Chapter 1

Examples of Ground States and Excitations of Bose System

1.1 Homogeneous Bose Gas

Hamiltonian of Homogeneous Bose Gas is given by

$$H - \mu N = \sum_k a_k^\dagger a_k (\epsilon_k - \mu) + \frac{g}{2V} \sum_{k,k',q} a^\dagger_{-k'+q} a^\dagger_{k'+q} a_{k+q} a_{k'+q} \tag{1.1}$$

Here the Hamiltonian is written in k space of a grand-canonical assemble. $\epsilon_k = \hbar k^2/2m$, non-interacting kinetic energy, V is Volume, and $g = \frac{4\pi\hbar^2 a_s}{m}$ is interaction, where a_s is scattering length. The interaction part is a typical two particle scattering process. And here we take $g > 0$.

Let's talk a bit of interaction g and scattering length a_s first.
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1.2 Bose Gas in a Trap

1.3 Special Cases of 1D Bose Gas

1.4 Rotating Bose Gas

1.5 Mixture of BEC of pseudo-spin 1/2 Bose Gas