Boson gas mean field models trapped by weak harmonic potentials in mesoscopic scaling

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A model of a mean-field interacting boson gas trapped by a weak harmonic potential is considered by means of the Random Point Fields(RPF). In the previous work[1], it was shown that in the Weak Harmonic Trap limit there are two phases: For chemical potentials less than a certain critical value, the resulting RPF coincides with the usual boson RPF, which corresponds to a non-interacting (ideal) boson gas. For the chemical potentials greater than the critical value, the RPF describes a divergent local density. In the limit procedure, the harmonic potential is supposed to be so weak that the gas trapped in a large region in the macroscopic sense. That is, the gas distributes in the volume much greater than the laboratory scale.

In this work, we consider the same model in the different scale in which the harmonic potential is weak, but the boson gas is supposed to be trapped in a finite volume of the laboratory scale. The RPF which describes the position distribution of the bosons is derived. It yields a complementary point of view to the distribution given in the previous work.

Possible generalizations to non-harmonic potentials are conjectured.

[1] H.Tamura and V.A. Zagrebnov: Mean-field interacting boson random point fields in weak harmonic traps, J. Math. Phys. **50**, 023301 (2009)