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Derivation of the Bogoliubov Time Evolution for Bose Gases with Finite Speed of Sound

We consider the dynamics of an interacting Bose gas near the ground state in a limit where both the volume and the density of the gas tend to infinity. The interaction is scaled with the inverse density. We prove a mean-field type result and consider the Bogoliubov excitations around a product state. This allows us to prove convergence of the N-body dynamics to the Bogoliubov approximation in L^2 norm, while the Hartree approximation gives convergence only in the sense of reduced densities. These results can be applied to the setting of a Bose gas with slight perturbations. Then the coupling constant is such that the self-interaction of the fluctuations is of leading order, which leads to a finite (non-zero) speed of sound in the gas.