Casimir force of geometrically confined Bose gas with a trapping potential

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An analogy of the Casimir effect (Casimir, 1948) can be found in a geometrically confined Bose-Einstein condensation (BEC) system. It is known that this geometry dependent Casimir-like effect in BEC systems caused by the long-range quantum fluctuation at zero temperature or thermal fluctuation at finite temperature. To understand the nature of the Casimir effect in BEC systems, it has been attracted a lot of interest both in experiment and theory (P. A. Martin and V. A. Zagrebn, 2006; A. Gambassi and S. Dietrich 2997; S. Biswas, 2007; M. E. Fisher, P.G. de Gennes, 1978). However, the role and importance of the Casimir force in the BEC systems has not been understand yet although there are many theoretical and experimental attempts. In experiments, to create BEC, the bosonic particles are generally trapped by external harmonic magnetic and optical lattice potentials. The optical lattice potential leads sinusoidal trapping of the particles and also allows to investigate quantum phase transition from a super-fluid to a Mott insulator while particles are trapped down to low energy levels of the system by the magnetic harmonic potential. With this motivation, we investigate the Casimir force of a geometrically BEC system due to the thermal fluctuations in the presence of a harmonic magnetic and optical trap potentials. To our knowledge this has not been studied before although the Casimir force of confined Bose gas with harmonic potential has been investigated in several studies. The aim here is to clarify the contribution of harmonic and optical potentials simultaneously to Casimir force in a well. In order to investigate the Casimir force we consider ideal Bose gas trapped in a two dimensional harmonic-optical potential between two infinite parallel plates at the xy planes that are separated by a distance d in the z-direction. We clarify the contribution of harmonic and optical potentials simultaneously to Casimir force in a well for present model. We show that the Casimir force of condensate Bose gas in a potential well decays with inversely proportional to d^5 when $T \approx T_c$ depends on Riemann's Zeta function and frequencies of harmonic-optical potential, however, in the case of $T > T_c$, it decays exponentially depending on separation d of the plates. Additionally, we report that the Casimir force and also related potentials for the present model have resonances in frequencies.

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