Fragmentation and Stillbirth of Condensation in the Rapid Evaporative Cooling of a Dual Species Bose Mixture

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Recently, the realization of dual-species Bose-Einstein condensate (BEC) with tunable miscibility has been reported [1]. It has been pointed out that the dual-species Bose-Einstein condensate (BEC) may fail to form if the particle number of one component is too large at the start of evaporation [1]. As a consequence, the other component cannot be cooled to condensation and thus remains a dilute thermal gas. In this investigation, we employ the stochastic projected Gross-Pitaevskii equation (SPGPE) to simulate the growth of dual-species condensate during the rapid temperature quench. The numerical results based on the SPGPE method are consistent with the experiment [1]. We have found that the formation of dual-species BEC is very sensitive to the geometry of confining traps, and the interaction between atoms. Fragmentation, i.e., the reduced one-particle density of the system of N identical bosons is having more than one macroscopic (with respect to N) eigenvalues, may occur and play a crucial role during the growth of condensates [2]. We demonstrate three scenarios for the growth of phase-separated condensates by numerical simulations: First, the successful formation of two BECs without fragmentation. Second, the formation of two BECs, yet one of them is fragmented. Third, one species is condensed without fragmentation, while the other is stillborn.

[1] S. B. Papp, J. M. Pino and C. E. Wieman, Phys. Rev. Lett. 101, 040402(2008)
[2] Nimrod Moiseyev, Alexej I. Streltsov and Lorenz S. Cederbaum, Phys. Rev. A 70, 053607(2004).