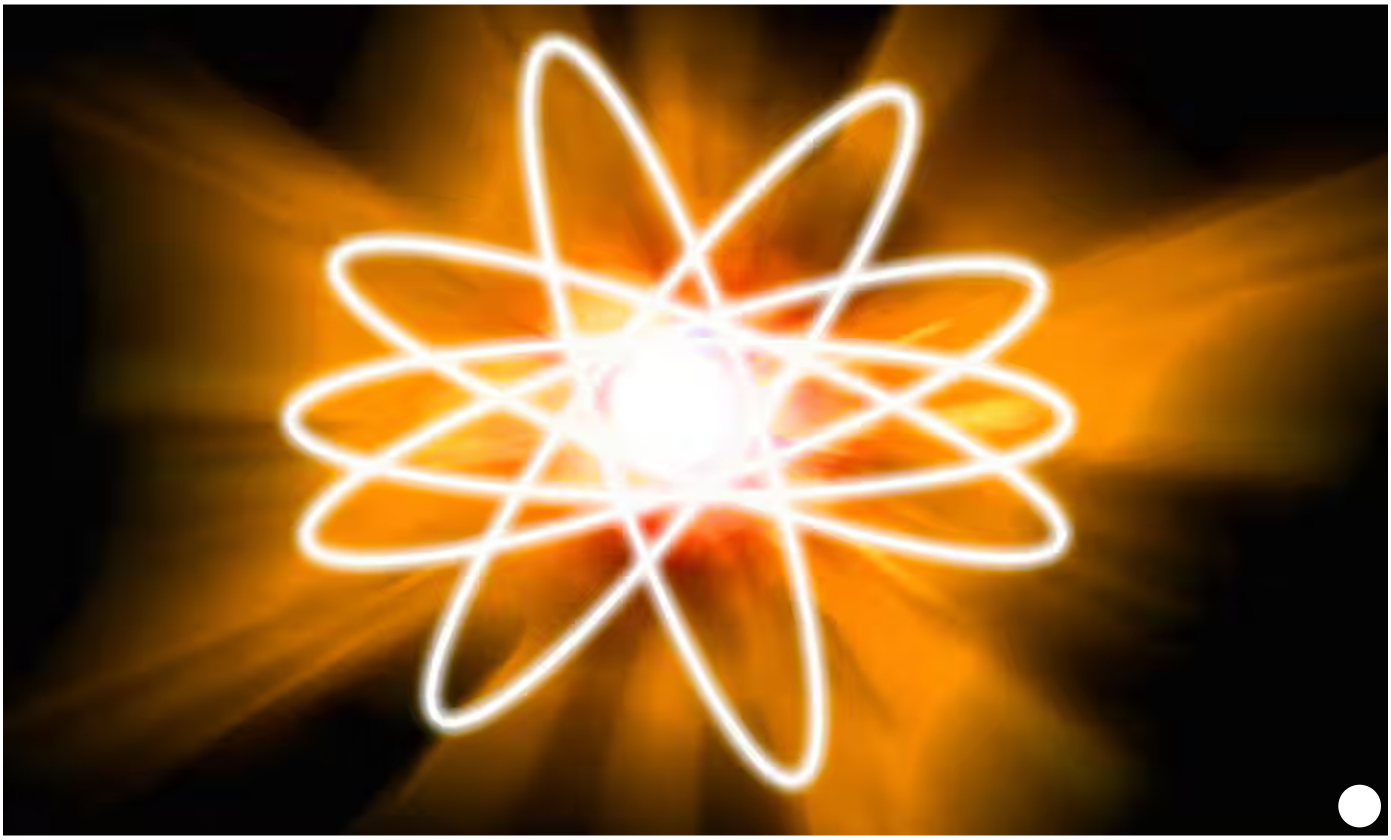

Physics

Quantum physics makes small leap with microscopic gravity measurement

Experiment records minuscule gravitational pull as a step to understanding how force operates at subatomic level

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Fri 23 Feb 2024 20.00 CET

Scientists have detected the pull of gravity on the microscopic scale in a feat that lays the groundwork for probing its nature in the mysterious quantum realm.

In an experiment involving sophisticated superconducting apparatus cooled to within a whisker of absolute zero, and brass weights stuck to an electrical bicycle wheel, physicists recorded a minuscule gravitational tug of 30 quintillionths of a newton on a particle less than a millimetre wide.

The demonstration paves the way for future work in which researchers aim to measure the gravity generated by ever smaller particles to understand how the unusual force behaves in the subatomic world where quantum rules dominate.

"We know that quantum mechanics and general relativity, Einstein's theory of gravity, are not reconcilable as we formulate them now," said Tim Fuchs, a postdoctoral experimental physicist at the University of Southampton. "The theories don't work together, so we know something has to give, or both have to give. This is trying to fill in the gaps with actual experiments."

For more than a century, physicists have tried and failed to combine gravity, which describes how mass bends space-time, with quantum theory, the rules of the subatomic world. Understanding gravity at the quantum scale could help solve some of the grand mysteries of the universe, from how it all began to the goings-on inside black holes. But while theorists have come up with a raft of promising ideas, it has proved hard to design experiments to see which, if any, nature has chosen.

In the latest work Fuchs and colleagues at Leiden University in the Netherlands, and the Institute for Photonics and Nanotechnologies in Italy, came up with a way to measure the extremely subtle gravitational forces that exist between tiny objects.

The experiment, which was heavily protected against interference from vibrations, centred on a magnetic particle that was levitated above a superconductor cooled to one hundredth of a degree above absolute zero, or -273.15C, the coldest temperature possible in the universe. The almost negligible pull on the hovering particle was then measured as an electrical bicycle wheel fitted with brass weights revolved about a metre away, bringing the weights near to the particle and then back again.

"When you start spinning the wheel, it causes the particle to move, a bit like a swing. The gravitational force pulls on it, and then starts letting go, and then pulls on it again," Fuchs said.

The gravitational force between two objects depends on their masses and the distance between them. The larger and closer they are, the stronger the attraction.

Writing in Science Advances, the physicists describe how the half milligram particle was gently pulled by a 30-attonewton force in their experiment. An attonewton is one billionth of a billionth of a newton. “It’s definitely not yet quantum gravity, but it’s a stepping stone towards it,” Fuchs told the Guardian.

Having demonstrated that the equipment works, the researchers now hope to measure how gravity behaves between smaller and smaller particles that are increasingly influenced by the rules of quantum mechanics. But those will take some time: the first such measurements could take another five to 10 years, Fuchs believes. “This is something we definitely need to probe with experiments,” he said.