The von Neumann lattice coherent states and quantum fluctuations in an interacting many-Boson system with spontaneous symmetry breaking

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We consider an interacting many-Boson system with spontaneous symmetry breaking whose order parameter is expressed as the expectation value of the second quantized Boson field operator in the space dimension $d = 3$. The order parameter is a classical field that satisfies a Schrödinger type equation. The equation is not closed with respect to the order parameter but contains other correlation functions due to the many-body interaction, i.e., the BBGKY hierarchy. Hence to calculate the order parameter it is certainly necessary to introduce an approximation to deal with such correlation functions. In this paper we propose an approximation scheme to calculate the effects of quantum fluctuations on the order parameter. We start with the coherent state description of the order parameter due to Langer [1]. Using the von Neumann lattice coherent states [2] and the Hill-Wheeler method [3][4], we shall show how the effects of the quantum fluctuations can be systematically calculated. The formulation is a natural extension of the previous work by Toyoda and Wildermuth [5][6]. We also discuss the connection to the finite temperature loop expansion [7][8].

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