Charged bosons in 2D harmonic trap: localization-delocalization

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In this work the localization and delocalization of strongly coupled ultra-cold bosonic atoms with a logaritmic repulsion confined to a two-dimensional (2D) harmonic trap is investigated numerically. Recent calculations on the structure and spectrum of classical 2D clusters with a logarithmic interaction potential on ordered structures formed in rotating ultracold Bose gases are regarded as introductory to a broader view of this research field. The work will be relevant to the experimental study of vortices in atomic Bose-Einstein condensates and will provide another method to understand the Abrikosov lattice formation of small numbers of vortices in the inhomogeneous systems.

In a system of N bosonic atoms (Rubidium), with N in the range from 2 to 10, the density profiles and energies can be obtained without any unnatural boundary conditions using the “ Unrestricted Bose-Hartree-Fock” method. The ground state properties of the systems are analyzed by changing the strength of the interactions and also the geometry of the traps from isotropic to nonistropic.

Starting from a symmetric Bose-Einstein Condensate, (BEC) the calculations show that symmetry broken states are observed under the effects of strong correlations between the bosonic atoms. The localization and delocalization of bosons (Wigner and Super -molecules) will be discussed with the comparison of their properties. The numerical calculations for BEC and Fermion-like states in a 2D geometry will be reported for a logaritmic potential in comparison with the results of 1/r type potential.