SUMMARY OF DOCTORAL THESIS

The author's name: Luong Thi Theu

Thesis title: Study of the Casimir effect in Bose-Einstein condensate

Scientific branch of the thesis: Physics

Major: Theoretical and Mathematical Physics Code: 9 44 01 03

The name of postgraduate training institution: Hanoi Pedagogical University 2

1. Thesis purpose and objectives

The influences of the finite-size effect on properties of a Bose-Einstein condensate (BEC) confined between two parallel plates are considered. In this thesis, we focus on studying the BEC at zero temperature and without an external field in both the canonical ensemble (CE) and grand canonical ensemble (GCE). The details are in order:

a) A single BEC:

- Investigating the wave function describing the ground state based on the Gross-Pitaevskii equation (GP). After that, we find the surface tension energy and the Casimir-like force.

- Studying the influences of finite-size effect on condensate density, Casimir energy and Casimir force in one-loop and two-loop approximations.

- Studying the total Casimir force, which is the net force of the quantum Casimir force and the Casimir-like force.

b) Two-component BEC:

In case of the two-component BEC, due to the complex of the mathematical calculations, we only investigate in GCE and mainly focus on:

- Using double parabola approximation (DPA) to study the surface tension energy and Casimir-like force.

- Investigating the Casimir effect in one-loop and two-loop approximations.

2. Research methods

- When studying surface tension force, we use the mean field method for the BEC at zero temperature, which is described by the GP(s) equation(s). In order to analytically solve this/these equation(s), we use the DPA.

- The Cornwall-Jackiw-Tombolis (CJT) effective action approach is employed to consider the Casimir effect.

3. Major results and conclusions

3.1. The major results

- For a single BEC, we obtain the properties of Casimir-like force (attractive

or repulsive) in various statistics. The thesis also evaluated that when the distance between the two parallel plates increases, the Casimir force magnitude decreases gradually according to the half-integer power law of the distance between two hard walls. In the meantime, the thesis also showed that there always exists a value of the distance between two parallel plates where the Casimir force is completely vanished.

- In case of two-component BEC, Casimir force is vanished in the limit of the full strong segregation.

- When studying the influnece of finite-size effect in a single and twocomponent BEC, we should not ignore the contribution of higher-order diagrams in the interaction Lagrangian.

3.2. Conclusions

- The research results of the thesis are reliable, and have been published in the prestigious scientific journals: Journal of Statistical Physics, International Journal of Modern Physics B, and Jounnal of Experimental and Theoretical Physics

- The obtained results in this thesis play an important role in the field of the Casimir force, and the influences of finite-size effect on the physical properties of the BEC.

On behalf of academic supervisors

Assoc. Prof. Nguyen Van Thu

PhD. Student

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