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DOE Pulse

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Livermore scientists team with Russia to discover element 118

Scientists from DOE's Lawrence Livermore National Laboratory, in collaboration with researchers from the Joint Institute for Nuclear Research in Russia, have discovered the newest superheavy element, element 118. In experiments conducted at the JINR U400 cyclotron between February and June 2005, the researchers observed atomic decay patterns, or chains, that establish the existence of element 118. The experiment produced three atoms of element 118 when calcium ions bombarded a californium target. The team then observed the alpha decay from element 118 to element 116 and then to element 114. The Livermore-Dubna team had created the same isotope of element 116 in earlier experiments. This discovery brings the total to five new elements for the Livermore-Dubna collaboration (113, 114, 115, 116 and 118).

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A ruler of gold and DNA

Scientists from DOE's Berkeley Lab and the University of California at Berkeley have developed a ruler made of gold nanoparticles and DNA that can measure the smallest of life's phenomena, such as precisely where on a DNA strand a protein attaches itself. The molecular ruler offers label-free and real-time measurement of a range of protein-DNA interactions at an extremely high resolution. As such, it promises to play a key role in the current push in biology to understand how genetic information flows from DNA to RNA to gene expression. Today, scientists involved in this research typically examine the final products of this chain of events by cataloging the expression levels of various genes and proteins.

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INL, industry form advanced nuclear design center

DOE's Idaho National Laboratory is joining forces with international engineering firm Burns & Roe and nuclear fuels analysis software leader Studsvik Scandpower to establish the Center for Nuclear Systems Design and Analysis (CNSDA) at INL. Part of INL's Center for Advanced Energy Studies, CNSDA scientists will use cutting edge technology to develop advanced nuclear fuel cycle and reactor concepts and designs.

Initial goals are to integrate digital design technology, reactor, and nuclear system simulations with advanced virtual reality software, allowing development and inspection of new facilities in VR before they are built physically.

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Pulsed Field Facility commissions 100-tesla magnet

Scientists and engineers at the DOE's Los Alamos National Laboratory recently commissioned the 100 Tesla Multi-shot Magnet for user operations at the National High Magnetic Field Laboratory's Pulsed Field Facility at Los Alamos. The achievement is the culmination of ten years of instrument development and construction, jointly supported by DOE's Office of Basic Energy Sciences and the National Science Foundation's 100 Tesla Multi-Shot magnet program. As part of the NHMFL's science user program, scientists and engineers from academia, government, and industry will now have access on a competitive basis to fields in excess of 85 tesla--the highest pulsed magnetic fields ever produced non-destructively.

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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).

Exotic relatives of protons and neutrons

Scientists of the CDF collaboration at DOE's Fermi National Accelerator Laboratory have discovered two rare types of particles, exotic relatives of the much more common proton and neutron.

"These particles, named Sigma-sub-b [Σ_b], are like rare jewels that we mined out of our data," said Jacobo Konigsberg, University of Florida, a spokesperson for the CDF collaboration. "Piece by piece, we are developing a better picture of how matter is built out of quarks. We learn more about the subatomic forces that hold quarks together and tear them apart. Our discovery helps complete the 'periodic table of baryons.'"

Baryons (derived from the Greek word "barys", meaning "heavy") are particles that contain three quarks, the most fundamental building blocks of matter. The CDF collaboration discovered two types of Sigma-sub-b particles, each one about six times heavier than a proton.

There are six different types of quarks: up, down, strange, charm, bottom and top (u, d, s, c, b and t). The two types of baryons discovered by the CDF experiment are made of two up quarks and one bottom quark (u-u-b), and two down quarks and a bottom quark (d-d-b). For comparison, protons are u-u-d combinations, while neutrons are d-d-u.

Utilizing Fermilab's Tevatron collider, physicists can recreate the conditions present in the early formation of the universe, reproducing the exotic matter that was abundant in the moments after the big bang. While the matter around us is composed of only up and down quarks, exotic matter contains other quarks as well. The new particles discovered by CDF are extremely short-lived and decay within a tiny fraction of a second.

The Tevatron collider at Fermilab accelerates protons and antiprotons close to the speed of light and makes them collide. In the collisions, energy transforms into mass, according to Einstein's famous equation $E=mc^2$. To beat the low odds of producing bottom quarks—which in turn transform into the Sigma-sub-b according to the laws of quantum physics—scientists take advantage of the billions of collisions produced by the Tevatron each second.

"It's amazing that scientists can build a particle accelerator that produces this many collisions, and equally amazing that the CDF collaboration was able to develop a particle detector that can measure them all," said CDF cospokesperson Rob Roser, of Fermilab. "We are confident that our data hold the secret to even more discoveries that we will find with time."

Submitted by DOE's Fermi National Accelerator Laboratory

Sandia's Jerry Simmons helps lead way to new form of lighting

Jerry Simmons looks at several items that are lighted by LEDs.

A revolution is under way. And no, it's not in some small African nation.

Instead, it's in the way the world will soon light houses, office buildings and schools.

Predicts Sandia National Laboratories researcher Jerry Simmons, "By the year 2025, all incandescent light bulbs will be in museums, with solid state lighting [SSL] being the main light source."

Simmons has been a champion of SSL and semiconductor-based light-emitting diodes (LEDs) ever since he became manager of the SSL program at the DOE laboratory. He worked on two-dimensional electron physics in the Semiconductor Material and Device Sciences group for 10 years after joining Sandia in 1990 with a new Princeton University Ph.D. in electrical engineering.

After being tapped as manager of the same group in 2000, his first job was to write an in-house Grand Challenge funding proposal for improving LEDs through Sandia's Laboratory Directed Research and Development (LDRD) program.

He discovered his passion.

"I had to learn fast," Simmons says. "But the idea of SSL got me really excited."

Over the past six years, his enthusiasm led Sandia to become a worldwide leader in LEDs development. He even traveled with Sen. Jeff Bingaman, D-N.M. to Japan and Taiwan to learn about those countries' LEDs research.

Most recently he led a team that wrote the winning proposal for a DOE virtual Center for Solid State Lighting Research and Development.

The center will be headquartered at Sandia and will receive about $2.6 million of the total funding for research. Other national laboratories that received money and will be participating in the initiative are Oak Ridge and Los Alamos.

"I see this center as a bridge between fundamental discoveries at DOE Nanoscale Science Research Centers and companies that will take these ideas and make them into useable products."

Submitted by DOE's Sandia National Laboratories