Phase separation dynamics of two-component Bose-Einstein condensates in various optical trap shapes

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1. Introduction

It is known theoretically and experimentally that multi-component Bose-Einstein condensates exhibit phase separation and form the spatial structure of spin domains [1], and expected to be a versatile source of intricate non-equilibrium pattern formation dynamics. The formation of various phase separation dynamics by varying potential shapes was theoretically predicted [2]. We investigate the dynamics of phase-separating two-component condensates in various optical trap shapes.

2. Experiment

We created ^{87}Rb Bose-Einstein condensates (BEC) in a magnetic trap. After that, the condensates were loaded into a crossed far-off-resonance optical trap formed with two 980-nm-wavelength laser beams. We prepared two axial direction beams with different shapes. In the first case, axial beam has a radius of 25 μm at the focus (circular beam). In the 2nd, axial beam (oblong beam) has a radius of 20 μm (horizontal) and 80 μm (vertical). The other laser beam has a beam waist of 85 μm, and that is crossed with the first beam at right angle. Figure 1 shows absorption images of condensates taken from the radial direction after a free expansion of 15ms. The holding time in the optical trap is 200 ms. Also, we measured the trap frequency of each optical trap by parametric resonances. The trap frequencies of the optical trap formed by the circular beam were ν_{radial} = 174 Hz and ν_{axial} = 30 Hz. And those of the oblong beam trap were ν_{radial} = 339 Hz (horizontal direction), ν_{radial} = 40 Hz (gravity direction) and ν_{axial} = 44 Hz. Figure 2 shows schematic view of the shapes of condensates in each optical trap.

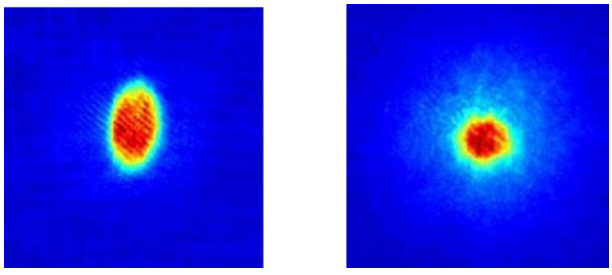

Figure 1 Absorption images of condensates taken from the radius direction after free expansion for 15ms, and correspond to 200 ms holding time in optical trap.
left：circular beam.　right：oblong beam.

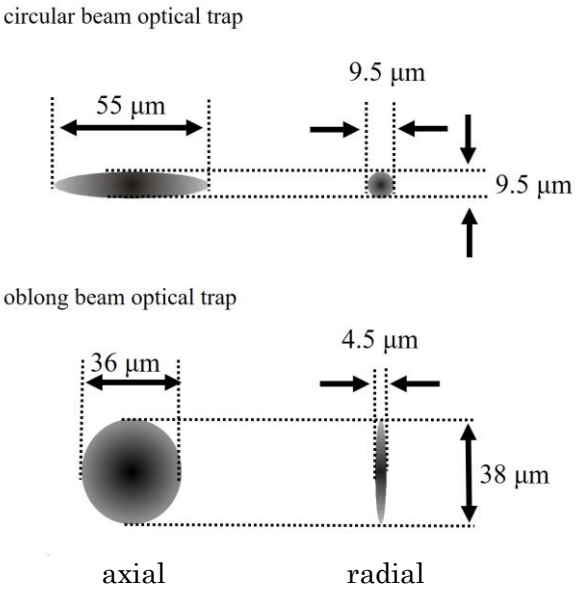

Figure 2 The schematic view of the shapes of condensates (^{87}Rb BEC containing 4×10^5 atoms) in each optical trap.

3. Conclusions

We confirmed that the condensates could be trapped by two different optical traps. The dynamics of phase-separating two-component Bose-Einstein condensates in two different potential shapes will be reported.

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References

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