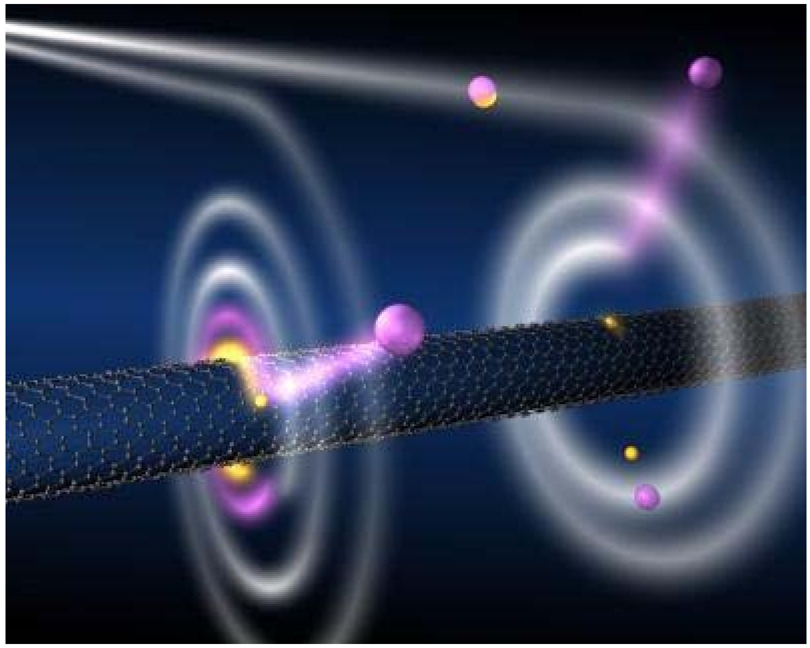
Discovery News

Nanotube Propels Atoms Into Black-Hole-Like Spiral

By Tracy Staedter | Thu Apr 8, 2010 09:06 AM ET



Physicists have created something akin to a black hole in their labs.

It's on the atomic scale, that is, very, very small. But it's the first time anything like this has ever been done and the experiment could prompt innovations in nano-sized devices.

Lene Vestergaard Hau, a physicist at Harvard University, and her colleagues cooled atoms to just a fraction of a degree above absolute zero. Next, they shot the cooled atoms toward a suspended single-walled carbon nanotube they named "Lucy." The nanotube had 300 volts of charge surging through it.

Atoms that came within a micron of the charged nanotube became attracted to it, spiraling around it at faster and faster speeds, maxing out at more than 2,700 miles per hour.

"It is a black-hole-like situation, where the nanotube's pull on the atom creates a singular potential. The atom is captured and cannot escape once it enters inside the capture range," said Hau.

In addition to accelerating, the atoms have increased kinetic energy that can be expressed in temperature. The cool atoms went from a chilly 0.1 degrees Kelvin to a blistering thousands of degrees Kelvin in less than a microsecond.

At some point the atom broke apart into an electron and an ion, which each continued to twirl around the nanotube at break neck speeds. Eventually, the electron got sucked into the nanotube and the ion, repelled by the charged nanotube, flung off into space at 59,000 miles per hour.

I asked Hau what sorts of nano-sized devices could be based on the science in this experiment and here's what she said.

1) A very compact atom detector, an "atom sniffer," for detection of trace gases with unprecedented high sensitivity. This includes detection of gases at room temperature (i.e. the gases do not need to be cold). Very important, for example, for National Security purposes.

2) We can create a chip-integrated detector with spatial resolution at the single nanometer level. (We could measure, for each individual atom, exactly the position along the nanotube length where the atom is ripped apart to create the ion that is then violently ejected and detected). This is of great importance for sensitive and high-precision detection of interference fringes in a compact chip-integrated atom interferometer (based on interference of cold matter waves rather than interference of light). This would be of great importance in navigation systems, for example.

Photo: Anne Goodsell and Tommi Hakala/Harvard University