Giday WoldeGabriel

Page 2

Research Highlights . . .

DOE Pulse

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A strange superconductor's secrets

Magnesium diboride (MgB2) is a rare bird, a high-temperature superconductor—at 39 degrees K—that's not a copper oxide. In hundreds of papers published since its superconductivity was discovered less than two years ago, researchers have reported anomalous and sometimes contradictory measurements of the layered metal, including multiple superconducting energy gaps. Writing in *Nature,* theorists Steven Louie and Marvin Cohen of DOE's Berkeley Lab's Materials Sciences Division reveal MgB2's secrets. A first-principles analysis based on Bardeen-Cooper-Schrieffer theory shows a bizarrely contorted Fermi surface and double sources of superconducting electron pairs, one from weak pi bonds, another from unfilled sigma bonds.

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Double duty to secure borders

Within seconds, a new portable instrument developed at DOE's Pacific Northwest National Laboratory can identify high-value metals, such as "dual-use" materials commonly found in industry but also required for production of nuclear weapons. Called the Dual-Use Analyzer, the system enables a border inspector or other field agent to immediately identify cargo and differentiate between metals of similar appearance, eliminating the need for costly off-site analysis. The analyzer determines the electrical conductivity of the metal, then compares this signal "signature" against a built-in library of nuclear dual-use and high-value metal signatures. The system also identifies varying metals that may have been "co-mingled" to avoid detection.

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Quality quantified

Tiny bonds between microchips and their circuits can now be tested quickly and precisely thanks to a product developed by scientists at DOE's Idaho National Engineering and Environmental Laboratory in collaboration with Simpex Technologies, The Johns Hopkins University and the National Institute of Standards & Technology. The Micro Laser Ultrasonic Bond Detection System uses a pulsed laser to generate waves in bond surfaces. The waves travel outward where a detector laser measures them, and computer software calculates a quality index value. The R&D 100 award-winning invention promises to increase reliability and manufacturing efficiency of electronics—including those used in weaponry, space and medicine—while cutting costs.

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Understanding beryllium's toxicity

Researchers at DOE's Los Alamos National Laboratory are seeking to better understand the pathology of Chronic Beryllium Disease. Beryllium is a silver-gray, nonradioactive metal that is extremely light and stable, but toxic to certain individuals. Laboratory researchers are studying the fundamental properties of metal interaction with carboxylate molecules, carbon/oxygen structures that are common in the body, to better understand how metals, specifically beryllium in water solution, might attack human cells. Beryllium is widely used in manufacturing for satellite guidance systems, spacecraft, optical instruments, nuclear reactors and golf clubs.

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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).

Oak Ridge datapipe: Fast as the *Wind*

The new computer link between DOE's Oak Ridge National Laboratory and Atlanta is 200,000 times faster than the fastest dial-up connections typical of home computers and is expected to spur significant advances in science and economic development in the region and beyond.

Ray Orbach, director of the DOE's Office of Science, symbolically completed the connection linking the laboratory's supercomputer to Southern Crossroads universities and other premier schools around the country. The link will connect DOE's ESnet computer network with Internet2, the network of top-tier universities, at speeds up to 20 times faster than the previous ORNL connection. With the new link, a data file the size of the film *Gone With the Wind* could be transmitted in a mere six seconds.

"This new high-speed network strengthens the partnership between DOE and the academic community, which is critical to our plans to reassert U.S. leadership in computational sciences," said ORNL's Thomas Zacharia, associate lab director for the Computing and Computational Sciences Directorate.

The network of fiber optic cables, which run from ORNL through Chattanooga to Georgia Tech in Atlanta, also will enhance the ORNL-Chattanooga technology corridor by positioning the region for new research and development opportunities. The benefits are likely to extend far beyond the ORNL-Chattanooga technology corridor and Georgia.

The connection to Southern Crossroads universities will allow for vastly increased flow of information between ORNL researchers and collaborators at Internet2 institutions. Southern Crossroads members include the universities of Tennessee, Georgia, Alabama, South Carolina and Kentucky and Florida State, Vanderbilt, and Emory universities along with Georgia Tech, the site of the 10 gigabit (10 billion bits per second) connection. The high-speed link is provided by Qwest Communications International, which also supplies the backbone for ESnet and Internet2.

With the link to ORNL's Cheetah, a 4.5 teraflop IBM machine recently listed No. 8 in the Top500 list of fastest computers in the world, researchers from leading universities and national laboratories will have access to incredible amounts of data that will help them in their studies of astrophysics, biology, chemistry, climate modeling, materials and fusion. Researchers will be able to acquire data through ORNL's Center for Computational Sciences in a matter of seconds.

"The network forms a test bed that will serve as the basis for network research and development that will carry DOE's computational mission forward for the next five to 10 years," Zacharia said. "Soon, we will need to transport petabyte-size files and this network and the research it enables will be crucial."

For example, John Drake, an ORNL senior researcher, noted the immediate impact the high-speed connection will have in ocean science studies and a $20 million SciDAC climate study.

"This enables our collaborators at Scripps Institution of Oceanography, the National Center for Atmospheric Research and Los Alamos National Laboratory to receive very large data files containing new analyses of the ocean's influence on future climates," Drake said. "With that information readily available, researchers will be able to perform studies more quickly and they will be able to develop more sophisticated models."

Submitted by DOE's Oak Ridge National Laboratory

Los Alamos' Giday WoldeGabriel: A life well lived

Giday WoldeGabriel

The life of Los Alamos National Laboratory scientist Giday WoldeGabriel is one that many have envied, but few can match. Beyond his principal role in such endeavors as the Yucca Mountain Project, WoldeGabriel has been a key player in some of biological anthropology's most significant discoveries, providing geological and paleoenvironmental contexts for the remains of Homo erectus, a precursor of modern man that lived more than a million years ago.

WoldeGabriel, a geologist in the DOE laboratory's Earth and Environmental Sciences Division, also serves as the lead geologist on the Middle Awash Project, a group that in the last 10 years has discovered the remains of about half of the known early hominid species - fossils ranging in age from 250,000 years to 6-million-years old.

WoldeGabriel's geological expertise in this area is invaluable. Using sediment layers of interbedded volcanic ash that contain the fossils, WoldeGabriel has been able to assess the geological history of the remains.

Born in the Tigray region of Ethiopia, WoldeGabriel's road to success has been challenging. Government instability, revolution, and war kept many of his fellow students from finishing the education WoldeGabriel eventually obtained.

Yet there were fortunate moments. While a lecturer at Addis Ababa University, he provided geological information to early Middle Awash Project expeditions and the team of the scientists who discovered the 3.2-million-year-old human ancestor known as "Lucy." Eventually James Aronson, one of the geologists who determined Lucy's age, asked if WoldeGabriel would be interested in coming to the United States to pursue his doctoral degree.

In January 1983 WoldeGabriel began a doctoral program with Aronson at Case Western Reserve University. Subsequent field trips to the American Southwest forged a lifelong interest in the volcanic geology of Northern New Mexico and set the course for a career and a life well lived in Los Alamos.

Submitted by DOE's Los Alamos National Laboratory