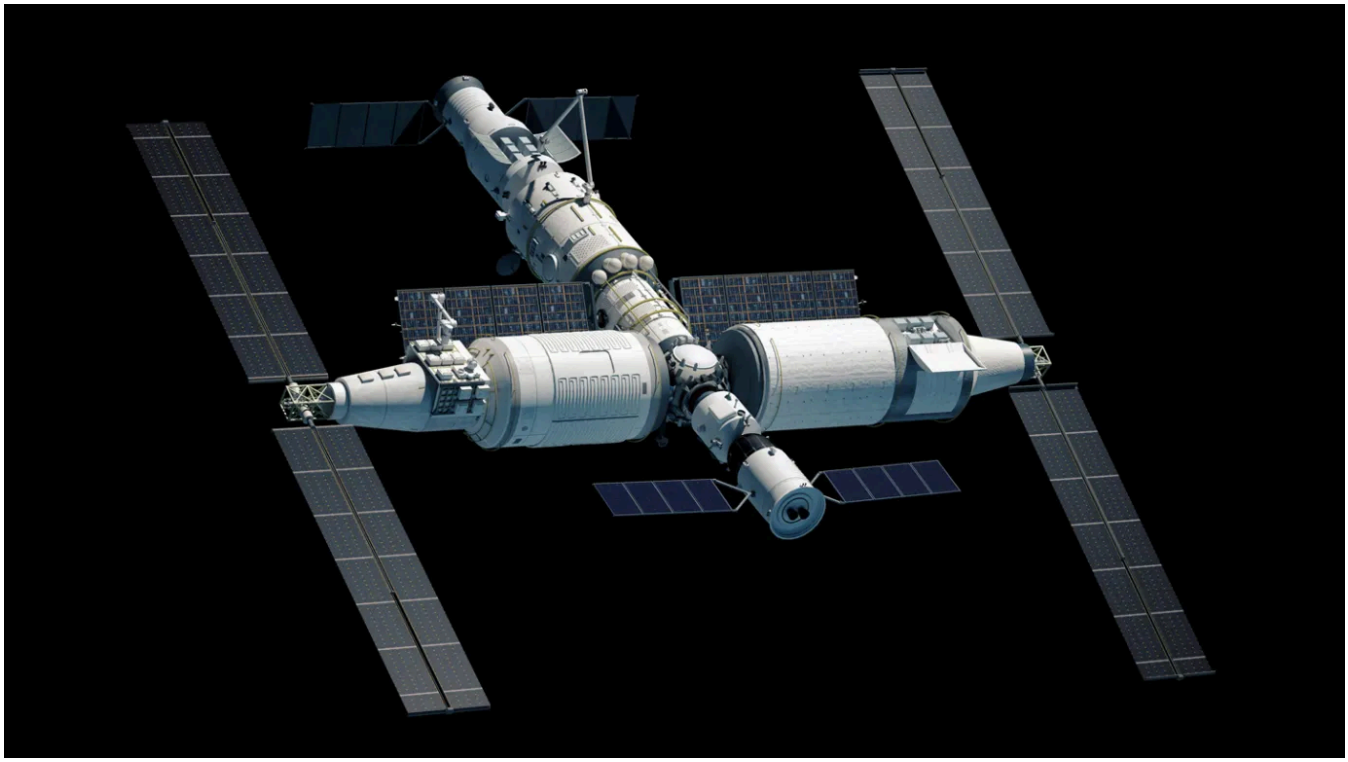
NEWS PHYSICS

Free-falling atoms in space put a new twist on Galileo's gravity test

A test on a space station reaffirms a core part of Einstein's general theory of relativity



Two clouds of atoms on China's Tiangong space station (rendering shown) fell with the same acceleration in a new experiment.

ADRIAN MANN/STOCKTREK IMAGE/ALAMY

By Emily Conover

5 HOURS AGO

An experiment made famous by Galileo has been shrunk down to the atomic level and shipped off to space.

To show that objects of different masses fall at the same rate, the 17th century Italian scientist is said — perhaps apocryphally — to have dropped weights off the Leaning Tower of Pisa. Now, scientists have

re-created that experiment with atoms falling while orbiting Earth. Two clouds of atoms on China's Tiangong space station fell with nearly identical accelerations, researchers report August 28 in *Science Advances*.

The researchers measured the relative accelerations of two clouds of cold rubidium atoms. The atoms in each cloud had different masses, due to a difference in the number of neutrons in their atomic nuclei. Yet the accelerations of the two clouds matched with a precision of 0.05 thousandths of a percent.

The matching accelerations confirm that two different ways of defining mass are equivalent. One, called gravitational mass, determines how an object responds to the pull of gravity. Another, called inertial mass, determines how much an object accelerates when pushed with a given amount of force. If the two definitions are equivalent, the effect of the mass cancels out in equations, and objects of different masses will fall at the same rate in a vacuum. The concept is known as the weak equivalence principle, and it's a foundation of Albert Einstein's general theory of relativity, which describes gravity as the warping of spacetime.

Scientists have tested the weak equivalence principle by dropping objects on Earth, including atoms. But objects on Earth can fall only so far, limiting the tests' precision. In orbit, free fall can go on indefinitely. Space-based tests of falling metal cylinders on a satellite have previously confirmed the weak equivalence principle. But atoms, unlike larger objects, obey the rules of quantum physics, and it's worth checking to see if they behave differently. Atoms in orbit take the weak equivalence principle to a whole new level.

CITATIONS

D. Zhang *et al.* In-orbit test of the weak equivalence principle with atom interferometry. *Science Advances.* 2026. doi: 10.1126/sciadv.aeh4502