Physica **84A** (1976) 82–100

APPLICATION OF METHODS OF THE SCATTERING THEORY IN THE STATISTICAL THEORY OF LIQUIDS

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Received 12 August 1975
Revised 4 December 1975

This paper is devoted to the application of the projection methods of the nonrelativistic quantum theory of scattering (the method of Petrov–Bubnov–Galerkin (PBG) and the Bubnov–Galerkin (BG) method) in the statistical theory of liquids. By means of the projection PBG method we have found a new family of equations both for the correlation functions and for the radial distribution function (RDF). In the generalized equation for the RDF we have obtained new terms which are linear and quadratic in the density and the latter are absent in all the previous theories. By means of the projection BG principle the approximate eigenfunctions of the Liouville operator in a liquid were obtained as a linear combination of the Kihara functions. It was shown that the spectrum of the collective excitations is determined by the complex Fourier transformation of the force acting on an arbitrary particle in a liquid.

1. Introduction

The considerable progress which is achieved in the statistical theory of the condensed systems for some time past is due to the introduction and wide acceptance of the methods of the quantum theory of fields[1,2]). The specific difficulties of the statistical theory of liquids were called forth by the intensive interactions and the high nonregularity of the thermal motion of particles[3]).

On account of this, perturbation methods turn out to be noneffective for liquids. At present a uniform approach independent of the model to the solution of the Schrödinger equation is developed for treating many-body scattering problems[4]). The theory has been formulated recently in an elegant and simple form by Feshbach[4,5]) using the channel-projection operators, although similar formalisms have been developed earlier by a number of authors. From a mathematical point of view a method of reduction of the equations is a particular case of a general scheme of Petrov–Bubnov–Galerkin (PBG) and Bubnov–Galerkin (BG) projection principles.

In this paper we use the projection methods of the nonrelativistic quantum scattering theory for the solution of two different and important problems of the