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Number-of-Particle Fluctuations and Stability of Bose-Condensed Systems CHANG-HUA ZHANG, Physics Department, Indiana University — In this paper we show that a normal total number-of-particle fluctuation can be obtained consistently from the static thermodynamic relation and dynamic compressibility sum rule. In models using the broken $U(1)$ gauge symmetry, in order to keep the consistency between statics and dynamics, it is important to identify the equilibrium state of the system with which the density response function is calculated, so that the condensate particle number N_0, the number of thermal depletion particles $\tilde{N}$, and the number of non-condensate particles N_{nc} can be unambiguously defined. We also show that the chemical potential determined from the Hugenholtz-Pines theorem should be consistent with that determined from the equilibrium equation of state. The $N^{4/3}$ anomalous fluctuation of the number of non- condensate particles is an intrinsic feature of the broken $U(1)$ gauge symmetry. However, this anomalous fluctuation does not imply the instability of the system. Using the random phase approximation, which preserves the $U(1)$ gauge symmetry, such an anomalous fluctuation of the number of non-condensate particles is completely absent.

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