Scientists closer to finding quantum gravity theory after measuring gravity on microscopic level

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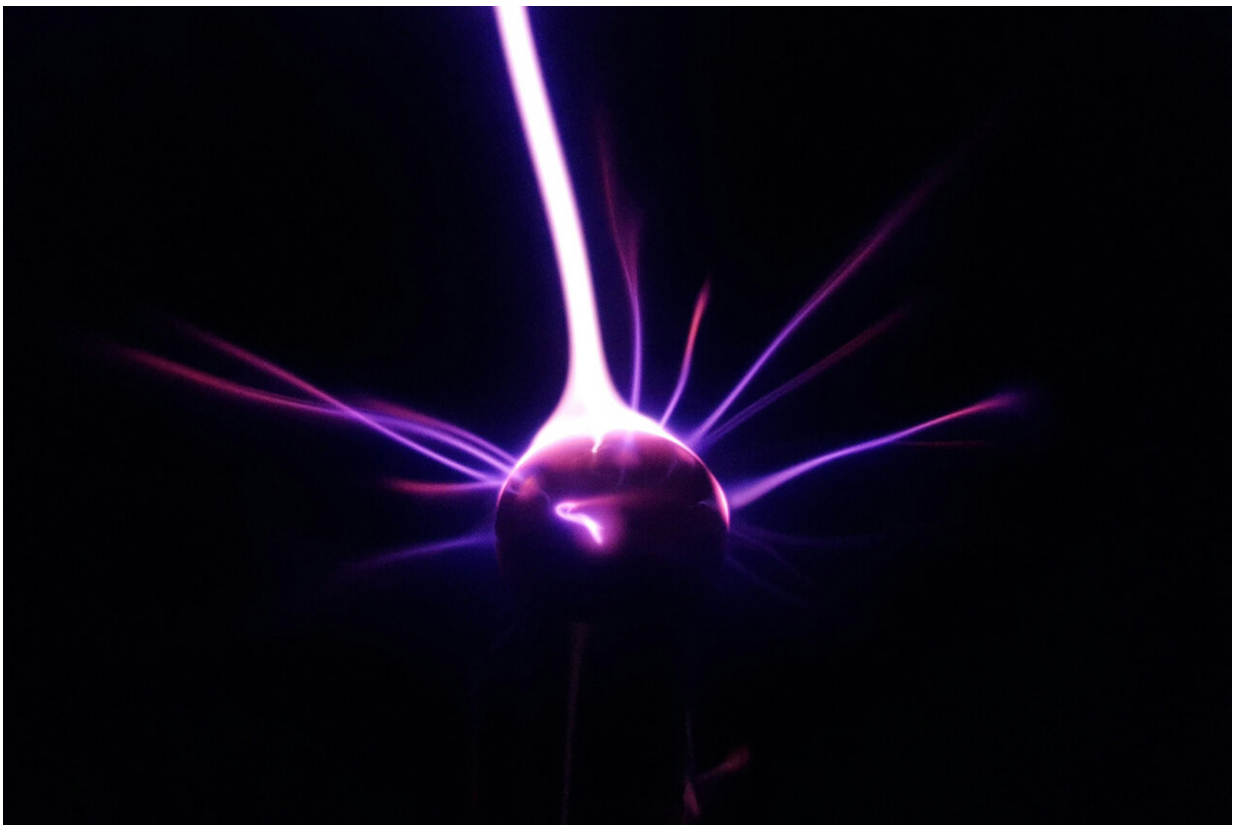

Artist impression of the quantum experiment. Credit: University of Southampton

Scientists are a step closer to unraveling the mysterious forces of the universe after working out how to measure gravity on a microscopic

level.

Experts have never fully understood how the force that was discovered by Isaac Newton works in the tiny quantum world. Even Einstein was baffled by quantum gravity and, in his theory of general relativity, said there is no realistic experiment that could show a quantum version of gravity.

But now physicists at the University of Southampton, working with scientists in Europe, have successfully detected a weak gravitational pull on a tiny particle using a new technique.

They claim it could pave the way to finding the elusive quantum gravity theory.

The experiment, published in *Science Advances*, used levitating magnets to detect gravity on microscopic particles—small enough to border on the quantum realm.

Lead author Tim Fuchs, from the University of Southampton, said the results could help experts find the missing puzzle piece in our picture of reality.

He added, "For a century, scientists have tried and failed to understand how gravity and quantum mechanics work together. Now we have successfully measured gravitational signals at a smallest mass ever recorded, it means we are one step closer to finally realizing how it works in tandem.

"From here we will start scaling the source down using this technique until we reach the quantum world on both sides. By understanding quantum gravity, we could solve some of the mysteries of our universe—like how it began, what happens inside black holes, or uniting

all forces into one big theory."

The rules of the quantum realm are still not fully understood by science—but it is believed that particles and forces at a microscopic scale interact differently than regular-sized objects.

Academics from Southampton conducted the experiment with scientists at Leiden University in the Netherlands and the Institute for Photonics and Nanotechnologies in Italy.

Their study used a sophisticated setup involving superconducting devices , known as traps, with magnetic fields, sensitive detectors and advanced vibration isolation. It measured a weak pull, just 30aN, on a tiny particle 0.43mg in size by levitating it in freezing temperatures a hundredth of a degree above absolute zero—about –273 degrees Celsius.

The results open the door for future experiments between even smaller objects and forces, said Professor of Physics Hendrik Ulbricht also at the University of Southampton.

He added, "We are pushing the boundaries of science that could lead to new discoveries about gravity and the quantum world.

"Our new technique that uses extremely cold temperatures and devices to isolate vibration of the particle will likely prove the way forward for measuring quantum gravity.

"Unraveling these mysteries will help us unlock more secrets about the universe's very fabric, from the tiniest particles to the grandest cosmic structures."

More information: Tim Fuchs et al, Measuring gravity with milligram levitated masses, *Science Advances* (2024). DOI:

10.1126/sciadv.adk2949. www.science.org/doi/10.1126/sciadv.adk2949