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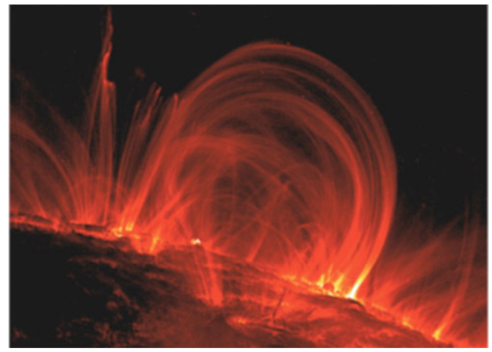
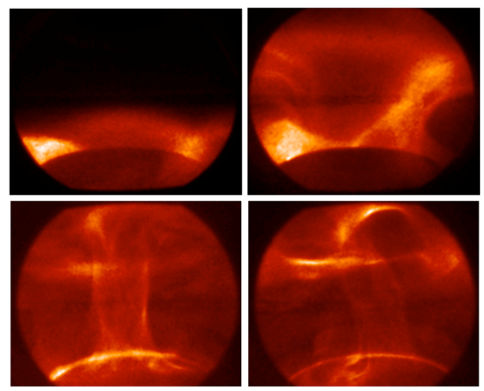
Stellar plasmas shed light on their laboratory cousins.

LIVERMORE, Calif — With a view toward generating electricity from fusion, researchers are conducting experiments to see if plasma dynamos can create magnetic fields strong enough to contain 100 million degree plasmas. Fusion scientists are looking to apply the physics of some of the most beautiful and complex structures observed in the universe to laboratory scale experiments here on earth. The plasmas in Lawrence Livermore's Sustained Spheromak Physics Experiment (SSPX) are much smaller and far shorter-lived than their celestial cousins, but the two varieties, nevertheless, share many of the same properties.

In both cases, fluctuating magnetic fields and plasma flows act as a dynamo to drive electrical currents that keep the ionized hydrogen plasma alive and confined in space. Magnetic fields pass through the flowing plasma and eventually touch one another and reconnect. When a reconnection occurs, it generates more plasma current and changes the direction of the magnetic fields to confine the plasma. This "self-organizing" dynamo is a physical state that the plasma forms naturally.





The physics of SSPX is similar to our sun's: On top, an image of solar coronal loops and flares. Below, a high-speed camera captures four images of plasma forming inside the SSPX Experiment.

"The science of spheromak plasmas is fascinating," says Dave Hill, leader of the Livermore team. "Their physics is essentially the same as the solar corona, interplanetary solar wind, and galactic magnetic fields. However, we still have much to learn about magnetized plasmas. For instance, we do not completely understand how magnetic dynamos work. We know that Earth's magnetic core operates as a dynamo, but scientists are still working hard to model it. Magnetic reconnection, essential for containing and sustaining the plasma, is another phenomena that is not well understood."

This past year the team was able to boost the plasma's electron temperature to over 4 million degrees, a record for spheromaks of this size. "This represents a significant advance for the spheromak concept," according to Hill. "We are now ready to increase the energy with neutral beams to explore the limits of operation and test our theoretical understanding. To help us we also use state of the art computer codes to simulate the spheromak, though the physics is so complex that months of computer time is required to simulate just milliseconds of a single discharge." Much of this complexity derives from magnetic turbulence and its role in sustaining the plasma. "We need some turbulence to maintain the magnetic field, but too much prevents the plasma from getting very hot," says Livermore physicist Harry McLean, who is responsible for energy confinement on SSPX. "It's a complicated balancing act."

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For further information:
http://www.llnl.gov/str/September05/Hill.html
http://www.mfescience.org/sspx/index.html

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During this Meeting:
Poster Session
2:00 PM–5:00 PM, Tuesday, October 25, 2005
(http://meetings.aps.org/Meeting/DPP05/Event/35189)

Invited Talk:
9:30 AM–12:30 PM, Friday, October 28, 2005
Adam's Mark Hotel - Plaza Ballroom EF
[UI2.00002] Transport and fluctuations in high temperature spheromak plasmas
(http://meetings.aps.org/Meeting/DPP05/Event/36146)