SLAC's Pisin Chen

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Research Highlights . . .

DOE Pulse highlights work being done at the Department of Energy's national laboratories. DOE's laboratories house world-class facilities where more than 30,000 scientists and engineers perform cutting-edge research spanning DOE's science, energy, national security and environmental quality missions. *DOE Pulse* (www.ornl.gov/news/pulse/) is distributed every two weeks. For more information, please contact Jeff Sherwood (jeff.sherwood@hq.doe.gov, 202-586-5806).

DOE Pulse

Science and Technology Highlights from the DOE National Laboratories

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DZero measurement another step in Higgs search

The DZero experiment at DOE's Fermilab has made the first measurement of Z+b production in a hadron collider environment, an important first step in looking for the Higgs in this channel. The Higgs boson is the last particle yet to be discovered in the Standard Model. It arises from the Higgs field that is thought to permeate the universe and give mass to all other particles. The Tevatron can search for a Higgs produced in association with a Z boson; observing Z+b production and measuring its rate are crucial. The measurement was done at the Tevatron by comparing the number of events with Z+b to the number of events with a Z and other quarks.

[Davide Castelvecchi, 630-840-3351; castel@fnal.gov]

An inside look at molecular movement

The secret lives of molecules are now less secret. Using the Advanced Light Source at DOE's Lawrence Berkeley National Laboratory, a team of physicists has obtained a clearer snapshot of the simultaneous behavior of all the electrons and nuclei inside a molecule. The team broke apart a deuterium molecule and measured the momenta of its particles, making possible a basic understanding of molecules and the processes they drive, from breathing to rust to photosynthesis. "By learning how particles move, we can probe the basic properties of molecules and how they work," says Thorsten Weber, a visiting scientist in Berkeley's Chemical Sciences Division who conducted the research with several other Berkeley Lab scientists and physicists from Kansas State University and institutions in Australia, Germany, and Spain. Their research is published in the Sept. 24 issue of *Nature*.

[Dan Krotz, 510/486-4019; dakrotz@lbl.gov]

Exploring the history of water on Mars

A team of researchers at DOE's Los Alamos National Laboratory has devised an analytic method for determining whether sulfate salts can account for evidence of water on Mars. The team exposed magnesium sulfate salts to various temperature, pressure and humidity conditions in the laboratory in order to correlate salt hydration states with martian surface conditions. The researchers discovered that the crystalline structure and water content of the salts are dependent on time-humidity history. Researchers theorize that magnesium salts could retain sufficient water to explain at least some of the NASA Odyssey observations, which revealed surprisingly high abundances of near-surface hydrogen on Mars.

[Todd A. Hanson, 505/665-2085; tahanson@lanl.gov]

Antennas go to the head of the class at INEEL

Wireless hotspots are cropping up nearly everywhere—even entire towns are blanketing their neighborhoods with Internet access. But enveloping large swaths of land with umbrella coverage isn't always ideal. Designers may prefer access points to hand out the equivalent of personal raincoats—providing coverage that follows individual users while leaving hackers out in the storm. Engineers at DOE's Idaho National Engineering and Environmental Laboratory are working to do just that, by combining several antenna elements into one "smart antenna" system. Their work will help wireless networks reach farther, juggle more users, navigate tricky environments, avoid electronic interference, and block rogue users.

[Regina Nuzzo, 208/526-3176; nuzzrl@inel.gov]

SLAC's Chen gets a cosmic charge

Pisin Chen

Pisin Chen knows that accelerators are astronomically useful, and he's not exaggerating: He uses the powerful linear accelerator at DOE's Stanford Linear Accelerator Center to study astrophysics and cosmology in a controlled laboratory setting.

SLAC physicist Chen began his career as a theoretical particle physicist with training from the University of California, Los Angeles. He developed original theories about using plasma for particle acceleration and for focusing particle beams, and has made seminal contributions to the physics of beamstrahlung in linear colliders.

Chen migrated to astrophysics and cosmology in the 1990s, when he heard results from the satellite experiment COBE that detected fluctuations in the cosmic microwave background that permeates the universe.

"When I saw that by putting detectors into space our eyesight, so to speak, became instantly clear, without pollution or atmospheric fluctuations, I quickly recognized astrophysics would enjoy a new renaissance and I immediately switched myself into it," he said.

Chen won an international Gravity Research Foundation Prize in 1995 for theoretical work showing additional ways that fluctuations in the cosmic microwave background could occur. He helped found the joint SLAC and Stanford University Kavli Institute for Particle Astrophysics and Cosmology. He leads a SLAC group that does both theoretical and experimental research in this frontier area.

His current experiment, FLASH, attempts to shed light on a crucial discrepancy between two world-leading experiments measuring ultra high energy cosmic rays (UHECRs). As they scream through our atmosphere, UHECRs turn into showers of charged particles that trigger nitrogen atoms in the air to fluoresce. FLASH measured precisely how much fluorescence is generated for each high-energy electron passing through simulated atmospheres in the lab. The experiment also simulated cosmic ray showers in the lab to monitor their development corresponding to different heights in the atmosphere. The results are important for current and future space-based and ground-based UHECR experiments.

***Submitted by DOE's** Stanford Linear Accelerator Center*

UNDER PRESSURE, ZIRCONIUM IS A "GLASS" ACT

Jianzhong Zhang studies zirconium under pressure

In experiments performed at the National Synchrotron Light Source at DOE's Brookhaven National Laboratory and the Advanced Photo Source at Argonne National Laboratory, scientists from Los Alamos National Laboratory have produced a new glass material by squeezing the metal zirconium under very high pressures. This glass may be stronger and more resilient than traditional glasses, and has the potential to be a better material for medical, sports, and electronics products.

This is the first time that this type of glass has been formed from a single element or pure metal. And because of its single-element nature and high stability at extreme temperatures, this zirconium glass has many exciting, potential applications.

Unlike conventional metals and alloys, which are made of tiny crystalline grains and are thus prone to breakage, metallic glasses made from a single element have a uniform, non-granular structure. These "bulk" glasses possess a high resistance to breaking, shattering, and distortion. In this way, bulk metallic glasses behave like a plastic yet are much stronger than other metal materials. These characteristics make them attractive engineering materials.

The scientists created the glass by placing a crystalline sample of pure zirconium in a device that subjected it to extreme conditions – up to 80,000 times atmospheric pressure and 1,300 degrees Fahrenheit. These factors caused the zirconium atoms in the crystal to change their positions and bond to each other differently, producing a different form of zirconium: glass. As opposed to other pressure production methods, which produce microscopic samples, this method creates millimeter-sized samples of bulk glass and can even create inch-sized pieces large enough to be used in industry.

Bulk metallic glasses are being used in an increasing number of practical applications, such as to make electronics components, jewelry, and sports equipment.

***Submitted by DOE's** Brookhaven National Laboratory*