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Physicists Finally Capture Mysterious Wigner Crystal After 90 Years

Electrons are marvelous little things. They often hang about orbiting atomic nuclei, but they don't have to – the Universe is full of loose electrons rattling about. Ninety years ago, theoretical physicist Eugene Wigner proposed that they didn't have to rattle about, either: that free electrons may be forced together in a peculiar kind of matter that has no atoms at all, just electrons trapped by their own repulsion a neat, crystalline lattice. This is known as a Wigner crystal, and physicists have finally obtained direct observational evidence that it can exist.

"Electrons, even when frozen into a Wigner crystal, should exhibit strong zero-point motion. It turns out this quantum motion covers a third of the distance between them, making the Wigner crystal a novel quantum crystal." The findings have been published in ***Nature***.

https://www.sciencealert.com/physicists-finally-capture-mysterious-wigner-crystal-after-90-years

CERN Physicists Zero In On Hypothetical Magnetic Monopoles

American theoretical physicist Joseph Polchinski once said the existence of magnetic monopoles is 'one of the safest bets that one can make about physics not yet seen.' In its quest for these particles, which have a magnetic charge and are predicted by several theories that extend the Standard Model, the MoEDAL (Monopole and Exotics Detector at the LHC) Collaboration has not yet proven Polchinski right, but its latest findings mark a significant stride forward. The new results narrow the search window for these hypothetical particles. In the first of its latest studies, the MoEDAL physicists sought monopoles and high-electric-charge objects (HECOs) produced via the Drell-Yan and photon-fusion mechanisms. In their second study, the MoEDAL scientists concentrated on the search for monopoles produced via the Schwinger mechanism in heavy-ion collision data taken during Run 1 of the LHC. Once again, the team found no monopoles, but it set the strongest-to-date mass limits on Schwinger monopoles with a charge between 2gD and 45gD, ruling out the existence of monopoles with masses of up to 80 GeV.

https://www.sci.news/physics/magnetic-monopoles-12891.html

Scientists Have Created a Functional Brain Cell Based on a Mix of Salt And Water

For the first time, researchers have simulated neurological junctions called synapses using the same water and salt ingredients the brain uses, contributing to an emerging field that combines biology with electronics called iontronics. Called an iontronic memristor, the device 'remembers' how much electrical charge has previously flowed through it, bringing us closer to generating artificial systems capable of mimicking the superpowers of the human brain.

The hope is that by following the blueprint provided by the brain so faithfully, rather than relying on traditional electrical processes and components, we'll be able to get close to the capacity and the efficiency of the brain with our own computers.

For the researchers, it's also a powerful example of how theoretical and experimental physics can be combined to break new scientific ground – giving the team a 'wow' factor moment when the artificial synapse was created.

The research has been published in *PNAS*.

https://www.sciencealert.com/scientists-have-created-a-functional-brain-cell-based-on-a-mix-of-salt-and-water

Physicists Can Finally Explain How Sand in an Hourglass Can Suddenly Stop Flowing

"The tendency of flowing granular matter to get 'jammed' and stop flowing at low densities is a practical problem that limits the flow rate in the industrial use of granular materials," Onuttom Narayan of the University of California, and Harsh Mathur at Case Western Reserve University in Ohio, explain in their published paper.. For their simulations, Narayan and Mathur used numerical data other researchers had collected from studying packs of frictionless polystyrene beads in the lab. The pair compared their simulations of beads nearing the jamming point with predictions of a branch of mathematics developed in the 1950s called random matrix theory.

"That the same model is able to reproduce both the static and vibrational properties of granular matter suggests it may be more broadly applicable to provide a unified understanding of the physics of granular matter," Narayan and Mathur conclude.

The study has been published in *European Physical Journal E*.

https://www.sciencealert.com/physicists-can-finally-explain-how-sand-in-an-hourglass-can-suddenly-stop-flowing

A shade closer to more efficient organic photovoltaics

Over the last five years, non-fullerene acceptors have produced heterojunction-based devices with record-breaking efficiencies, nearing the 20% mark. However, researchers recently suggested that single-component films of the non-fullerene acceptor Y6 could generate charges without the need for a heterojunction when exposed to sunlight.

Inspired by this finding, the team led by Derya Baran and postdoc Anirudh Sharma investigated charge generation in other non-fullerene acceptors. Similar to Y6, the acceptors, which strongly absorb near-infrared light, produced charges without a donor–acceptor interface. They did so because the exciton split spontaneously, which surprised the researchers. The findings are published in the journal *Advanced Materials*. Solar modules based on semitransparent devices resulted in 5.3% efficiency and 82% visible transmittance, indicating their high degree of transparency.

"We are now investigating next-generation non-fullerene acceptors at a fundamental level to understand their photophysics and how charge transport layers impact the overall performance of homo-junction devices," Sharma says.

https://phys.org/news/2024-04-closer-efficient-photovoltaics.html

Light Waves Brought to a Stop in a Crystal Promises New Ways to Control Photons

Light can be brought to a halt in a few different ways, such as by cooling clouds of atoms or even braiding light waves together. This new method, from AMOLF and Delft University of Technology in the Netherlands, has advantages that could bring new technological applications to reality.

"This principle offers a new approach to slow down light fields and thereby enhance their strength," says physicist Ewold Verhagen of AMOLF. "Realizing this on a chip is particularly important for many applications."

The team's work was based on manipulating electrons using two-dimensional materials such as graphene. In a conducting material, electrons can move freely, zooming along like a tiny highway. However, applying a magnetic field can restrict movement of the electrons to certain energies, known as Landau levels.

"If we can confine light at the nanoscale and bring it to a halt like this, its strength will be enhanced tremendously. And not only at one location, but over the entire crystal surface. Such light concentration is very important in nanophotonic devices, for example for the development of efficient lasers or quantum light sources."

The team's research has been published in *Nature Photonics*.

https://www.sciencealert.com/light-waves-brought-to-a-stop-in-a-crystal-promises-new-ways-to-control-photons

How light can vaporize water without the need for heat

In a series of painstakingly precise experiments, a team of researchers at MIT has demonstrated that heat isn't alone in causing water to evaporate. Light, striking the water's surface where air and water meet, can break water molecules away and float them into the air, causing evaporation in the absence of any source of heat.

The astonishing new discovery could have a wide range of significant implications. It could help explain mysterious measurements over the years of how sunlight affects clouds, and therefore affect calculations of the effects of climate change on cloud cover and precipitation. It could also lead to new ways of designing industrial processes such as solar-powered desalination or drying of materials.

The findings, and the many different lines of evidence that demonstrate the reality of the phenomenon and the details of how it works, are described today in the *Proceedings of the National Academy of Sciences.*

The new work builds on research reported last year, which described this new "photomolecular effect" but only under very specialized conditions: on the surface of specially prepared hydrogels soaked with water.

https://phys.org/news/2024-04-vaporize.html

Thank you!

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