Scientists Measure Coldest Temperature Ever

Jet Propulsion Lab -- NASA-funded researchers at the Massachusetts Institute of Technology in Cambridge have cooled sodium gas to the lowest temperature ever recorded -- one-half-billionth degree above absolute zero. Absolute zero is the point where no further cooling is possible.

This new temperature is six times lower than the previous record, and marks the first time that a gas was cooled below 1 nanokelvin (1 billionth of a degree).

At absolute zero (-273? Celsius or -460? Fahrenheit), all motion stops, except for tiny atomic vibrations, since the cooling process has extracted all energy from the particles. By improving cooling methods, scientists have succeeded in getting closer to absolute zero.

"To go below 1 nanokelvin is like running a mile below four minute for the first time," said Dr. Wolfgang Ketterle, a physics professor the Massachusetts Institute of Technology and co-leader of the research team.

"Ultra-low temperature gases could lead to vast improvements in precision measurements by allowing better atomic clocks and sensors for gravity and rotation," said Dr. David E. Pritchard, Massachusetts Institute of Technology physics professor, pioneer in atom optics and atom interferometry, and co-leader of the team.

In 1995, a group at the University of Colorado, Boulder and a Massachusetts Institute of Technology group led by Ketterle cooled atomic gases to below 1 microkelvin (one-millionth degree above absolute zero).

In doing so, they discovered a new form of matter, the Bose-Einstein condensate, where the particles march in lockstep instead of flitting around independently.

The discovery was recognized with the 2001 Nobel Prize in Physics, which Ketterle shared with his Boulder colleagues, Drs. Eric Cornell and Carl Wieman.

Since the 1995 breakthrough, many groups have routinely reached nanokelvin temperatures, with 3 nanokelvin as the lowest temperature previously recorded. The new record set by the Massachusetts group is 500 picokelvin, or six times lower.

At such low temperatures, atoms cannot be kept in physical containers, because they would stick to the walls. Also no known container can be cooled to such temperatures.
To circumvent this problem, magnets surround the atoms, which keep the gaseous cloud confined without touching it. To reach the record-low temperatures, the researchers invented a novel way of confining atoms, which they call a "gravito-magnetic trap." The magnetic fields acted together with gravitational forces to keep the atoms trapped.

All the researchers are affiliated with the Massachusetts Institute of Technology physics department, the Research Laboratory of Electronics and the Massachusetts Institute of Technology-Harvard Center for Ultracold Atoms, funded by the National Science Foundation.

Ketterle, Leanhardt and Pritchard co-authored the low-temperature paper, scheduled to appear in the September 12 issue of Science.

NASA, the National Science Foundation, the Office of Naval Research and the Army Research Office funded the research. Ketterle conducts research under NASA's Fundamental Physics in Physical Sciences Research Program part of the agency's Office of Biological and Physical Research, Washington. NASA's Jet Propulsion Laboratory, Pasadena, Calif., a division of the California Institute of Technology, Pasadena, manages the Fundamental Physics Program.

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