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Laser light made into a supersolid for the first time

A small international team of nanotechnologists, engineers and physicists has developed a way to force laser light into becoming a supersolid. Their paper is published in the journal *Nature*. The editors at *Nature* have published a Research Briefing in the same issue summarizing the work.

Supersolids are entities that exist only in the quantum world, and, up until now, they have all been made using atoms. Prior research has shown that they have zero viscosity and are formed in crystal-like structures similar to the way atoms are arranged in salt crystals.

Because of their nature, supersolids have been created in extremely cold environments where the quantum effects can be seen. Notably, one of the team members on this new effort was part of the team that demonstrated more than a decade ago that light could become a fluid under the right set of circumstances.

To create their supersolid, the researchers fired a laser at a piece of gallium arsenide that had been shaped with special ridges. As the light struck the ridges, interactions between it and the material resulted in the formation of polaritons—a kind of hybrid particle—which were constrained by the ridges in a predesigned way. Doing so forced the polaritons into forming themselves into a supersolid.

https://phys.org/news/2025-03-laser-supersolid.html

Physicists find unexpected crystals of electrons in new ultrathin material

MIT physicists report the unexpected discovery of electrons forming crystalline structures in a material only billionths of a meter thick. The work adds to a gold mine of discoveries originating from the material, which the same team discovered only about three years ago.

In a paper published Jan. 22 in *Nature*, the team describes how electrons in devices made, in part, of the new material can become solid, or form crystals, by changing the voltage applied to the devices when they are kept at a temperature similar to that of outer space. Under the same conditions, they also showed the emergence of two new electronic states that add to work they reported last year showing that electrons can split into fractions of themselves.

The physicists were able to make the discoveries thanks to new custom-made filters for better insulation of the equipment involved in the work. These allowed them to cool their devices to a temperature an order of magnitude colder than they achieved for the earlier results.

The team also observed all of these phenomena using two slightly different "versions" of the new material, one composed of five layers of atomically thin carbon; the other composed of four layers.

https://phys.org/news/2025-02-physicists-unexpected-crystals-electrons-ultrathin.html

How Schrödinger's cat could help improve quantum computers

Quantum computers could be made with fewer overall components, thanks to technology inspired by Schrödinger's cat. A team of researchers from Amazon Web Services has used "bosonic cat qubits," to improve the ability of quantum computers to correct errors. The demonstration of quantum error correction requiring reduced hardware overheads is reported in a paper published in *Nature*.

The system uses so-called cat qubits (qubits are the quantum equivalent to classical computing bits), which are designed to be resistant against certain types of noise and errors that might disrupt the output of quantum systems. This approach requires fewer overall components to achieve quantum error correction than other designs.

Quantum computers are prone to errors, which limits their potential to exceed the capabilities of classical computers at certain tasks. Quantum error correction is a method that helps reduce errors by spreading information over multiple qubits, allowing the identification and correction of errors without corrupting the computation. However, most approaches to quantum error correction typically rely on a large number of additional qubits to provide sufficient protection against errors, potentially leading to an overall decrease in efficiency.

Researcher Harald Putterman and colleagues explore a potentially more efficient way to implement quantum error correction using a type of qubit called a bosonic cat qubit. These cat qubits are intrinsically—at the hardware level—highly resistant to one type of error (called a bit flip) at the expense of being more likely to experience another kind (called a phase flip).

https://phys.org/news/2025-02-schrdinger-cat-quantum.html

A completely new type of microscopy based on quantum sensors

Researchers at the Technical University of Munich (TUM) have invented an entirely new field of microscopy called nuclear spin microscopy. The team can visualize magnetic signals of nuclear magnetic resonance with a microscope. Quantum sensors convert the signals into light, enabling extremely high-resolution optical imaging.

Magnetic resonance imaging (MRI) scanners are known for their ability to look deep into the human body and create images of organs and tissues. The new method, published in the journal *Nature Communications*, extends this technique to the realm of microscopic detail.

"The quantum sensors used make it possible to convert magnetic resonance signals into optical signals. These signals are captured by a camera and displayed as images," explains Dominik Bucher, Professor of Quantum Sensing and researcher at the Cluster of Excellence Munich Center for Quantum Science and Technology (MCQST).

Diamond chip acts as a quantum sensor

The resolution of the new MRI microscope reaches ten-millionths of a meter—that is so fine that even the structures of individual cells can be made visible in the future. At the heart of the new microscope is a tiny diamond chip.

https://phys.org/news/2025-02-microscopy-based-quantum-sensors.html

Scientists map the forces acting inside a proton

Scientists have now mapped the forces acting inside a proton, showing in unprecedented detail how quarks—the tiny particles within—respond when hit by high-energy photons.

The international team includes experts from the University of Adelaide who are exploring the structure of sub-atomic matter to try and provide further insight into the forces that underpin the natural world.

"We have used a powerful computational technique called lattice quantum chromodynamics to map the forces acting inside a proton," said Associate Professor Ross Young, Associate Head of Learning and Teaching, School of Physics, Chemistry and Earth Sciences, who is part of the team.

"This approach breaks down space and time into a fine grid, allowing us to simulate how the strong force—the fundamental interaction that binds quarks into protons and neutrons—varies across different regions inside the proton."

The team's result is possibly the smallest-ever force field map of nature ever generated. They have published their findings in the journal *Physical Review Letters*.

https://phys.org/news/2025-02-scientists-proton.html

Static electricity depends on materials' contact history, physicists show

For centuries, static electricity has been the subject of intrigue and scientific investigation. Now, researchers from the Waitukaitis group at the Institute of Science and Technology Austria (ISTA) have uncovered a vital clue to this enduring mystery: the contact history of materials controls how they exchange charge.

The findings, published in *Nature*, explain the prevailing unpredictability of contact electrification, unveiling order from what has long been considered chaos.

From a tiny electric jolt when touching a doorknob to styrofoam peanuts that cling to a mischievous cat's fur—the well-known and seemingly simple phenomenon of static electricity has puzzled people since antiquity. How could this ubiquitous effect, frequently demonstrated to bedazzled children by rubbing a balloon on their hair, still not be completely understood by scientists?

Static electricity goes by multiple names, but scientists prefer to call it "contact electrification." As opposed to what the name "static electricity" might imply, the essence of the effect is not static but includes movement, as some charge is transferred whenever two electrically neutral materials touch.

https://phys.org/news/2025-02-static-electricity-materials-contact-history.html

3.5 kilometers underwater, scientists found a staggeringly energetic particle from outer space

Three and a half kilometers beneath the Mediterranean Sea, around 80km off the coast of Sicily, lies half of a very unusual telescope called KM3NeT.

The enormous device is still under construction, but today the telescope's scientific team announced they have already detected a particle from outer space with a staggering amount of energy.

In fact, as the team report in *Nature*, they found the most energetic neutrino anyone has ever seen—and it represents a tremendous leap forward in exploring the uncharted waters of the extreme universe.

To explain why it's such a remarkable discovery, we need to understand what KM3NeT is, what it's looking for, and what it saw.

KM3NeT is a gigantic deep sea telescope being built by an international collaboration of more than 300 scientists and engineers from 21 countries.

At the site off Sicily, and another off the coast of Provence in France, KM3NeT will be made up of more than 6,000 light detectors hanging in the pitch-black depths. When the telescope is complete, it will cover about a cubic kilometer of sea.

https://phys.org/news/2025-02-kilometers-underwater-scientists-staggeringly-energetic.html

Thank you

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