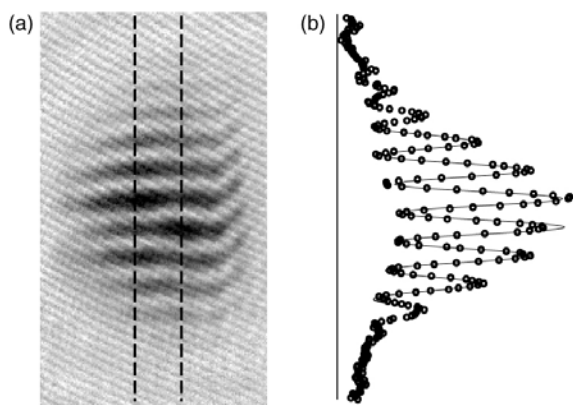
Atom interferometry with Bose-Einstein condensates in a double-well potential

The applicability, accuracy, and sensitivity of atom interferometers may be improved by exploiting the laser-like coherence properties of gaseous Bose-Einstein condensates in combination with the fine manipulation capabilities of atomic microtraps and waveguides. Current proposals for microtrap and waveguide interferometers utilize double-well potentials for beam splitters and recombiners. To implement a prototype of such schemes, we created a trapped-atom interferometer using gaseous Bose-Einstein condensates coherently split by deforming an optical single-well potential into a double-well potential [1].

Sodium condensates were split by deforming an initially single-well potential into two wells separated by 13 μm. To avoid deleterious mean field effects common to traditional in-trap recombination schemes, the relative phase between the two condensates was determined from the spatial phase of the matter wave interference pattern formed upon releasing the atoms from the separated potential wells. The coherence time of the separated condensates was measured to be 5 ms, and was set by technical limitations of our current setup. The large separation between the split potential wells allowed the phase of each condensate to evolve independently and either condensate to be addressed individually.



Matter wave interference. (a) Absorption image of condensates released from the optical double-well potential and allowed to expand for 30 ms. The field of view is 600 μm × 350 μm. (b) Radial density profiles were obtained by integrating the absorption signal between the dashed lines, and typical interference patterns had > 60% contrast. The spatial phase of the matter wave interference pattern was extracted from the fit shown.

1. Y. Shin, A.E. Leanhardt, M. Saba, T. Pasquini, W. Ketterle, and D.E. Pritchard, *Atom interferometry with Bose-Einstein condensates in a double-well potential*, preprint cond-mat/0306305.