Jefferson Lab's Ross Young

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DOE Pulse

Science and Technology Highlights from the DOE National Laboratories

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New way to spin up pulsars

A team of scientists using supercomputers at DOE's Oak Ridge National Laboratory has discovered the first plausible explanation for a pulsar's spin that fits the observations made by astronomers. According to three-dimensional simulations they performed at the Leadership Computing Facility at ORNL, the spin of a pulsar is determined not by the spin of the original star, but by the shock wave created when the star's massive iron core collapses. That shock wave is inherently unstable, a discovery the team made in 2002. The instability creates two counter-rotating flows. The asymmetrical flows establish a "sloshing" motion that, in the complex 3-D models, accounts for the pulsars observed spin velocities from once every 15 to 300 milliseconds, which is much slower than previous models predicted.

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Plant a tree and save the earth?

In the first study to investigate the combined climate and carbon-cycle effects of large-scale deforestation in a fully interactive three-dimensional climate-carbon model, scientists from DOE's Lawrence Livermore National Laboratory, Carnegie Institution and Université Montpellier II found that global forests actually produce a net warming of the planet. The study provides a holistic view of the deforestation issue. "This is the first comprehensive assessment of the deforestation problem" said Govindasamy Bala, lead author of the research. The models calculated the carbon/climate interactions and took into account the physical climate effect and the partitioning of the carbon dioxide release from deforestation among land, atmosphere and ocean.

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NREL dedicates new Wind to Hydrogen project

DOE's National Renewable Energy Laboratory and Xcel Energy recently dedicated a new demonstration project that will examine system integration issues with the production hydrogen from wind energy and the compression, storage and use of the hydrogen. Two NREL wind turbines will be connected to devices called electrolyzers, which pass the wind-generated electricity through water to split the liquid into hydrogen and oxygen. The hydrogen can be stored and used later to generate electricity from either an internal combustion engine turning a generator or from a fuel cell. NREL and Xcel are each paying part of the $2 million budget for the two-year project.

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NETL develops microreactor for accelerated testing of fuel thermal stability

Researchers on the Defense Fuels Team at DOE's National Energy Technology Laboratory have designed and constructed a microreactor for testing thermal stability of liquid fuel formulations. The research supports the Department of Defense's initiative to develop a single, fully-synthetic, hydrogen-rich fuel capable of powering fuel cells and ground vehicles, aircraft, and ships. The microreactor allows researchers to test fuels under conditions mimicking those encountered over longer periods of time in advanced military aircraft fuel systems. Subsequent analysis of the fuel composition to identify products of oxidation will help determine the ability of the additized fuel to withstand the effects of thermal stress.

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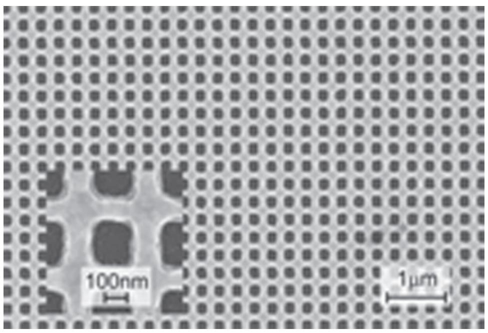
DOE Pulse highlights work being done at the Department of Energy's national laboratories. DOE's laboratories house world-class facilities where more than 30,000 scientists and engineers perform cutting-edge research spanning DOE's science, energy, national security and environmental quality missions. *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).

Metamaterials found to work for visible light

For the first time ever, researchers at the DOE's Ames Laboratory have developed a material with a negative refractive index for visible light. Ames Laboratory senior physicist Costas Soukoulis, working with colleagues in Karlsruhe, Germany, designed a silver-based, mesh-like material that marks the latest advance in the rapidly evolving field of metamaterials, materials that could lead to a wide range of new applications as varied as ultrahigh-resolution imaging systems and cloaking devices.



This micrograph shows the silver-based "fishnet" metamaterial developed by Soukoulis and colleagues at the University of Karlsruhe.

The discovery, detailed in the Jan. 5 issue of Science and the Jan. 1 issue of Optic Letters, marks a significant step forward from existing metamaterials that operate in the microwave or far infrared – but still invisible – regions of the spectrum. Soukoulis' material exhibits a negative refractive index of -0.6 at the red end of the visible spectrum (wavelength 780 nm).

Natural materials refract light, or electromagnetic radiation, to the right of the incident beam at different angles and speeds. Metamaterials, also known as left-handed materials, are exotic, artificially created materials that refract light to the left, or at a negative angle. This backward-bending characteristic provides scientists the ability to control light similar to the way they use semiconductors to control electricity.

The "fishnet" design developed by Soukoulis' group and produced by researchers Stefan Linden and Martin Wegener at the University of Karlsruhe was made by etching an array of holes into layers of silver and magnesium fluoride on a glass substrate. The holes are roughly 100 nanometers wide. For some perspective, a human hair is about 100,000 nanometers in diameter.

While the silver used in the fishnet material offers less resistance when subjected to electromagnetic radiation than the gold used in earlier materials, energy loss is still a major limiting factor. The difficulties in manufacturing materials at such a small scale also limit the attempts to harness light at ever smaller wavelengths.

Submitted by DOE's Ames Laboratory

Prize-winning theoretical physicist loves his Vegemite

Aussie Native Ross Young keeps a stash of Vegemite handy for taming cravings while puzzling through problems in theoretical nuclear physics.

Ross Young, a postdoctoral researcher in the Theory Center at DOE's Jefferson Lab, received the Harold Woolhouse 2005 prize for the best Ph.D. thesis produced in the University of Adelaide's Faculty of Sciences. According to the citation, Young's thesis, titled "Finite-Range Regularisation of Chiral Effective Field Theory," breaks new ground in connecting supercomputer simulations of QCD to Nature.

"Math has always come easily to me, and my particular interest in science and physics was sparked when I was about 10 years old and my granddad, who wasn't a scientist but read a lot, told me about the theory of relativity. I thought that was just so interesting," Young says.

Young was born in Adelaide, Australia, and received his B.S. and Ph.D. in theoretical physics from the University of Adelaide. "I knew early on that I would do theoretical physics, because I'm definitely not an experimentalist. I couldn't take measurements. I couldn't sit there turning knobs. I wanted to know what the theories were," he says.

While working on his Ph.D., Young prepared 23 refereed journal publications, of which three were published in Physical Review Letters. Young arrived at Jefferson Lab in October 2004.

"I love being here, where the work is actually done. I finally am getting to see theory matching up with real work, and I'm finding meaning in all that I'm doing. It's great to be able to talk to people about how it all inter-relates."

With just one more year left in his postdoc, Young is optimistic about the future. "It's time for me to start applying for positions. The only thing I'm sure of is that I want to stay in physics. I'll just keep doing what's comfortable and interesting for me and see where it leads."

Submitted by DOE's Jefferson Lab