Abstract Submitted
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A large-N expansion based theoretical framework for modeling cold atoms in and out of equilibrium[1] CHIH-CHUN CHIEN, University of California, Merced, FRED COOPER, Harvard University, EDDY TIMMERMANS, BOGDAN MIHAILA, Los Alamos National Laboratory, JOHN DAWSON, University of New Hampshire — The large-N expansion is a scheme for rearranging Feynman diagrams. Although this technique can be applied to cold atoms with contact interactions, for single-component ultra-cold bosons the leading-order large-N expansion does not reproduce Bogoliubov dispersion in the Bose-Einstein condensation (BEC) phase. However, we prove that the correct vacuum leads to a dispersion resembling Bogoliubov dispersion. Moreover, we have developed a theory, which includes the normal as well as the anomalous Green's functions. This theory, named leading-order auxiliary field theory, is gapless, conserving, and has a second-order phase transition. We also generalize it to describe a two-component Bose gas above its BEC transition temperature. The mixture to phase-separation transition is shown to survive at high temperature in this model without any BEC. Furthermore, the same theoretical framework can be applied to ultra-cold fermions and we found that the BCS-Leggett theory of BCS-BEC crossover can be derived as the leading-order theory from this framework. Importantly, our theoretical framework can be generalized to include time dependence so interesting dynamics in cold atoms could be investigated in a coherent fashion.

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