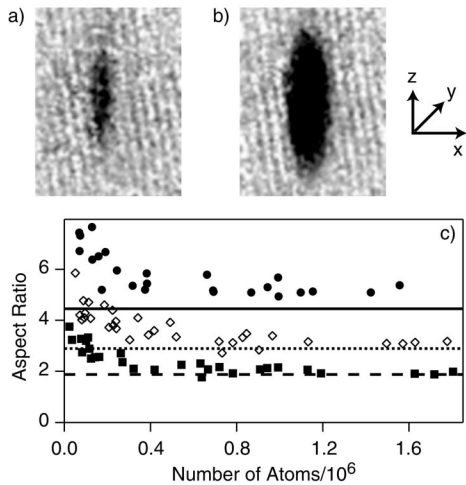


Realization of Bose-Einstein condensates in lower dimensions

Bose-Einstein condensates of sodium atoms have been prepared in optical and magnetic traps in which the energy-level spacing in one or two dimensions exceeds the interaction energy between atoms. This realized condensates of lower dimensionality [1]. In anisotropic traps, a primary indicator of crossing the transition temperature for Bose-Einstein condensation is a sudden change of the aspect ratio of the ballistically expanding cloud. The transition to lower dimensions is a smooth cross-over, but has similar indicators. In the 3D Thomas-Fermi limit the degree of anisotropy of a BEC is independent of the number N of atoms, whereas in 1D and 2D, the aspect ratio depends on N . This was used in our experiments as a distinctive feature of lower dimensionality.

In our traps, the ratio of the highest to lowest frequency was about 100. Due to this extreme geometry the number of atoms at the cross-over to lower-dimensionality was rather large ($> 10^5$ in the 2D case) which provides a good starting point for the exploration of phenomena which only occur in one or two dimensions.



Cross-over from 3D to 2D condensates observed in the change of the aspect ratio. Condensates were released from a disk-shaped optical trap and observed after 15 ms time-of-flight. a) (2D) condensate with 9×10^4 atoms b) (3D) condensate with 8×10^5 atoms in a trap with vertical trap frequency of 790 Hz. c) Aspect ratio as a function of atom number for optical traps with vertical trap frequencies of 1620 Hz (filled circles), 790 Hz (open diamonds) and 450 Hz (filled squares). The lines indicate the aspect ratios as expected for condensates in the 3D (Thomas-Fermi) regime. We attribute discrepancies between expected and measured aspect ratio for large numbers to the influence of anharmonicities on the measurement of the trap frequencies.

1. A. Görlitz, J.M. Vogels, A.E. Leanhardt, C. Raman, T.L. Gustavson, J.R. Abo-Shaeer, A.P. Chikkatur, S. Gupta, S. Inouye, T. Rosenband, and W. Ketterle, *Realization of Bose-Einstein condensates in lower dimensions*, Phys. Rev. Lett. **87**, 130402 (2001).