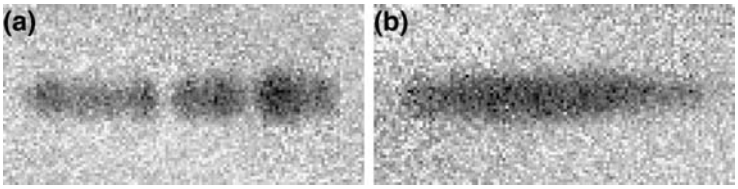
Bose-Einstein condensates near a microfabricated surface

Microfabricated chips with current-carrying wires can confine ultracold atoms more tightly and in more complex geometries. However, previous experiments revealed unexpected phenomena when ultracold atoms were trapped very close to microfabricated surfaces: Fragmentation of the cloud, and shortening of the lifetime were observed. In this study, we compared magnetically and optically confined Bose-Einstein condensates near a microfabricated surface [1]. Since the two traps operate on different principles, this study provided a unique examination of the interaction between Bose-Einstein condensates and a microfabricated surface.

Condensate fragmentation observed in microfabricated magnetic traps was not observed in optical dipole traps at the same location. Therefore, the corrugated potential was created by the current carrying wires. The measured condensate lifetime was >20 s and independent of the atom-surface separation under both magnetic and optical confinement. The much shorter lifetimes observed elsewhere were probably due to technical noise. Radio-frequency spin-flip transitions driven by technical noise were directly observed for optically confined condensates and could limit the condensate lifetime in microfabricated magnetic traps.



Fragmentation of Bose-Einstein condensates. Radial absorption images after 10 ms ballistic expansion of condensates containing $\approx 10^6$ atoms after holding at a distance of 85 μm from the microfabricated surface for 15 s in the (a) microfabricated magnetic trap and (b) optical dipole trap. Longitudinal fragmentation occurred for condensates held in the microfabricated magnetic trap, but not for those confined optically at the same location with the microfabricated magnetic trap off. The field of view is 0.5 mm x 1.0 mm.

1. A.E. Leanhardt, Y. Shin, A.P. Chikkatur, D. Kielpinski, W. Ketterle, and D.E. Pritchard, *Bose-Einstein condensates near a microfabricated surface*, Phys. Rev. Lett. **90**, 100404 (2003).