

Quantum correlations of dilute quantum gases with extended mean-field theory

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After a brief introduction to the field of ultracold atomic physics, the main concepts of an extended mean-field theory are presented. This theory expands the state of a quantum field around a classical mean-field amplitude. The second order deviations around the mean-field are then treated as dynamical variables and a consistent theory is presented for these normal and anomalous fluctuations. This framework is applied to a quasi one-dimensional geometry for which we calculate phase correlations, density fluctuations and three-body loss rates, that are relevant for many experiments.

In particular we study the transition from the weakly correlated Gross-Pitaevskii limit to the strongly correlated Tonks-Girardeau regime at zero temperature and discuss the impact of finite temperatures. Additionally we investigate the influence of number fluctuations on this transition for small systems.