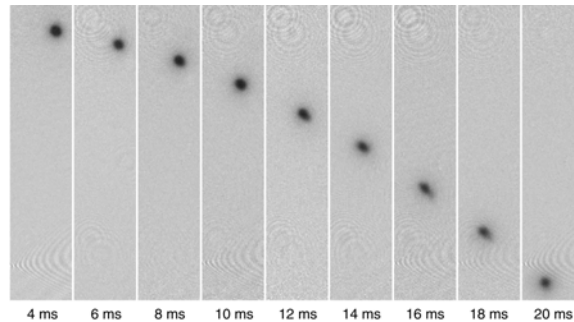


Formation of Quantum-Degenerate Sodium Molecules

A current frontier in the field of ultracold gases is the study of ultracold molecules. In 2003, several groups succeeded in converting ultracold atoms into ultracold molecules by magnetically tuning a molecular level close to zero binding energy (Feshbach resonance). Atoms can then form molecules without release of heat.

In our experiment, we produced ultracold sodium molecules from an atomic Bose-Einstein condensate by ramping an applied magnetic field across a Feshbach resonance [1]. More than 10^5 molecules were generated with a conversion efficiency of $\sim 4\%$. High phase-space density could only be achieved by rapidly removing residual atoms, before atom-molecule collisions caused trap loss and heating. This was accomplished by a new technique for preparing pure molecular clouds, where light resonant with an atomic transition selectively “blasted” unpaired atoms from the trap. Time-of-flight analysis of the pure molecular sample yielded an instantaneous phase-space density greater than 20.



Ballistic expansion of a pure molecular sample. Absorption images of molecular clouds (after reversion to atoms) are shown for increasing expansion time after switching off the optical trap. The small expansion velocity corresponds to a temperature of about 30 nK, characteristic of high phase-space density. The images are taken along the weak axis of the trap. The field of view of each image is 3.0 mm x 0.7 mm.

1. K. Xu, T. Mukaiyama, J.R. Abo-Shaeer, J.K. Chin, D.E. Miller, and W. Ketterle, *Formation of Quantum-Degenerate Sodium Molecules*, Phys. Rev. Lett. **91**, 210402 (2003).