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DOE Pulse

Science and Technology Highlights from the DOE National Laboratories

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Research Highlights . . .

A revolutionary physics discovery

A finding by an astrophysicist at DOE's Oak Ridge National Laboratory is casting doubt on the long-held chemical equilibrium theory and clearing the way for a new field—kinetic chemistry. Weihong Liu and professors at Clemson and Harvard discovered that radioactivity destroys the strong chemical bond that holds carbon and oxygen together. This bond was thought to be virtually unbreakable. Scientists also believed it was impossible to convert cosmic carbon from a gas into a solid if there was more oxygen than carbon present. Conventional theory held that the carbon would be taken up by the oxygen and be transformed into carbon monoxide. Liu's work is published in the Feb. 26 *Science*.

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No hitchhikers allowed

You might think of it as a silent bug zapper—for very tiny bugs. Researchers Bill Jacoby, Pin Ching Maness, Dan Blake and Ed Wolfrum of DOE's National Renewable Energy Laboratory are working under an agreement with NASA on a way to sterilize and clean unmanned space probes by using a titanium dioxide coating on the surfaces of the spacecraft. NASA needs to ensure that no microorganisms from Earth travel to other planets and that no microorganisms from other planets (if there are any) travel here, except in special sample containers. So the space agency must find a way to kill any "bugs" that land on its planetary probes. Titanium dioxide looks promising because, when exposed to light, it can kill microorganisms by breaking down their cellular structures.

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Don't touch that! New shipping containers can identify tampering

Researchers at DOE's Pacific Northwest National Laboratory have created a new container that lets security officials track the safety of its contents during transportation and storage. These "tamper-indicating" containers use electronics, sensors, fiber optics and communications to monitor the condition and activity of contents in real-time. Containers can be designed for specific needs, such as monitoring for pressure, temperature, movement or the removal of contents. Global positioning capabilities also can be added to a container to continually monitor its location. Tamper-indicating containers can be used by the military for transporting missiles; by medical companies transporting organs; or by companies transporting classified documents, to name a few examples.

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NSTX has "first plasma"

On Friday, February 12, the National Spherical Torus Experiment (NSTX) at DOE's Princeton Plasma Physics Laboratory achieved "first plasma," two months ahead of schedule and on budget. This marks the beginning of experimental operations for this new, innovative fusion energy research device. Scientists use of magnetic fields to confine the hot ionized gas, or plasma, with the temperature, pressure, and duration necessary for the production of useful amounts of fusion energy. NSTX will create a plasma that is shaped like a sphere with a hole through its center—"a spherical torus." This configuration has several important advantages which need to be tested experimentally, including the ability to confine a higher plasma pressure for a given magnetic field. Consequently, NSTX could lead to a less expensive path to commercial fusion energy.

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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).

Satellite records millions of lightning strikes for study

Scientists are gaining new insights into the electrodynamic processes surrounding lightning by examining measurements of more than two million individual lightning strokes recorded by a sophisticated radio receiver aboard the FORTE satellite.

FORTE—which stands for Fast On-orbit Recording of Transient Events—was developed jointly by DOE's Los Alamos and Sandia national laboratories.

The lightning measurements recorded by FORTE are sufficiently detailed that the researchers can pick out signals from the separate processes that build to form an atmospheric discharge, providing a new, high-quality tool for deepening understanding of the physical processes governing lightning.

The researchers also are linking FORTE recordings with ground-based measurements from the National Lightning Detection Network and from a network of sensors that measure low-frequency electromagnetic emissions, or "sferics," and changes in the direction of the electric field.

Matching FORTE's readings with others could identify those radio signatures useful for remotely identifying important storm systems, convective cells that spawn tornadoes, for example, or unleash damaging hail.

Launched in August 1997, FORTE began acquiring radio data almost immediately, and kicked into high gear when it unfolded a 30-foot-long antenna that had been stowed in a foot-high canister for launch. The sophisticated radio receiver samples a wide range of radio frequencies at a very high rate, essential since the impulsive radio emissions associated with lightning last less than a thousandth of a second. The receiver can make a recording and reset its trigger almost instantaneously.

FORTE was developed to demonstrate advanced technologies for detecting nuclear weapon detonations and thus help curb nuclear proliferation.

"Lightning is of interest to Los Alamos' national security missions because there is a parallel between the spectrum of lightning emissions and the electromagnetic pulse created by a nuclear weapon detonation," said Los Alamos physicist Abe Jacobson, who heads the FORTE science team.

Submitted by DOE's Los Alamos National Laboratory

Los Alamos and Sandia teamed up to develop the FORTE satellite.

Career has led ORNL researcher over hill and Dale

A college class in ecology taken to fulfill a requirement as an undergraduate mathematics student started Virginia Dale on a trail she's pursued from coast to coast and around the world for two decades.

While ecology examines the relationships between plants, animals and their environments, mathematics enables Dale to express those relationships using equations. And just as there's beauty in nature, there's a certain beauty in mathematics, which Dale uses to solve complex environmental problems.

"For example, we work a lot with trees," said Dale, a senior scientist at DOE's Oak Ridge National Laboratory. "We study effects of natural and manmade disturbances to forests. Since trees live hundreds of years, we have to rely on mathematics and computer simulation models to predict impacts over decades and centuries."

Information gained through computer simulations can help policy makers in their decisions involving land, and land management is what Dale's work is all about. Preserving habitats often requires nothing more than a little thought and planning. For example, computer models of endangered woodpeckers and butterflies show the importance of animal movements, so management efforts to create or maintain paths can help them thrive. These efforts may be as simple as lifting the cutting blade of lawnmowers when they mow areas containing the plants the butterflies eat.

Dale's laboratory is more often than not government land obtained decades ago as buffer for the development of nuclear weapons technology or for military reservations.

"Protected from commercial disturbance and fragmentation over the ensuing five decades, the two million acres of the DOE research parks have evolved into ecological sanctuaries of remarkable size and diversity," Dale said.

In recent years, however, there's been a push to sell this land for residential or industrial development, and Dale is worried that valuable environmental resources and research possibilities will be lost. It's a real problem that will require a long-term ecological perspective and the kind of information that only mathematical ecology can provide.

Submitted by DOE's Oak Ridge National Laboratory