Controlling most atoms now possible

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Stopping and cooling most of the atoms of the periodic table is now possible using a pair of techniques developed by physicist Mark Raizen at The University of Texas at Austin.

Raizen stopped atoms by passing a supersonic beam through an "atomic coilgun" and cooled them using "single-photon cooling."

The techniques are a major step forward in atomic physics and have a variety of scientific and technological applications. They could be used to determine the mass of the neutrino, which is the primary candidate for dark matter.

"Our methods open up whole new avenues of research," says Raizen, professor of physics. "We can control almost any atom and many molecules."

The results, published in two papers in the March 7 issue of *Physical Review Letters*, are the culmination of years of work trapping and cooling atoms by Raizen and his research group.

To date, cooling atoms near the Absolute Zero (-459 degrees Fahrenheit) has been accomplished using laser cooling, a method that was recognized by the Nobel Prize in Physics in 1997. Despite its enormous success, laser cooling has been limited to a small set of atoms in the periodic table.

Raizen says his two methods can be used in tandem to trap and cool near

Absolute Zero any of the paramagnetic atoms, which make up over 85 percent of the periodic table.

In one set of experiments, a supersonic beam of neon atoms was completely stopped using a 64-stage coilgun. (In prior studies, Raizen used an 18-stage coilgun to slow neon atoms.)

The coilgun works by shooting a supersonic beam of atoms through a 3-millimeter diameter bore wrapped by 64 magnetic coils made of copper wire (thus, 64 stages). The coils slow the atoms by making them climb a "magnetic hill." The hill is removed before the atoms have time to roll off and regain speed, and the atoms become magnetically trapped.

"The wonderful thing about the coilgun technology is its simplicity," says Raizen. "We use ordinary copper wire for the coils. The hope is that this will allow others to use the technique to trap and cool the other elements."

Key to the success of the coilgun is the use of supersonic beam technology developed by Raizen's collaborator, Professor Uzi Even, from Tel-Aviv University.

In the other set of experiments, atoms were cooled using a method called "single-photon cooling."

The atoms were trapped in a box made of green lasers fitted with an internal barrier—a one-way wall of laser light that allows atoms to pass through one way and not the other. It behaves much like a cellular membrane that allows ions to pass through in only one direction.

Source: University of Texas at Austin