

SCIENCE FLASH NEWS

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Atomic spins set quantum fluid in motion: Experimental realization of the Einstein–de Haas effect

The Einstein–de Haas effect, which links the spin of electrons to macroscopic rotation, has now been demonstrated in a quantum fluid by researchers at Science Tokyo. The team observed this effect in a Bose–Einstein condensate of europium atoms, showing that a change in magnetization causes the coherent transfer of angular momentum from atomic spins to fluid motion, thereby experimentally demonstrating that angular momentum is conserved at the quantum level.

In 1915, physicists Einstein and Wander de Haas conducted an experiment demonstrating that the angular momentum contained in the spin of electrons could be transferred into the mechanical rotation of an object upon a change in its magnetization. This effect, known as the Einstein–de Haas effect, illustrates the conservation of total angular momentum, where the sum of spin and mechanical rotation must remain constant.

A new experiment conducted by researchers at the Institute of Science Tokyo (Science Tokyo), Japan, has now observed this effect in a quantum fluid—specifically, in a Bose–Einstein condensate (BEC) made from a dilute gas of europium atoms. A BEC is a state of matter formed when a dilute gas of integer-spin atoms is cooled to near absolute zero, causing a macroscopic number of particles to occupy the same motional ground state and behave collectively as a single quantum fluid.

The study, published in *Science* on January 22, 2026, was led by Professor Mikio Kozuma and Assistant Professor Yuki Miyazawa, in collaboration with Professor Yuki Kawaguchi.

<https://phys.org/news/2026-01-atomic-quantum-fluid-motion-experimental.html>

Science Flash News

Chip-sized optical amplifier can intensify light 100-fold with minimal energy

Light does a lot of work in the modern world, enabling all types of information technology, from TVs to satellites to fiber-optic cables that carry the internet across oceans. Stanford physicists recently found a way to make that light work even harder with an optical amplifier that requires low amounts of energy without any loss of bandwidth, all on a device the size of a fingertip.

Similar to sound amplifiers, optical amplifiers take a light signal and intensify it. Current small-sized optical amplifiers need a lot of power to function. The new optical amplifier, detailed in the journal *Nature*, solves this problem by using a method that essentially recycles the energy used to power it.

"We've demonstrated, for the first time, a truly versatile, low-power optical amplifier, one that can operate across the optical spectrum and is efficient enough that it can be integrated on a chip," said Amir Safavi-Naeini, the study's senior author and associate professor of physics in Stanford's School of Humanities and Sciences. "That means we can now build much more complex optical systems than were possible before."

The Stanford-developed device achieves about 100 times amplification, or increases the intensity of a light signal, while only using a couple hundred milliwatts of power

<https://phys.org/news/2026-01-chip-sized-optical-amplifier-minimal.html>

Watching atoms roam before they decay

Together with an international team, researchers from the Molecular Physics Department at the Fritz Haber Institute have revealed how atoms rearrange themselves before releasing low-energy electrons in a decay process initiated by X-ray irradiation. For the first time, they have gained detailed insights into the timing of the process—shedding light on related radiation damage mechanisms. Their research is published in the *Journal of the American Chemical Society*.

High-energy radiation, for example in the X-ray range, can cause damage to our cells. This is because energetic radiation can excite atoms and molecules, which then often decay—meaning that biomolecules are destroyed and larger biological units can lose their function. There is a wide variety of such decay processes, and studying them is of great interest in order to better understand and avert radiation damage.

In the study, researchers from the Molecular Physics Department, together with international partners, investigated a radiation-induced decay process that plays a key role in radiation chemistry and biological damage processes: electron-transfer-mediated decay (ETMD). In this process, one atom is excited by irradiation. Afterward, this atom relaxes by stealing an electron from a neighbor, while the released energy ionizes yet another nearby atom.

The research team was able to directly track how atoms in a model system move and rearrange themselves before undergoing this exotic electronic decay process. Their work provides the most detailed real-space and real-time picture of ETMD to date.

<https://phys.org/news/2026-01-atoms-roam-decay.html>

A new optical centrifuge is helping physicists probe the mysteries of superfluids

Physicists have used a new optical centrifuge to control the rotation of molecules suspended in liquid helium nano-droplets, bringing them a step closer to demystifying the behavior of exotic, frictionless superfluids.

It's the first demonstration of controlled spinning inside a superfluid—researchers can now directly set the direction and frequency of the molecule's rotation, which is vital in studying how molecules interact with the quantum environment at various rotational frequencies. The method was outlined this week by researchers at the University of British Columbia (UBC) and colleagues at the University of Freiburg in the journal *Physical Review Letters*.

"Controlling the rotation of a molecule dissolved in any fluid is a challenge," said Dr. Valery Milner, associate professor with UBC Physics and Astronomy and lead author on the paper.

"Dissolved molecules interact with the atomic or molecular constituents of the fluid, effectively getting bigger and harder to spin up. Imagine making a snowball: It's very easy to move it when it's small, but gets harder and harder as more snow gets attached to it."

Superfluids like liquid helium are exotic states of matter, at near-absolute zero, that flow with no viscosity. But despite the lack of friction, they actually do act as solvents.

"The question of interest in the science of quantum matter, and the one this new approach will help us explore, is what changes from the perspective of the solvated—dissolved—molecule when you make the transition from a normal fluid to this type of quantum superfluid," adds Dr. Milner.

<https://phys.org/news/2026-01-optical-centrifuge-physicists-probe-mysteries.html>

Entangled atomic clouds enable more precise quantum measurements

Researchers at the University of Basel and the Laboratoire Kastler Brossel have demonstrated how quantum mechanical entanglement can be used to measure several physical parameters simultaneously with greater precision.

Entanglement is probably the most puzzling phenomenon observed in quantum systems. It causes measurements on two quantum objects, even if they are at different locations, to exhibit statistical correlations that should not exist according to classical physics—it's almost as if a measurement on one object influences the other one at a distance.

The experimental demonstration of this effect, also known as the Einstein-Podolsky-Rosen paradox, was awarded the 2022 Nobel Prize in physics.

Now, a research team led by Prof. Dr. Philipp Treutlein at the University of Basel and Prof. Dr. Alice Sinatra at the Laboratoire Kastler Brossel (LKB) in Paris has shown that the entanglement of spatially separated quantum objects can also be used to measure several physical parameters simultaneously with increased precision. The researchers published their results in *Science*.

<https://phys.org/news/2026-01-entangled-atomic-clouds-enable-precise.html>

Are your memories illusions? New study disentangles the Boltzmann brain paradox

In a recent paper, SFI Professor David Wolpert, SFI Fractal Faculty member Carlo Rovelli, and physicist Jordan Scharnhorst examine a longstanding, paradoxical thought experiment in statistical physics and cosmology known as the "Boltzmann brain" hypothesis—the possibility that our memories, perceptions, and observations could arise from random fluctuations in entropy rather than reflecting the universe's actual past. The work is published in the journal *Entropy*.

The paradox arises from a tension at the heart of statistical physics. One of the central pillars of our understanding of the time-asymmetric second law of thermodynamics is Boltzmann's H theorem, a fundamental concept in statistical mechanics. However, paradoxically, the H theorem is itself symmetric in time.

That time-symmetry implies that it is, formally speaking, far more likely for the structures of our memories, perceptions, and observations to arise from random fluctuations in the universe's entropy than to represent genuine records of our actual external universe in the past. In other words, statistical physics seems to force us to conclude that our memories might be spurious—elaborate illusions produced by chance that tell us nothing about what we think they do. This is the Boltzmann brain hypothesis.

<https://phys.org/news/2026-01-memories-illusions-disentangles-boltzmann-brain.html>

A twitch in time? Quantum collapse models hint at tiny time fluctuations

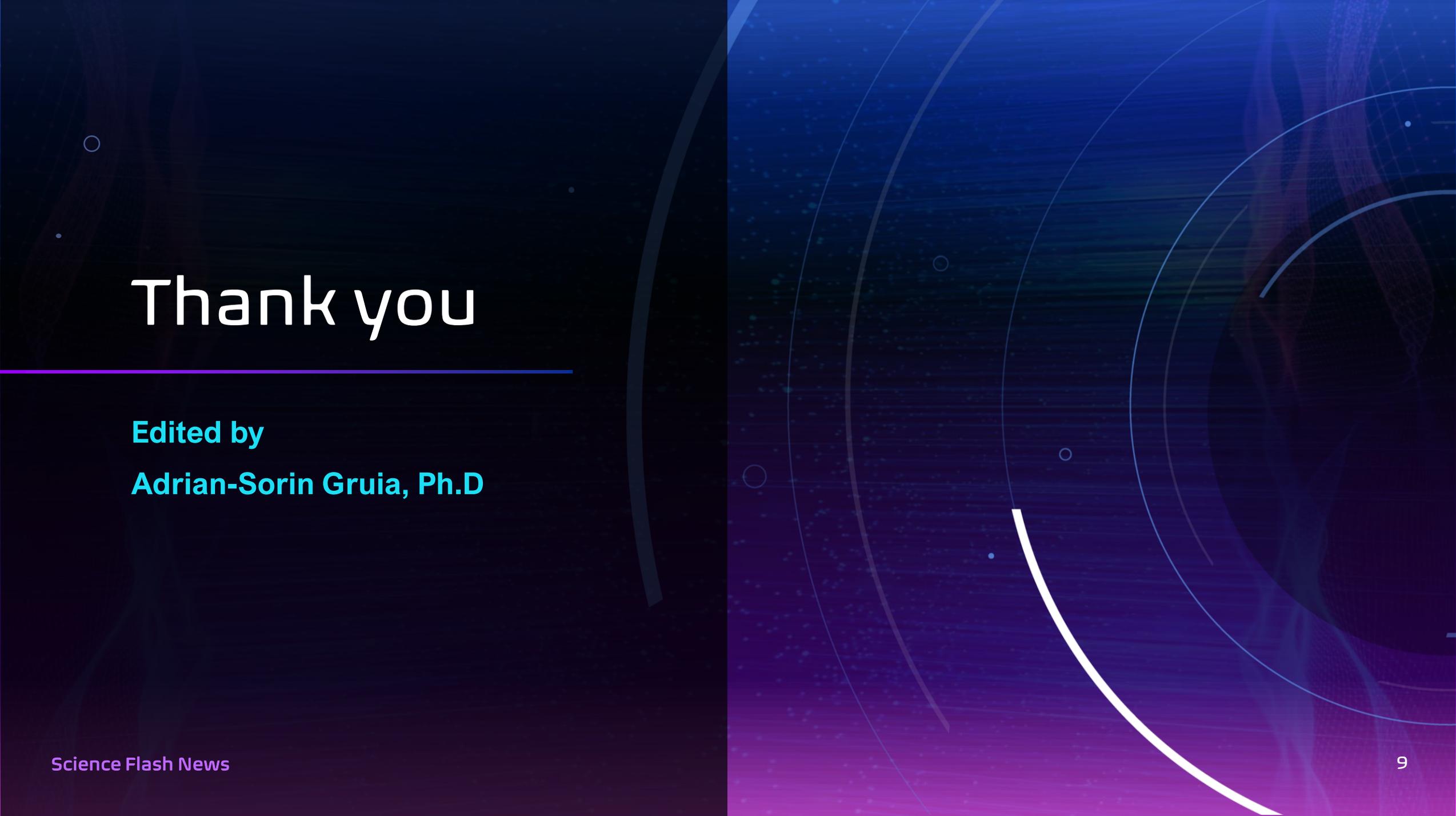
Quantum mechanics is rich with paradoxes and contradictions. It describes a microscopic world in which particles exist in a superposition of states—being in multiple places and configurations all at once, defined mathematically by what physicists call a "wavefunction." But this runs counter to our everyday experience of objects that are either here or there, never both at the same time.

Typically, physicists manage this conflict by arguing that, when a quantum system comes into contact with a measuring device or an experimental observer, the system's wavefunction "collapses" into a single, definite state. Now, with support from the Foundational Questions Institute, FQxi, an international team of physicists has shown that a family of unconventional solutions to this measurement problem—called "quantum collapse models"—has far-reaching implications for the nature of time and for clock precision.

They published their results suggesting a new way to distinguish these rival models from standard quantum theory, in *Physical Review Research*, in November 2025.

"What we did was to take seriously the idea that collapse models may be linked to gravity," says Nicola Bortolotti, a Ph.D. student at the Enrico Fermi Museum and Research Center (CREF) in Rome, Italy, who led the study. "And then we asked a very concrete question: What does this imply for time itself?"

<https://phys.org/news/2026-01-twitch-quantum-collapse-hint-tiny.html>



Thank you

Edited by

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