Synopsis: Cooling Multiple Atoms in a Cavity

May 1, 2017

A cavity-based method of cooling single atoms or other objects has now been used to cool multiple atoms simultaneously.

Laser cooling can chill atomic gases to near absolute zero, but it tends to work only with specific types of atoms. Cavity cooling is a more generic method that has successfully been used to cool single atoms, nanoparticles, and mechanical oscillators. A group at the Massachusetts Institute of Technology, Cambridge, led by Vladan Vuletić has now demonstrated cavity cooling of a few hundred atoms, perhaps opening the door to molecules, which have largely thwarted laser cooling techniques.

Most optical cooling methods rely on a light-induced force that is tuned to selectively remove energy from the target object. In Doppler cooling, for example, the light-induced force is based on the discrete absorption of light at a specific transition frequency, which
is shifted to pick out objects moving toward the light source. The problem, however, is 
that many atoms and molecules do not have “closed” transitions that allow a repeating 
cycle of absorptions.

Cavity cooling does not depend on discrete absorption but utilizes continuum scattering 
for its light-induced force. Normally, the outgoing photon from such a scattering 
interaction has a range of frequencies, but inside a cavity the scattering spectrum narrows 
to a specific frequency corresponding to a cavity resonance. To use this selectivity for 
cooling, one tunes the resonance so that the outgoing photons take energy away from the 
target object. Cavity cooling of multiple atoms requires strong atom-cavity coupling as 
well as a trapping mechanism to localize the atoms in the cavity. With their cavity system, 
the researchers managed to cool a small cloud of cesium atoms to 10 μK. The team 
expects that further optimization of their method could allow cooling of an ensemble of 
molecules in many different rotational and vibrational states.

This research is published in *Physical Review Letters*.

–Michael Schirber

Michael Schirber is a Corresponding Editor for *Physics* based in Lyon, France.

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**Subject Areas**

Atomic and Molecular Physics

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**Cavity Cooling of Many Atoms**

Mahdi Hosseini, Yiheng Duan, Kristin M. Beck, Yu-Ting Chen, and Vladan Vuletić


Published May 1, 2017