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Fusion Closer to Reality as Scientists Smash Density Limit by Factor of 10

Nuclear fusion promises a virtually limitless, sustainable energy source via processes similar to those powering the Sun, provided some rather tricky and fundamental physics problems can be figured out first.

There are a variety of methods currently being investigated for squeezing energy out of atoms, each with its pros and cons. New research suggests we may soon have a way of overcoming a major obstacle in processes that use donut-shaped tunnels known as tokamaks.

A previously theorized barrier to tokamak fusion known as the Greenwald limit has now been smashed by a factor of ten, thanks to the efforts of a team of researchers from the University of Wisconsin.

"Questions remain about why, specifically, MST is able to operate with high Greenwald fraction, and to what extent this capability could be extended to higher-performance devices," write the researchers.

The research has been published in *Physical Review Letters*.

https://www.sciencealert.com/fusion-closer-to-reality-as-scientists-smash-density-limit-by-factor-of-10

Paper cut physics pinpoints the most hazardous types of paper

Any way you slice it, a paper cut is painful.

Magazines, letters and books harbor a devious potential for minor self-induced agony. But other types of paper — like thin tissue paper or the thicker stuff used for postcards — are less likely to offend. Scientists have now explained the physics behind why some paper is more prone to shred fingers.

In experiments with a gelatin replica of human tissue, researchers found that a thin sheet of paper tended to buckle before it could cut. Thick paper typically indented the material but didn't pierce it: Like a dull knife blade, it didn't concentrate force into a small enough area. A thickness of around 65 micrometers was a paper cut sweet spot — or sore spot — physicist Kaare Jensen and colleagues report in a paper to appear in *Physical Review E.*

Future work will study more realistic, finger-shaped materials, rather than flat sheets of gelatin, says Jensen, of the Technical University of Denmark in Kongens Lyngby. "Ideally you would want some test subjects, but it's hard to find volunteers."

https://www.sciencenews.org/article/paper-cut-physics

Nuclear physicists question origin of radioactive beryllium in the solar system

Scientists have determined that a rare element found in some of the oldest solids in the solar system, such as meteorites, and previously thought to have been forged in supernova explosions, actually predate such cosmic events, challenging long-held theories about its origin.

Scientists at the Department of Energy's Oak Ridge National Laboratory led studies of the radioactive isotope beryllium-10, which existed when the solar system came into being some 4.5 to 5 billion years ago. They probed whether this isotope can be formed in sufficient quantities during the massive explosions of gigantic stars in their death throes, called supernovae.

"It is unlikely that such a stellar explosion is the main source for this isotope, as it is observed in the early solar system," said Raphael Hix, an ORNL nuclear astrophysicist who participated in the study published in the journal *Physical Review C*. The findings "help us to understand the history of the solar system and the galaxy as a whole.„

https://phys.org/news/2024-07-nuclear-physicists-radioactive-beryllium-solar.html

Microscopy breakthrough promises better imaging for sensitive materials

An international team of scientists, led by Trinity College Dublin, has devised an innovative imaging method using state-of-the-art microscopes that significantly reduces the time and radiation required. Their work represents a significant breakthrough that will benefit several disciplines, from materials science to medicine, as the method promises to deliver improved imaging for sensitive materials such as biological tissues that are especially vulnerable to damage. Dr. Lewys Jones, Ussher Assistant Professor in Trinity College Dublin's School of Physics, Royal Society-Science Foundation Ireland University Research Fellow, and Investigator in AMBER, the SFI Center for Advanced Materials and Bioengineering Research, led the team behind the research article that has been published in *Science*.

He said, "Combining two already state-of-the-art technologies in such an exciting way delivers a real leap in the microscope's capabilities. Giving microscopists the ability to 'blank' or 'shutter' the electron beam on and off in a matter of nanoseconds in response to real-time events has never been done before.

https://phys.org/news/2024-08-microscopy-breakthrough-imaging-sensitive-materials.html

Can quantum particles mimic gravitational waves?

When two black holes collide, space and time shake and energy spreads out like ripples in a pond. These gravitational waves, predicted by Einstein in 1916, were observed for the first time by the Laser Interferometer Gravitational-Wave Observatory (LIGO) telescope in September 2015.

Observing gravitational waves is an unfathomably complicated feat of engineering: to detect a gravitational wave the size of the solar system, one must measure changes in length smaller than the diameter of an atomic nucleus.

But now, researchers from the Okinawa Institute for Science and Technology (OIST), the University of Tohoku and the University of Tokyo have proposed a method for simulating gravitational waves on the laboratory bench through the quantum condensate of cold atoms.

The scientists are all current or previous members of the Theory of Quantum Matter Unit at OIST, and their findings have now been published in the journal *Physical Review B*, where the paper was selected as the Editor's choice.

https://phys.org/news/2024-08-quantum-particles-mimic-gravitational.html

Physicists use light to probe deeper into the 'invisible' energy states of molecules

A new optical phenomenon has been demonstrated by an international team of scientists led by physicists at the University of Bath, with significant potential impact on pharmaceutical science, security, forensics, environmental science, art conservation and medicine.

The research is published in the journal *Nature Photonics*.

Molecules rotate and vibrate in very specific ways. When light shines on them it bounces and scatters. For every million light particles (photons), a single one changes color. This change is the Raman effect. Collecting many of these color-changing photons paints a picture of the energy states of molecules and identifies them.

Yet some molecular features (energy states) are invisible to the Raman effect. To reveal them and paint a more complete picture, "hyper-Raman" is needed.

https://phys.org/news/2024-07-physicists-probe-deeper-invisible-energy.html

Experiment uses quantum techniques to stimulate photons, enhancing search for dark matter

Scientists cannot observe dark matter directly, so to "see" it, they look for signals that it has interacted with other matter by creating a visible photon. However, signals from dark matter are incredibly weak. If scientists can make a particle detector more receptive to these signals, they can increase the likelihood of discovery and decrease the time to get there. One way to do this is to stimulate the emission of photons.

Scientists at the U.S. Department of Energy's Fermi National Accelerator Laboratory and University of Chicago reported the ability to enhance the signals from dark matter waves by a factor of 2.78 using novel quantum techniques. This technology demonstrates how advances in quantum information science can be applied, not only to quantum computing applications, but also to new physics discoveries.

This exciting result was made possible by the DOE's Quantum Information Science Enabled Discovery program, and the Heising-Simons Foundation. University of Chicago graduate student Ankur Agrawal conducted this research for his doctoral thesis supervised by Fermilab scientist Aaron Chou in collaboration with members of Professor David Schuster's group at the University of Chicago. The results were recently published in *Physical Review Letters*.

https://phys.org/news/2024-08-quantum-techniques-photons-dark.html

Thank you!

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