Two-step condensation of the ideal Bose gas in highly anisotropic traps

The ideal Bose gas in a highly anisotropic harmonic potential was studied theoretically [1]. It was found that Bose-Einstein condensation occurs in two distinct steps as the temperature is lowered. In the first step the specific heat shows a sharp feature, but the system still occupies many one-dimensional quantum states. In the second step, at significantly lower temperature, the ground state becomes macroscopically occupied. It should be possible to verify these predictions using present-day atom traps. The two-step behavior can occur in a rather general class of anisotropic traps, including the box potential.

Overview of the three different regimes of BEC in an anisotropic harmonic oscillator potential with $\omega_1 << \omega_2 = \omega_3$ as a function of particle number $N$, and trap anisotropy $\omega_2/\omega_1$. The two-step BEC regime separates the regime of “normal” three-dimensional BEC and the regime of extreme anisotropy where the system first becomes one-dimensional and then undergoes 1D BEC as a second step.