DOE Pulse

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Research Highlights . . .

BaBar finds new massive particle

The BaBar experiment at DOE's Stanford Linear Accelerator Center recently discovered a new massive particle with curious behavior. For the moment the particle has been named Y(4260), reflecting the measured mass of 4260 Mega-electron volts but the unknown nature of the state. BaBar physicists have established the particle's quantum numbers—which define a particle's intrinsic properties such as spin and charge. However, they have yet to learn which combinations of quarks and gluons—the universe's indivisible bricks and mortar—make up the particle. Its quantum numbers make it likely to be a member of the psi meson family, yet mysteriously, the particle doesn't decay the way other psi mesons do.

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Storage tank cleaner gets specific

Cleaning the inside of a storage tank or other vessel presents challenges, especially when the vessel has areas of contamination. Inventors at DOE's Savannah River National Laboratory have developed and patented the Directed Spray Mast to overcome many of those challenges, accessing the interior of the vessel through a port just a few inches in diameter to precisely clean contaminated areas. A typical sprayer is able to spray the entire inside of a vessel. When contamination is only present in specific areas, however, global spraying is not needed, and results in unnecessary quantities of waste liquid. "The water sprayed in the tank becomes a waste product," says Tom Nance, one of the inventors, "so there is a real need to minimize the amount of liquid used for cleaning."

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Mirrors focus X-ray, neutron beams

Precision mirrors to focus X-rays and neutron beams could speed the path to new materials and perhaps help explain why computers, cell phones and satellites go on the blink. In the last few years, a team of researchers at DOE's Oak Ridge and Argonne national laboratories has improved by a factor of nearly 10 the performance of mirrors that enable researchers to examine variations in structure and chemistry and even individual nanoparticles. Information at this fine level is essential to understanding composition and structure of materials, and researchers continue to push the boundaries. With recent advances in the optics and manufacturing processes, the team has obtained a resolution of 70 nanometers. The ultimate goal is 1 nanometer.

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Z-pinch boosts fusion outlook

The refinement of the Z-pinch in fusion research at DOE's Sandia National Laboratories has led to an increase in the number of wires in a pinch, which increased the output radiation pulse from 15 to 40 terawatts. The improvement puts Z-pinches on track for far higher outputs and has improved them from a tool of somewhat abstract investigation into a possible source of power from controlled nuclear fusion. Sandia's Tom Sanford recently shared the European Physical Society's Hannes Alfven Prize this year for this transformational research. He shared the prize with Malcolm Haines, former director of London's Imperial College Plasma Physics Department, and Valentin Smirnov, director of the Institute of Nuclear Fusion at the Kurchatov Institute in Moscow.

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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).

New technology could fuel biorefinery growth

Researchers at DOE's Argonne National Laboratory and Archer Daniels Midland Co. (ADM) are developing a separative bioreactor that efficiently turns sugar from corn into valuable chemicals. The technology could help bio-based chemicals replace large amounts of petrochemicals, helping reduce U.S. dependence on foreign oil, benefiting rural economies and reducing greenhouse gas emissions.

The two-year joint research effort will evaluate and optimize the production of gluconic acid using the separative bioreactor. Eventually, the technology could extend beyond gluconic acid to the production of a variety of organic acids and polyols, which form the chemical building blocks for plastics, pharmaceuticals and other consumer products.

Gluconic acid is produced by the biochemical oxidation of glucose, a sugar found in corn starch. This reaction, facilitated by enzymes in fermentation broths, has been known for more than 100 years. The challenge is one of engineering – how to process gluconic acid cheaply and cleanly enough to compete economically with petrochemicals.

The separative bioreactor could overcome technical and economic barriers to the production of gluconic acid, said Seth Snyder, the principal investigator at Argonne.

Argonne researchers have learned how to immobilize the enzyme that turns glucose into gluconic acid, and they have merged that capability with a separation process called electrodeionization, which uses electricity to remove even low concentrations of ions from a solution. Argonne researchers developed and patented an improved EDI resin wafer stack that won a 2002 R&D 100 Award. Funding for the stack research, which efficiently removes salt from high fructose corn syrup, was provided by DOE's Industrial Technology program.

Inside the separative bioreactor, enzymes convert a steady stream of glucose into gluconic acid. The gluconic acid ionizes and is immediately separated from the glucose solution by the EDI process.

The EDI separation eliminates a major problem in large-scale gluconic acid production – the incompatibility of the enzyme and the product acid. The Argonne separative bioreactor operates continuously, using only electricity to separate the product. Snyder said the cost of the electricity is “very, very small. It's well within our goals for the overall bioprocessing cost.”

In the test-scale systems at Argonne , the process has been demonstrated effectively at speeds of about a gallon of glucose solution a day. A commercial-scale reactor would be several times larger, and hundreds of units would be stacked together to achieve industrial-scale output.

***Submitted by** Argonne National Laboratory*

Carol Jantzen: Focused on the Long Term

Carol Jantzen

Dr. Carol Jantzen’s professional interests have always seemed to focus on things that last a long time. Her first paying job – as a child, the then-named Carol Fredericks helped her father collect and assemble rocks and minerals for educational kits – led her into university studies in geochemistry and subsequently into materials science and engineering. Today, the Savannah River National Laboratory scientist and internationally recognized expert in glass and ceramics conducts research and development to ensure that the materials used for disposing of high-level radioactive waste will last for thousands of years.

Dr. Jantzen came to DOE's SRNL in the 1980s as part of the laboratory team developing the processes to be used in the Savannah River Site’s Defense Waste Processing Facility, the nation’s first facility for converting high-level radioactive waste (HLW) into a stable glass form for permanent disposal, which began operation in 1994. Her contributions – including the development of the statistical process control models for the process – helped ensure a real solution for the decades-old problem of nuclear waste disposal. She has developed waste forms for a wide variety of high-level radioactive wastes and hazardous/mixed and low-level wastes in both the U.S. and Europe. Recently, she developed a new glass durability model that has the potential to increase the “waste loading,” or the amount of waste that can be incorporated into a HLW glass.

At this fall’s Materials Science & Technology conference, she will receive the Bleininger Award, recognizing excellence and lifelong achievements in the field of ceramics.

As the first female president of the American Ceramic Society in 100 years, she helped found the society’s Student Mentor Program and is committed to the encouragement of students and future ceramics professionals.

Her ongoing work in developing solutions to important waste management challenges, combined with that dedication to future scientists, will ensure that her influence is felt for a very long time.

***Submitted by** Savannah River National Laboratory*