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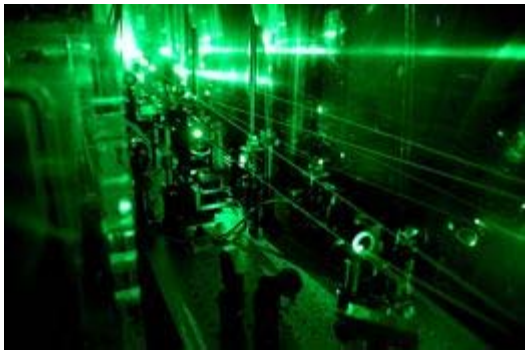
News

The proton shrinks in size

Tiny change in radius has huge implications.

Geoff Brumfiel

The proton seems to be 0.00000000000003 millimetres smaller than researchers previously thought, according to work published in today's issue of *Nature*[1].



Measurements with lasers have revealed that the proton may be a touch smaller than predicted by current theories. *PSI / F. Reiser*

The difference is so infinitesimal that it might defy belief that anyone, even physicists, would care. But the new measurements could mean that there is a gap in existing theories of quantum mechanics. "It's a very serious discrepancy," says Ingo Sick, a physicist at the University of Basel in Switzerland, who has tried to reconcile the finding with four decades of previous measurements. "There is really something seriously wrong someplace."

Protons are among the most common particles out there. Together with their neutral counterparts, neutrons, they form the nuclei of every atom in the Universe. But despite its everday appearance, the proton remains something of a mystery to nuclear physicists, says Randolf Pohl, a researcher at the Max Planck Institute of Quantum Optics in Garching, Germany, and an author on the *Nature* paper. "We don't understand a lot of its internal structure," he says.

From afar, the proton looks like a small point of positive charge, but on much closer inspection, the particle is more complex. Each proton is made of smaller fundamental particles called quarks, and that means its charge is roughly spread throughout a spherical area.

Physicists can measure the size of the proton by watching as an electron interacts with a proton. A single electron orbiting a proton can occupy only certain, discrete energy levels, which are described by the laws of quantum mechanics. Some of these energy levels depend in part on the size of the proton, and since the 1960s physicists have made hundreds of measurements of the proton's size with staggering accuracy. The most recent estimates, made by Sick using previous data, put the radius of the proton at around 0.8768 femtometres (1 femtometre = 10^{-15} metres).

Small wonder

Pohl and his team have a come up with a smaller number by using a cousin of the electron, known as the muon. Muons are about 200 times heavier than electrons, making them more sensitive to the proton's size. To measure the proton radius using the muon, Pohl and his colleagues fired muons from a particle accelerator at a cloud of hydrogen. Hydrogen nuclei each consist of a single proton, orbited by an electron. Sometimes a muon replaces an electron and orbits around a proton. Using lasers, the team

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