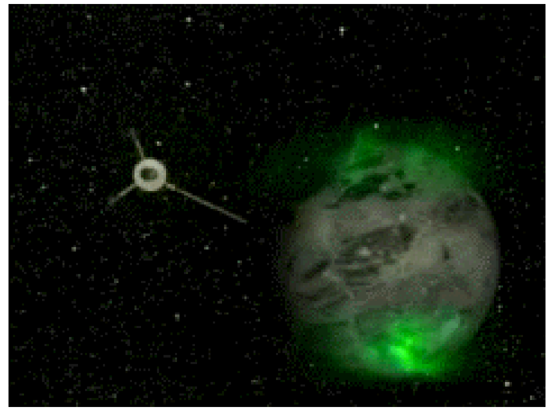
Mapping auroral plasma glows around Ganymede might reveal even more: The paths of electrons approaching Ganymede from Jupiter's radiation belts are determined by lines of magnetic force, explained Johnson, so the location of the glows triggered by those electrons might delineate the shape of Ganymede's magnetic field.

Information and images are available on the internet at: http://spacescience.com/headlines/y2000/ast28dec_1.htm

NASA is also at work observing plasmas closer to home. As the Sun's stormy season approaches its zenith, solar scientists have the best seat in the house, using the largest coordinated fleet of spacecraft and ground observatories ever assembled to observe these angry outbursts of solar radiation and predict the impact of turbulent space weather.

According to scientists from NASA and the National Oceanic and Atmospheric Administration (NOAA), the Sun is near the peak of its 11-year cycle of activity. Solar maximum is the two-to-three year period around that peak when the Sun's activity is most tempestuous and the Earth is buffeted with powerful solar gusts.

"This is a unique solar maximum in history," said Dr. George Withbroe, Science Director for NASA's Sun-Earth Connection Program. "The images and data are beyond the wildest expectations of the astronomers of a generation ago."



This frame from a JPL animation shows what auroras on Ganymede might look like as Galileo swings by the large moon. Credit: NASA TV.

By combining sophisticated new instruments and time-tested older ones, researchers believe their predictions and warnings related to space weather events are becoming more accurate and timely. "The new results from space feed directly into NOAA's plans and programs for forecasting space weather and its effects on Earth and technological systems," said Dr. Ernest Hildner, director of NOAA's Space Environment Center in Boulder, CO.

Information and images are available at http://science.nasa.gov/headlines/y2000/ast22dec_1.htm?list112104.

Plasmas in the New York Times

Two recent New York Times articles demonstrate the varied directions of current plasma research and applications. In "Unlocking Secrets of Magnetic Fields" (Oct. 24, 2000), James Glanz explores the recent renewal of interest in magnetic reconnection, a little understood process that could be used to explain the science of solar flares, and to suggest new ways of controlling and confining hot plasmas in magnetic fusion devices.

Glanz reviews research at the Princeton Plasma Physics Laboratory's Magnetic Reconnection Experiment, which investigates the physics of the phenomenon, and their National Spherical Torus Experiment, which explores its practical application to creating fusion. He does an excellent job of walking the reader through the steps necessary to understand this process, from an introduction to how plasmas follow magnetic field lines, through details of how strong field lines and dense plasmas can become so connected that the field line moves with the plasma. Glanz explains how such a moving field line could "splice" into an adjacent line, resulting in a sudden release of tension that could explain solar flares. Understanding this phenomenon could affect current approaches to magnetic confinement of plasmas in fusion devices.

On the other side of the plasma spectrum, Catherine Greenman writes about "Plasma Televisions: Like Works of Art and Just as Costly" (Dec. 28, 2000). The strength of the article is its clear description of how plasma displays work and why they can get so thin. This elegant thinness, plus screen size and shape, make them perfect for DVD players that can show wide-screen format films. Greenman points out the relative expensiveness of plasma displays, especially those with higher resolutions (768 lines vs 480 lines), while observing that prices have come down in response to buyer demand.