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Two new ways to measure the gravitational constant

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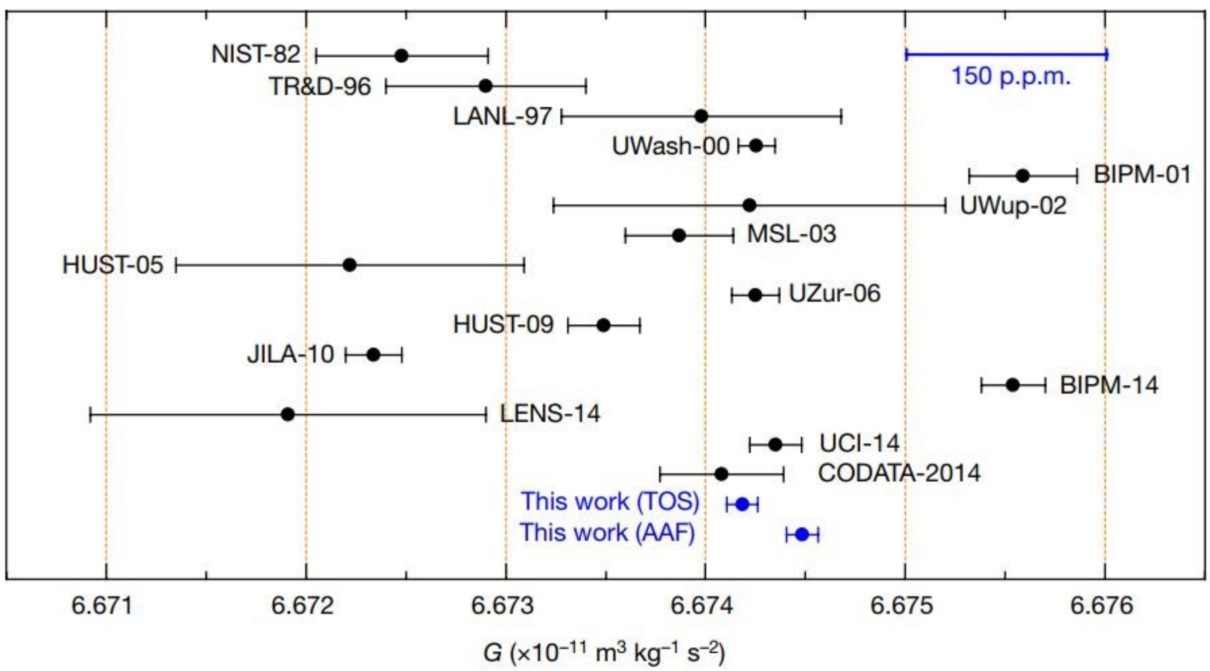

Comparison with previous results. G values obtained in this work compared with recent measurements . Credit: *Nature* (2018). DOI: 10.1038/s41586-018-0431-5

A team of researchers affiliated with several institutions in China and one in Russia has devised two new ways to measure the gravitational constant. In their paper published in the journal *Nature*, the group describes the two methods and how accurate they were. Stephan Schlamminger with the National Institute of Standards and Technology in the U.S. writes a News & Views piece on the work done by the team in the same journal edition.

Gravity is one of the four fundamental forces of nature (the others are the weak and strong interaction and electromagnetism). Despite hundreds of years of concerted effort by scientists around the world, there is still no explanation for how it works. Adding to the frustration is the fact that no one has been able to find a way to measure its actual force—scientists have been trying to do that for hundreds of years, as well. In modern times, researchers have come very close, however—the current accepted value is 6.67408×10^{-11} m^3 kg^{-1} s^{-2}. In this new effort, researchers working in China have modified a standard way of measuring the gravitational constant—torsion pendulums. The method was first devised by Henry Cavendish back in 1798, and since then, has been modified many times to make it more accurate.

In the first approach, the researchers built a device consisting of a silica plate coated with metal hung in the air by a wire. Two steel balls provided a gravitational attraction. The force of gravity was measured by noting how much the wire twisted. The second approach was similar to the first, except that the plate was hung from a spinning turntable that kept the wire in place. In such an apparatus, the gravitational force was measured by noting the rotation of the turntable.

In both approaches, the researchers added features to prevent interference from nearby objects and disturbances, including seismic. They report measurements of 6.674484×10^{-11} and 6.674184×10^{-11} m^3 kg^{-1} s^{-2}—both of which, the team claims, are more precise than other previous measurements.

More information: Qing Li et al. Measurements of the gravitational constant using two independent methods, *Nature* (2018). DOI: 10.1038/s41586-018-0431-5

Abstract
The Newtonian gravitational constant, G, is one of the most fundamental constants of nature, but we still do not have an accurate value for it. Despite two centuries of experimental effort, the value of G remains the least precisely known of the fundamental constants. A discrepancy of up to 0.05 per cent in recent determinations of G suggests that there may be undiscovered systematic errors in the various existing methods. One way to resolve this issue is to measure G using a number of methods that are unlikely to involve the same systematic effects. Here we report two independent determinations of G using torsion pendulum experiments with the time-of-swing method and the angular-acceleration-feedback method. We obtain G values of 6.674184×10^{-11} and 6.674484×10^{-11} cubic metres per kilogram per second squared, with relative standard uncertainties of 11.64 and 11.61 parts per million, respectively. These values have the smallest uncertainties reported until now, and both agree with the latest recommended value within two standard deviations.