SCIENCE FLASH NEWS

No. 5/2025
May

A new super material could lead to more powerful, energy-saving electronics

A research team led by physicists Ming Yi and Emilia Morosan from Rice University has developed a new material with unique electronic properties that could enable more powerful and energy-efficient electronic devices.

The material, known as a Kramers nodal line metal, was produced by introducing a small amount of indium into a layered compound based on tantalum and sulfur. The addition of indium changes the symmetry of the crystal structure, and the result promotes the novel physical properties associated with the Kramers nodal line behavior. The research, published in *Nature Communications*, represents a step toward low-energy-loss electronics and paves the way for more sustainable technologies.

"Our work provides a clear path for discovering and designing new quantum materials with desirable properties for future electronics," said Yi, associate professor of physics and astronomy.

The researchers discovered that when they added tiny amounts of indium to tantalum disulfide (TaS_2), the material's underlying crystalline symmetry changed, leading to a uniquely protected pattern where electrons that spin up and spin down follow different pathways in momentum space, much like cars going in opposite directions on a highway. This happens until the two paths merge at the Kramers nodal line.

https://phys.org/news/2025-05-super-material-powerful-energy-electronics.html

Record-breaking performance in data security achieved with quantum mechanics

A joint team of researchers led by scientists at King Abdullah University of Science and Technology (KAUST) and King Abdulaziz City for Science and Technology (KACST) has reported the fastest quantum random number generator (QRNG) to date based on international benchmarks. The QRNG, which passed the required randomness tests of the National Institute of Standards and Technology, could produce random numbers at a rate nearly a thousand times faster than other QRNG.

"This is a significant leap for any industry that depends on strong data security," said KAUST Professor Boon Ooi, who led the study, which is published in *Optics Express*. KAUST Professor Osman Bakr also contributed to the study.

Random number generators are critical for industries that depend on security, such as health, finance, and defense. But the random number generators currently used are vulnerable because of an intrinsic flaw in their design.

"Most random number generators are 'pseudorandom number generators.' In other words, they seem random, but in reality, they are complicated algorithms that can be solved. QRNGs do not suffer from this concern," explained Ooi.

The reason is that QRNG uses the principles of quantum mechanics to produce a truly unpredictable random number. The high random number generation rate reported in the new study was the result of innovations made by the scientists in the fabrication and the post-processing algorithms of the device.

https://phys.org/news/2025-05-quantum-mechanics.html

First-of-its-kind measurement may help physicists learn about gluons, which hold together nuclei in atoms

A team of physicists has embarked on a journey where few others have gone: into the glue that binds atomic nuclei. The resultant measurement, which was extracted from experimental data taken at the U.S. Department of Energy's Thomas Jefferson National Accelerator Facility, is the first of its kind and will help physicists image particles called gluons.

The paper revealing the results is published and featured as an editor's suggestion in *Physical Review Letters*.

Gluons mediate the strong force that "glues" together quarks, another type of subatomic particle, to form the protons and neutrons situated at the center of atoms of ordinary matter. While previous measurements have allowed researchers to learn about the distribution of gluons in solitary protons or neutrons, they know less about how gluons behave inside protons or neutrons bound in nuclei.

"This result represents a big step forward in learning about where that gluon field is located in a proton," said Axel Schmidt, an assistant professor of physics at George Washington University and a principal investigator of this work. "We see evidence that it might be changing when a proton or neutron is inside a nucleus."

https://phys.org/news/2025-05-kind-physicists-gluons-nuclei-atoms.html

A newly discovered type of superconductor is also a magnet

Magnets and superconductors go together like oil and water—or so scientists have thought. But a new finding by MIT physicists is challenging this century-old assumption.

In a paper appearing in the journal *Nature*, the physicists report that they have discovered a "chiral superconductor"—a material that conducts electricity without resistance, and also, paradoxically, is intrinsically magnetic. What's more, they observed this exotic superconductivity in a surprisingly ordinary material: graphite, the primary material in pencil lead.

Graphite is made from many layers of graphene—atomically thin, lattice-like sheets of carbon atoms—that are stacked together and can easily flake off when pressure is applied, as when pressing down to write on a piece of paper. A single flake of graphite can contain several million sheets of graphene, which are normally stacked such that every other layer aligns. But every so often, graphite contains tiny pockets where graphene is stacked in a different pattern, resembling a staircase of offset layers.

The MIT team has found that when four or five sheets of graphene are stacked in this "rhombohedral" configuration, the resulting structure can exhibit exceptional electronic properties that are not seen in graphite as a whole.

https://phys.org/news/2025-05-newly-superconductor-magnet.html

Photon manipulation near absolute zero: New record for processing individual light particles

Scientists at Paderborn University have made a further step forward in the field of quantum research: for the first time ever, they have demonstrated a cryogenic circuit (i.e. one that operates in extremely cold conditions) that allows light quanta—also known as photons—to be controlled more quickly than ever before.

Specifically, these scientists have discovered a way of using circuits to actively manipulate light pulses made up of individual photons. This milestone could substantially contribute to developing modern technologies in quantum information science, communication and simulation. The results have now been published in the journal *Optica*.

Photons, the smallest units of light, are vital for processing quantum information. This often requires measuring a photon's state in real time and using this information to actively control the luminous flux—a method known as a "feedforward operation."

However, thus far this has butted up against technical limitations: light was measured, processed and controlled at a delay, limiting its use for complex applications. With their new method, these scientists have managed to significantly reduce the delay—to less than a quarter of a billionth of a second.

https://phys.org/news/2025-05-photon-absolute-individual-particles.html

Structure of liquid carbon measured for the first time

With the declared aim of measuring matter under extreme pressure, an international research collaboration headed by the University of Rostock and the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) used the high-performance laser DIPOLE 100-X at the European XFEL for the first time in 2023. With spectacular results: In this initial experiment they managed to study liquid carbon—an unprecedented achievement as the researchers report in the journal *Nature*.

Liquid carbon can be found, for example, in the interior of planets and plays an important role in future technologies like nuclear fusion. To date, however, only very little was known about carbon in its liquid form because in this state it was practically impossible to study in the lab: Under normal pressure, carbon does not melt but immediately changes into a gaseous state.

Only under extreme pressure and at temperatures of approximately 4,500 degrees Celsius—the highest melting point of any material—does carbon become liquid. No container would withstand that.

Laser compression, on the other hand, can turn solid carbon into liquid for fractions of a second. And the challenge was to use these fractions of a second to take measurements. In a previously unimaginable way, this has now become reality at the European XFEL, the world's largest X-ray laser with its ultrashort pulses, in Schenefeld, near Hamburg.

https://phys.org/news/2025-05-liquid-carbon.html

Physicists determine how to cut onions with fewer tears

A team of physicists, biologists and engineers at Cornell University, in the U.S., has discovered some of the factors that lead to more or less spray when cutting onions and found a couple of ways to reduce the amount of eye irritation. The group has published a paper describing their study on the *arXiv* preprint server.

Prior research has shown that eye irritation when cutting onions is caused by the release of syn-propanethial-S-oxide into the air along with other juices in the onion. For this new study, the team in New York wanted to know what factors led to more or less of the juices being spewed into the air during slicing.

To find out, the research team outfitted a special guillotine that could be fitted with different types of blades. They also coated onion chunks with paint to allow for better viewing of the cutting process. They used the guillotine to cut samples, each of which was recorded. Trials varied knife size, sharpness and cutting speed. They even used an electron microscope to accurately measure the knives before use.

The videos revealed that the differences in the amount of spray released, and thus the amount of eye irritation, were due to the sharpness of the knife and the speed at which it cut the onion. The sharper the knife, and slower the cut, the less spray. This was because duller knives tended to push down on the onion, forcing its layers to bend inward—as the cut ensued, the layers sprang back, forcing juice out into the air.

https://phys.org/news/2025-05-physicists-onions.html

Thank you

Edited by

Adrian-Sorin Gruia, Ph.D