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Physics

Tiny magnet could help measure gravity on the quantum scale

A device that measures minuscule gravitational forces could help us understand how gravity works on the quantum scale

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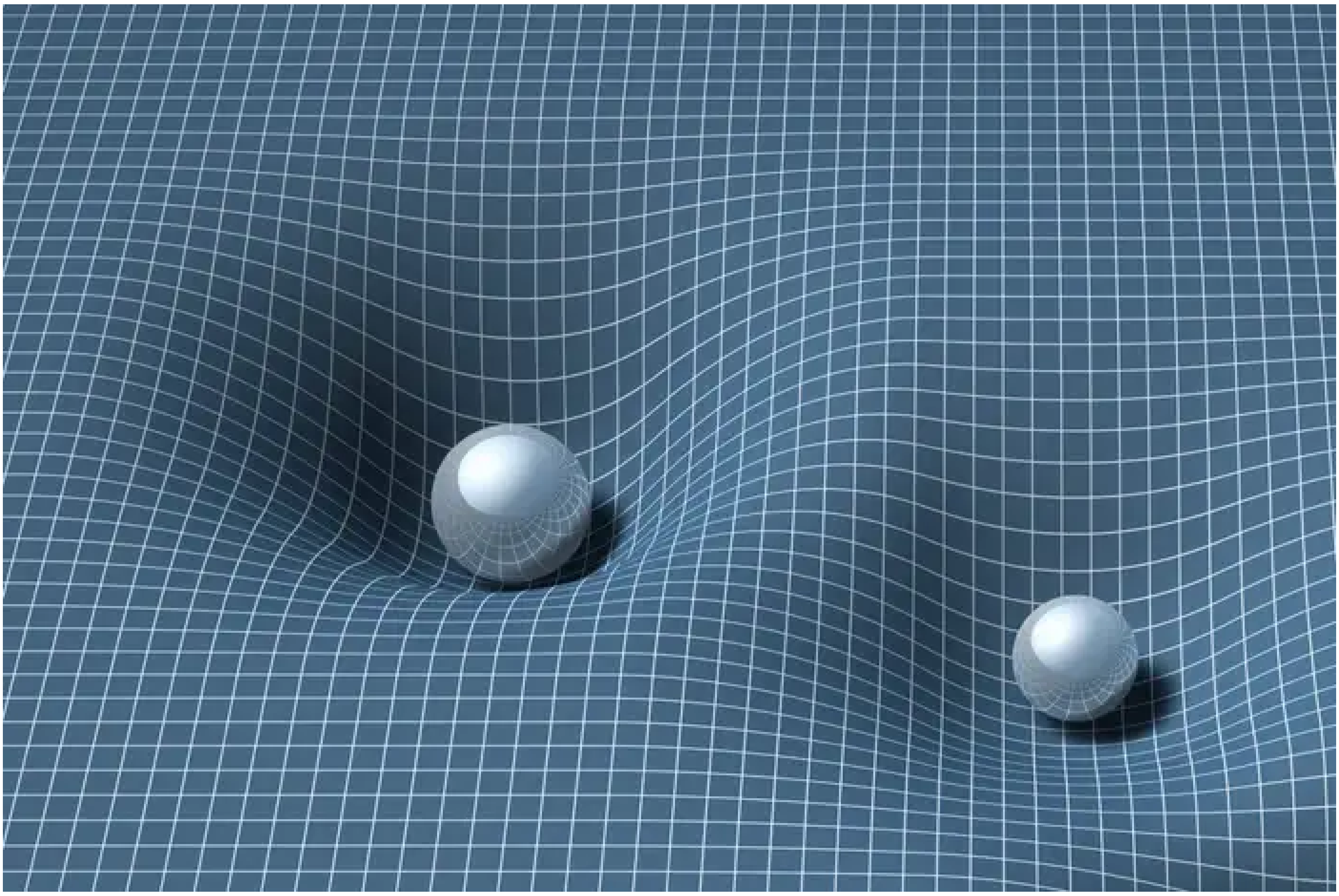

All objects exert a gravitational pull, no matter how small

Karl Dolenc/BeholdingEye/Getty Images

A device that can measure the gravitational force on a particle that weighs less than a grain of pollen could help us understand how gravity works /article-topic/quantum-gravity/ in the quantum world.

Despite keeping you stuck to the ground, gravity is the weakest force we know of. Only very large objects, like planets and stars, produce enough gravitational force to be easily measured. Doing the same for very small objects /article/2270494-

physicists-have-measured-gravity-on-the-smallest-scale-ever/, on the tiny distances and masses of the quantum realm, is extremely difficult, in part because of the miniscule size of the force, but also because larger objects nearby can overwhelm the signal.

Now Hendrik Ulbricht 🔗 https://www.southampton.ac.uk/people/5x5wz8/professor-hendrik-ulbricht at the University of Southampton in the UK and his colleagues have developed a new way to measure gravity on small scales by using a tiny neodymium magnet, weighing around 0.5 milligrams, that is levitated by a magnetic field to counteract Earth's gravity.

Tiny changes in the magnetic field of the magnet created by the gravitational influence of nearby objects can then be converted into a measure of the gravitational force. The whole thing is cooled to almost absolute zero and suspended in a system of springs to minimise outsides forces.

The probe can measure the gravitational tug of objects that weigh just a few micrograms. "You can increase the sensitivity and push the investigation of gravity into a new regime," says Ulbricht.

He and his team found that, with a 1 kilogram test mass spinning nearby, they could measure a force on the particle of 30 attonewtons. An attonewton is a billionth of a billionth of a newton. One limitation is that the test mass must be in motion at the right speed to create a gravitational resonance with the magnet, otherwise the force won't be strong enough to be picked up.

The next stage of the experiment will be to shrink the test mass to a similar size as the magnetic particle, so that gravity can be tested while the particles are showing quantum effects like entanglement or superposition. This will be difficult, says Ulbricht, as such small masses will require all other parts of the experiment to be incredibly precise, such as the exact distance between the two particles. Getting to this stage could take at least a decade.

"The fact that they even tried this measurement I find mind-boggling," says Julian Stirling 🔗 https://scholar.google.ro/citations?user=n8qaCvgAAAAJ&hl=en, a UK-based engineer, due to the difficulty in isolating other gravitational effects from their probe mass. The researchers will need to figure out how to minimise the gravitational influence of the anti-vibrational system, says Stirling, because it seems to have exerted a small but noticeable effect on the levitated particle in this experiment.