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Liquid helium-4 in the static fluctuation approximation

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Abstract

In this work liquid helium-4 is studied for the first time within the framework of the so-called static fluctuation approximation. This is based on the replacement of the square of the local-field operator with its mean value. A closed set of nonlinear integral equations is derived for weakly as well as for strongly interacting systems. This set is solved numerically by an iteration method for a realistic interhelium potential. The thermodynamic properties are then obtained for both the weakly interacting system, liquid 4He in Vycor glass, and the strongly interacting system, liquid 4He. It turns out, however, that the present quadratic-fluctuation approximation is valid in the latter, strongly interacting case only in the low-temperature limit (≤0.15 K). Our results are presented in a set of figures. The role of the interaction is emphasized and the functional dependence of key thermodynamic quantities on the temperature is derived for both weakly and strongly interacting 4He systems.