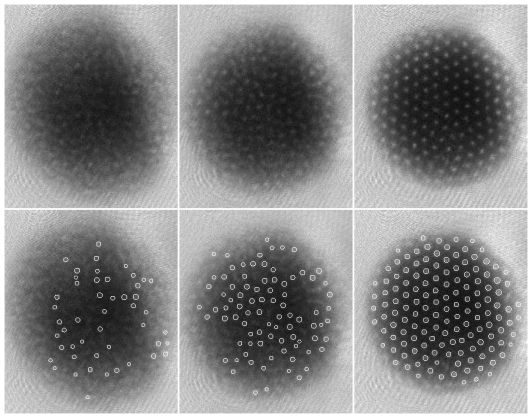
Formation and Decay of Vortex Lattices in Bose-Einstein Condensates at Finite Temperatures

Gaseous Bose-Einstein condensates (BEC) are a testbed for many-body theory. Recently, rotating condensates and vortices have become the focus of many theoretical and experimental studies [1]. We have done the first quantitative investigation of vortex dynamics at finite temperature [2].

The decay of the vortex lattice was observed non-destructively by monitoring the centrifugal distortions of the rotating condensate. The formation of the vortex lattice could be deduced from the increasing contrast of the vortex cores observed in ballistic expansion. In contrast to the decay, the formation of the vortex lattice was insensitive to temperature. Both processes are dissipative and require physics beyond the Gross-Pitaevskii equation.



Crystallization of the vortex lattice. The top row shows three condensates that have equilibrated for 50, 150 and 300 ms, respectively, and have 48, 86 and 140 vortices recognized as "visible" by our algorithm. The bottom row shows the same condensates with the "visible" vortices circled. The field of view was 1.4 mm by 1.6 mm. The increase in visibility was shown to be independent of temperature in the range studied.

1. A.L. Fetter and A.A. Svidzinsky, *Vortices in a trapped dilute Bose-Einstein condensate*, J. Phys.: Condens. Matter **13**, R135 (2001).
2. J.R. Abo-Shaeer, C. Raman, and W. Ketterle, *Formation and Decay of Vortex Lattices in Bose-Einstein Condensates at Finite Temperatures*, Phys. Rev. Lett. **88**, 070409 (2002).