SCIENCE FLASH NEWS

No. 6/2025
June

Physicists recreate forgotten experiment observing fusion

A Los Alamos collaboration has replicated an important but largely forgotten physics experiment: the first deuterium-tritium (DT) fusion observation. As described in the article published in *Physical Review C*, the reworking of the previously unheralded experiment confirmed the role of University of Michigan physicist Arthur Ruhlig, whose 1938 experiment and observation of deuterium-tritium fusion likely planted the seed for a physics process that informs national security work and nuclear energy research to this day.

"As we've uncovered, Ruhlig's contribution was to hypothesize that DT fusion happens with very high probability when deuterium and tritium are brought sufficiently close together," said Mark Chadwick, associate Laboratory director for Science, Computation and Theory at Los Alamos. "Replicating his experiment helped us interpret his work and better understand his role, and what proved to be his essentially correct conclusions. The course of nuclear fuel physics has borne out the profound consequences of Arthur Ruhlig's clever insight."

The DT fusion reaction is central to enabling fusion technologies, whether as part of the nation's nuclear deterrence capabilities or in ongoing efforts to develop fusion for civilian energy. For instance, the deuterium-tritium reaction is at the center of efforts at the National Ignition Facility to harness fusion. Los Alamos physicists developed a theory about where the idea came from—Ruhlig—and then built an experiment that would confirm the import and accuracy of Ruhlig's suggestion.

https://phys.org/news/2025-06-physicists-recreate-forgotten-fusion.html

Computational trick enables better understanding of exotic state of matter

It can be found inside gas giants such as Jupiter and is briefly created during meteorite impacts or in laser fusion experiments: warm dense matter. This exotic state of matter combines features of solid, liquid and gaseous phases. Until now, simulating warm dense matter accurately has been considered a major challenge.

An international team led by researchers from the Center for Advanced Systems Understanding (CASUS) at the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) in Germany and Lawrence Livermore National Laboratory (LLNL) has succeeded in describing this state of matter much more accurately than before using a new computational method. The approach could advance laser fusion and help in the synthesis of new high-tech materials.

The team presents its results in the journal *Nature Communications*.

Warm dense matter (WDM) is characterized by temperatures ranging from several thousand to hundreds of millions of Kelvin and densities that sometimes exceed those of solids.

"Such conditions can be found, for example, inside gas planets, in brown dwarfs, or in the atmospheres of white dwarfs," explains Tobias Dornheim, junior group leader at CASUS and first author of the publication. "On Earth, it can be created during meteorite impacts, or—for example—in experiments with powerful lasers."

https://phys.org/news/2025-06-enables-exotic-state.html

Researchers confirm fundamental conservation laws at the quantum level

Researchers at Tampere University and their collaborators from Germany and India have experimentally confirmed that angular momentum is conserved when a single photon is converted into a pair—validating a key principle of physics at the quantum level for the first time. This breakthrough opens new possibilities for creating complex quantum states useful in computing, communication, and sensing.

Conservation laws are the heart of our natural scientific understanding as they govern which processes are allowed or forbidden. A simple example is that of colliding billiard balls, where the motion—and with it, their linear momentum—is transferred from one ball to another. A similar conservation rule also exists for rotating objects, which have angular momentum. Interestingly, light can also have an angular momentum, e.g., orbital angular momentum (OAM), which is connected to the light's spatial structure.

In the quantum realm, this implies that single particles of light, so-called photons, have well-defined quanta of OAM, which need to be conserved in light-matter interactions. In a recent study in *Physical Review Letters,* researchers from Tampere University and their collaborators have now pushed the test of these conservation laws to an absolute quantum limit. They explore if the conservation of OAM quanta holds when a single photon is split into a photon pair.

https://phys.org/news/2025-06-fundamental-laws-quantum.html

Study tightens King plot-based constraints on hypothetical fifth force

While the Standard Model (SM) describes all known fundamental particles and many of the interactions between them, it fails to explain dark matter, dark energy and the apparent asymmetry between matter and antimatter in the universe. Over the past decades, physicists have thus introduced various frameworks and methods to study physics beyond the SM, one of which is known as the King plot.

The King plot is a graphical technique used to analyze isotope shifts, variations in the energy levels of different isotopes (e.g., atoms of the same element that contain a different number of neutrons). This graphical tool has proved promising for separating effects explained by the SM from signals linked to new physics.

Researchers at Physikalisch-Technische Bundesanstalt, Max Planck Institute for Nuclear Physics, and ETH Zurich recently collected new measurements that tightened King plot-based constraints on the properties of a hypothetical particle that has not yet been observed, known as a Yukawa-type boson.

Their paper, published in *Physical Review Letters*, further highlights the potential of isotope shift spectroscopy and the King plot technique for testing particle physics theories and searching for physics outside the SM.

https://phys.org/news/2025-06-tightens-king-plot-based-constraints.html

Novel yet simple model provides smooth answer to friction mystery

Atoms slip against one another, eventually sticking in various combinations. Tectonic plates do the same, sliding across each other until they stick in a stationary state. Everything from the tiniest particles to unfathomably large landmasses possesses this fundamental stick and slip characteristic, but only now are scientists beginning to understand the mechanics of the friction underpinning this property.

"The intermittent motion in sliding systems is termed stick-slip since the two surfaces in contact seem to repeat the stick and slip states. However, several precise measurements have found that extremely slow slip occurs in even apparently stick states before every stick-to-slip transition," said Toshiki Watanabe, doctoral student in Yokohama National University's Graduate School of Environmental and Information Sciences, who recently co-authored a paper describing a new model to explain the puzzling switch.

"This strange phenomenon, termed the static friction paradox, has remained an unsolved problem for decades."

The problem the model helps answer is that to explain these slow slips, other researchers reached for artificial friction laws, or explanations that included specific but fictional parameters like state variables. The new model—which was developed by Watanabe and co-author Ken Nakano, a professor in Yokohama National University's Faculty of Environmental and Information Sciences, and was published in *Physical Review E* on June 18—offers a simplified solution, without relying on artificial friction laws.

https://phys.org/news/2025-06-simple-smooth-friction-mystery.html

New theory proposes time has three dimensions, with space as a secondary effect

Time, not space plus time, might be the single fundamental property in which all physical phenomena occur, according to a new theory by a University of Alaska Fairbanks scientist.

The theory also argues that time comes in three dimensions rather than just the single one we experience as continual forward progression. Space emerges as a secondary manifestation.

"These three time dimensions are the primary fabric of everything, like the canvas of a painting," said associate research professor Gunther Kletetschka at the UAF Geophysical Institute. "Space still exists with its three dimensions, but it's more like the paint on the canvas rather than the canvas itself."

Those thoughts are a marked difference from generally accepted physics, which holds that a single dimension of time plus the three dimensions of space constitute reality. This is known as spacetime, the concept developed more than a century ago that views time and space as one entity.

Kletetschka's mathematical formula of six total dimensions—of time and space combined—could bring scientists closer to finding the single unifying explanation of the universe.

Dimensions of time beyond our everyday forward progression are difficult to grasp. Theoretical physicists have proposed many variations.

Kletetschka's work, published April 21 in *Reports in Advances of Physical Science*, adds to a long-running body of research by theoretical physicists on a subject outside of mainstream physics.

https://phys.org/news/2025-06-theory-dimensions-space-secondary-effect.html

Thermodynamics revisited: Study solves 120-year-old problem and corrects one of Einstein's ideas

Nernst's theorem—a general experimental observation presented in 1905 that entropy exchanges tend to zero when the temperature tends to zero—has been directly linked to the second principle of thermodynamics in a paper published in *The European Physical Journal Plus*, whose sole author is University of Seville professor José Martín-Olalla.

In addition to solving a problem posed 120 years ago, the demonstration is an extension of the consequences linked to the second principle of thermodynamics (the principle that establishes the increasing entropy of the universe). It also corrects an idea put forward more than a century ago by Albert Einstein.

The problem of the Nernst theorem arose at the beginning of the 20th century when the general properties of matter at temperatures close to absolute zero (-273°C) were being studied. Walther Nernst was awarded the Nobel Prize in Chemistry in 1920 for these studies.

As an explanation of his results, Nernst argued that absolute zero had to be inaccessible, because otherwise it would be possible to build an engine that, using absolute zero as a coolant, would convert all heat into work, going against the principle of entropy increase. Thus, he proved his theorem in 1912.

Immediately afterward, Einstein refuted this demonstration by pointing out that such a hypothetical engine could not be built in practice and, therefore, could not question the validity of the principle of entropy increase. Thus, Einstein detached the theorem from the second principle of thermodynamics and associated it to a third principle, independent of the second. This idea is now refuted.

https://phys.org/news/2025-06-thermodynamics-revisited-year-problem-einstein.html

Thank you!

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