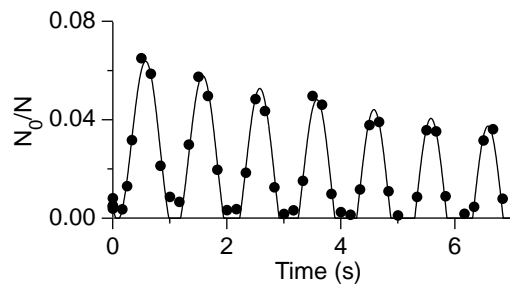


Reversible formation of a Bose-Einstein condensate

In an ordinary cryostat, the experimenter can raise and lower the temperature of a sample reversibly. In contrast, evaporative cooling is irreversible due to the loss of the evaporated atoms. Even if the temperature is raised again by (internal or external) heating of the sample, the number of atoms lost during the cooling stage cannot be recovered.

In recent experiments, we could cross the BEC transition reversibly by slowly changing the shape of the trapping potential using a combination of magnetic and optical forces [1]. This process conserves entropy while changing the local phase space density.

By ramping up the power of an infrared beam focused into the center of the magnetic trap, we could increase the phase-space density by a factor of 50. The reversibility of crossing the BEC phase transition was demonstrated by preparing a magnetically trapped cloud just above the critical temperature and then sinusoidally modulating the infrared power. We could reversibly cycle at least 15 times back and forth across the BEC transition.



Adiabatic cycling through the phase transition by sinusoidally modulating the optical trapping potential. Shown is the condensate fraction versus time. The solid lines are guides to the eye.

1. D.M. Stamper-Kurn, H.-J. Miesner, A.P. Chikkatur, S. Inouye, J. Stenger, and W. Ketterle, Phys. Rev. Lett. **81**, 2194 (1998).