SCIENCE FLASH NEWS

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Ultra-high speed camera for molecules: Attosecond spectroscopy captures electron transfer dynamics

In nature, photosynthesis powers plants and bacteria; within solar panels, photovoltaics transform light into electric energy. These processes are driven by electronic motion and imply charge transfer at the molecular level. The redistribution of electronic density in molecules after they absorb light is an ultrafast phenomenon of great importance involving quantum effects and molecular dynamics.

In a study published in *Nature Chemistry*, researchers at Politecnico di Milano, Madrid Institute for Advanced Studies in Nanoscience (IMDEA Nanociencia), Autonomous University and Complutense University of Madrid unveil new insights into the ultrafast dynamics of molecular systems using attosecond extreme-ultraviolet pulses.

This pioneering work offers a fresh perspective on the complex interplay between electrons and nuclei in donor-acceptor molecules, significantly advancing our understanding of chemical processes at the most fundamental level.

https://phys.org/news/2024-09-ultra-high-camera-molecules-attosecond.html

Discovering new energy levels in atomic hyperfine structures

Since the late 1960s, the Laboratoire Aimé Cotton (LAC) in Orsay, France, has made significant progress in the classification of complex atomic spectra. These advances have been driven both by the development of Fourier transform spectroscopy, and through novel theoretical interpretations of atomic spectra.

In research published in *The European Physical Journal D*, Sophie Kröger from the Berlin University of Technology and Economics carried out detailed analysis of protactinium's infrared (IR) spectrum, revealing 20 new energy levels that were previously undetectable with earlier methods employed by the LAC. The study showcases important progress in the precision of atomic spectrum measurements, which could soon offer deeper insights into atomic structures and interactions.

https://phys.org/news/2024-09-energy-atomic-hyperfine.html

Were Bohr and von Neumann really in conflict over quantum measurements?

Analysis suggests that the two pioneers of quantum mechanics, Niels Bohr and John von Neumann, may have had more similar views than previously thought regarding the nature of quantum systems, and the classical apparatus used to measure them.

In the early years of quantum theory, two foundational thinkers developed independent ideas about how measurements of quantum systems should be interpreted.

While Bohr suggested that these measurements require a clear distinction between the quantum system being measured and the classical apparatus performing the measurement, von Neumann argued that quantum mechanics should apply to everything, including the measurement apparatus.

Since these interpretations emerged, quantum theorists have widely viewed them as being in conflict with each other. Yet through new analysis published in *The European Physical Journal H*, Federico Laudisa at the University of Trento suggests that Bohr and von Neumann's views are far closer than currently thought.

https://phys.org/news/2024-09-bohr-von-neumann-conflict-quantum.html

Energy transmission in quantum field theory requires information: Research finds surprisingly simple relationship

An international team of researchers has found a surprisingly simple relationship between the rates of energy and information transmission across an interface connecting two quantum field theories. Their work was published in *Physical Review Letters* on August 30.

The interface between different quantum field theories is an important concept that arises in a variety of problems in particle physics and condensed matter physics. However, it has been difficult to calculate the transmission rates of energy and information across interfaces.

Hirosi Ooguri, Professor at the Kavli Institute for the Physics and Mathematics of the Universe (Kavli IPMU, WPI) at the University of Tokyo and Fred Kavli, Professor at the California Institute of Technology, together with collaborators, showed that for theories in two dimensions with scale invariance there are simple and universal inequalities between three quantities.

https://phys.org/news/2024-09-energy-transmission-quantum-field-theory.html

Discovery of a new phase of matter in 2D defies normal statistical mechanics

Physicists from the Cavendish Laboratory in Cambridge have created the first two-dimensional version of the Bose glass, a novel phase of matter that challenges statistical mechanics. The details of the study have been published in *Nature.*

As the name suggests, the Bose glass has some glassy properties and within it all particles are localized. This means that each particle in the system sticks to itself, not mixing with its neighbors. If coffee was localized, then when stirring milk into the coffee, the intricate pattern of black and white stripes would remain forever, instead of washing out to an average.

To create this new phase of matter, the group overlapped several laser beams to create a quasiperiodic pattern, a pattern that is long-range ordered like a conventional crystal, but not periodic, meaning that, like a Penrose tiling, it never repeats. When filling the resulting structure with ultracold atoms, cooled to nanokelvin temperatures—close to absolute zero, the atoms formed the Bose glass.

https://phys.org/news/2024-09-discovery-phase-2d-defies-statistical.html

Smartphone-based microscope rapidly reconstructs 3D holograms

Holographic microscopes digitally reconstruct holograms to extract detailed 3D information about a sample, enabling precise measurements of the sample's surface and internal structures. However, existing digital holographic microscopes typically require complex optical systems and a personal computer for calculations, making them difficult to transport or use outdoors.

"Our digital holographic microscope uses a simple optical system created with a 3D printer and a calculation system based on a smartphone," said research team leader Yuki Nagahama from the Tokyo University of Agriculture and Technology. "This makes it inexpensive, portable and useful for a variety of applications and settings."

In the journal *Applied Optics,* the researchers demonstrate the smartphone-based digital holographic microscope's ability to capture, reconstruct and display holograms in almost real time. The user can even use a pinch gesture on the smartphone screen to zoom in on the reconstructed hologram image.

https://phys.org/news/2024-09-smartphone-based-microscope-rapidly-reconstructs.html

Supercomputer simulations provide new insights into calcium-48's controversial nuclear magnetic excitation

Nuclear physicists at the Department of Energy's Oak Ridge National Laboratory recently used Frontier, the world's most powerful supercomputer, to calculate the magnetic properties of calcium-48's atomic nucleus. Their findings, published in the journal *Physical Review Letters*, will not only provide a better understanding of how magnetism manifests inside other nuclei but will also help to resolve a decade-old disagreement between experiments that drew different conclusions about calcium-48's magnetic behavior. Additionally, the research could provide new insights into the subatomic interactions that happen inside supernovae.

"The calcium-48 nucleus has an excited state that decays quickly because it has strong magnetic interactions and one of the highest transition strengths," said Gaute Hagen, a computational physicist at ORNL. "We're very interested in the rules that govern how nuclei are made. Simulating the fundamental forces inside calcium-48 will help us better understand how it's created and perhaps also give us some insight into what other nuclei could exist."

https://phys.org/news/2024-09-supercomputer-simulations-insights-calcium-controversial.html

Thank you!

Edited by

Adrian-Sorin Gruia, Ph.D