NETL's Stephen Zitney

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Research Highlights . . .

DOE Pulse

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Volcanic rock reveals ancient travel routes

The 890-square-mile site for DOE's Idaho National Laboratory has yielded artifacts dating back to the last Ice Age. Among those artifacts are obsidian tools crafted by Native American hunter-gatherers who inhabited the area over the past 13,000 years. Because the volcanic eruptions that produced the obsidian each had their own unique chemistry, INL archaeologist Clayton Marler can use a method called X-ray fluorescence to trace an artifact to its geological source. Marler has identified obsidian sources ranging from Yellowstone National Park to the California-Nevada border, and the resulting map could help recreate old routes travelled by these roaming tribes.

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Los Alamos observatory fingers cosmic ray 'hot spots'

A Los Alamos National Laboratory cosmic-ray observatory has seen for the first time two hot spots that appear to be bombarding Earth with cosmic rays. The research calls into question our understanding about galactic magnetic fields near our solar system. Los Alamos researchers Brenda Dingus, Gus Sinnis, Gary Walker, Petra Hüntemeyer and John Pretz and an international team published the findings in Physical Review Letters. "The source of cosmic rays has been a 100-year-old problem for astrophysicists," Pretz said. "With the Milagro observatory, we identified two distinct regions with an excess of cosmic rays. This discovery calls into question our understanding of cosmic rays and raises the possibility that an unknown source or magnetic effect near our solar system is responsible."

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Mysterious neutrinos

Stretch out your hand, and a trillion neutrinos cross it within three seconds. Yet very little is known about these invisible particles, which can morph from one type into another. Last Thursday (Dec. 11), the MiniBooNE collaboration at DOE's Fermi National Accelerator Laboratory presented its first, preliminary results on antineutrinos. In April 2007, MiniBooNE had reported an unexpected excess of electron neutrinos emerging from a beam of low-energy muon neutrinos. While theorists pondered what might be behind this result, the collaboration began repeating the experiment with antineutrinos. So far, the experiment sees no evidence for a corresponding electron antineutrino excess, but data are still sparse. The experiment will continue taking antineutrino data until June 2009.

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Tough ceramic mimics mother of pearl

Biomimicry—technological innovation inspired by nature—is one of the hottest ideas in science but has yet to yield many practical advances. Time for a change. Scientists with DOE's Lawrence Berkeley National Laboratory (Berkeley Lab) have mimicked the structure of mother of pearl, the inner lining of the shells of abalone and certain other mollusks, to create what may well be the toughest ceramic ever produced. Through the controlled freezing of suspensions in water of alumina and a well known polymer (PMMA), the scientists, led by Robert Ritchie, produced ceramics that were 300 times tougher than their constituent components.

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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).

Zero sum game for neutrons

A recent study of a "spinning" helium-3 nucleus at DOE's Jefferson Lab revealed that under certain conditions, the entire nucleus behaves much like a single neutron.

Freed from the nucleus of the atom, neutrons naturally disintegrate in about 15 minutes. So physicists have to come up with creative ways to study the neutron's properties.

One solution is to set "spinning" the protons and neutrons inside a nucleus.

In one isotope of helium, helium-3, there are two protons and one neutron. The intrinsic angular momentum, or spin, of the protons in helium-3 will naturally align in opposite directions. Their contributions to the nucleus's spin cancel out, leaving its spin resting almost solely on the neutron.

By then measuring quantities related to spin, researchers can collect information about the neutron's spin and about the nucleus in which it resides.

A team of physicists used this process in an experiment conducted in Jefferson Lab's Hall A. They also gave the spinning neutron some additional energy by pinging it with electrons from the lab's electron-beam accelerator.

Karl Slifer, an assistant professor at the University of New Hampshire, says the researchers then watched how the neutron and nucleus responded.

"What we see is that the neutron enters into a series of excited states," he explains. "We found that each of these states can be very complicated."

A relation called the Burkhardt–Cottingham sum rule predicts that regardless of the complexity of individual excited states, the sum of these states is zero under the conditions in which the experiment was performed.

For this study, researchers specifically addressed changes in the nucleus in which the neutron resides.

"What we found is that even though this is a more complicated situation, and you have more excited states, it still all sums to zero. So the helium-3 nucleus is behaving, at least in this particular situation, very much like the neutron is by itself."

Submitted by DOE's Jefferson Lab

NETL's Zitney Enjoying Lifetime Process of Research, Exploration, and Outreach

NETL researchers and collaborators from Iowa State University conduct a virtual FutureGen power plant simulation.

Dr. Stephen Zitney, the Director of Collaboratory for Process & Dynamic Systems Research at DOE's National Energy Technology Laboratory, is leading efforts to accelerate the development of innovative process systems engineering tools for designing and operating next-generation power plants.

Zitney earned a B.S. in Chemical Engineering at Carnegie Mellon University (CMU), Pittsburgh, Pa., and an M.S. and Ph.D. in Chemical Engineering from the University of Illinois. He began his career in the high-tech computer industry with Cray Research in Minnesota, where he had the privilege to meet with Seymour Cray, the "father of supercomputing." Zitney then ventured into the rapidly growing areas of process simulation and computational fluid dynamics software with AspenTech and Fluent, respectively.

His career has provided opportunities to learn, experience, and explore through travels worldwide, including two years living and working in Cambridge, England. Collecting coins along the way, Zitney continues his long-time numismatics hobby. His family also enjoys traveling, and his children have become collectors, too—of key chains they link together from their world travels.

Mentoring graduate students from CMU and West Virginia University is an important and enjoyable part of his work that has also allowed Zitney to collaborate on research with some of his former chemical engineering professors from CMU in his hometown of Pittsburgh. He finds it rewarding to give back to his alma mater, its students, and research faculty.

Among the many awards Zitney has received for his research are two just this year: NETL's Hugh Guthrie Award for Innovation and Research & Development Magazine's R&D100 Award.

Currently residing in Morgantown, W.Va., Zitney has three children: a son and daughter in high school and a son in music performance, viola, at WVU. When he's not devoting time to his children, he shares his time and talents with his church and others.

Submitted by DOE's National Energy Technology Laboratory