Team develops most sensitive scale ever

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(PhysOrg.com) -- A Spanish research team in Barcelona working out of the Catalan Institute of Nanotechnology, has succeeded in building the most sensitive scale ever created. It's capable, as the team describes in their paper published in *Nature Nanotechnology*, of weighing a single proton.

For most of civilized human history, people have been weighing things, all the while trying to improve on their ability to do so. Something's mass quite often leads to its value, and modern scales are no different. A scale that can weigh not just atoms, but their parts, could be useful as a tool to help researchers distinguish between minute quantities of different materials, or medical researches looking to find differences between very similar molecules.

The team achieved their feat by using a short carbon nanotube (~150 nm) that vibrates at a frequency of just under 2 GHz, working as a nanomechanical resonator. Measurements are made by noting changes in vibrations when objects are placed on it. By using a shorter than normal nanotube, the team was able to achieve better resolution than with current scales and found it could be used at lower temperatures as well. In their test, they weighed a xenon atom (in a vacuum) to the nearest 10-24 grams (one septillionth of a gram) or one yoctogram, after first heating the nanotube to remove any other atoms that might have been present. In so doing, they found they were able to weigh one single proton (1.7 yoctograms), a truly astounding achievement. The previous best mass sensitivity measurement was a whopping 100 yoctograms.

The researchers suggest that the scale could be used for surface science, magnetometry and mass spectrometry applications to weigh cells, gas molecules and biomolecules.

Unfortunately, while building a scale with such sensitivity is truly remarkable, there remains one more hurdle. As with any scale, its usefulness only becomes apparent when it becomes available to others. Thus, a way to create a process whereby such a scale could be produced in sufficient quantity at a reasonable cost still needs to be worked out. Once that happens though, it's likely this new scale will become an important research tool in labs across the world.

More information: A nanomechanical mass sensor with yoctogram resolution, *Nature Nanotechnology* (2012) doi:10.1038/nnano.2012.42

Abstract
Nanomechanical resonators have been used to weigh cells, biomolecules and gas molecules, and to study basic phenomena in surface science, such as phase transitions and diffusion. These experiments all rely on the ability of nanomechanical mass sensors to resolve small masses. Here, we report mass sensing experiments with a resolution of 1.7 yg (1 yg = 10−24 g), which corresponds to the mass of one proton. The resonator is a carbon nanotube of length ~150 nm that vibrates at a frequency of almost 2 GHz. This unprecedented level of sensitivity allows us to detect adsorption events of naphthalene molecules ($C_{10}H_8$), and to measure the binding energy of a xenon atom on the nanotube surface. These ultrasensitive nanotube resonators could have applications in mass spectrometry, magnetometry and surface science.

https://phys.org/news/2012-04-team-sensitive-scale.html