PREFACE

This book is devoted to a consistent representation of the basic concepts and ideas of quantum statistical mechanics as well as to problems of the theory of a non-ideal Bose gas, superfluidity, and fundamental aspects of quasi-averages.

In the first part, the Liouville equation in classical and quantum mechanics, the Gibbs equilibrium distribution, thermodynamic functions, two-time correlation functions and Green functions in the theory of statistical equilibrium are considered. A theorem on the infinitesimal variations of the expectation value of a dynamical quantity under small variations of a Hamiltonian is formulated. The theorem can be used for derivation of kinetic equation in terms of the Green functions.

The second part present a consistent discussion of the method of secondary quantization. This method is widely used in modern quantum statistical physics, solid state physics, the theory of magnetism, the theory of lasers, and other problems of many-body theory.

Our approach differs from previous ones by its greater generality, simplicity of proofs, and natural formulation of problems. In this approach, we discuss fundamental questions arising under application of the method of secondary quantization from a single point of view. A certain interest to such a discussion is brought about by a method of approximating Hamiltonians which essentially uses the representation of secondary quantization. Moreover, in most textbooks on quantum mechanics and statistical physics, only a few of the results of the method of secondary quantization are discussed, due to the long calculations involved. The results, therefore are presented formally and do not touch the complex physical picture of this important method.

In the third part, it is is shown how it is possible to write different dynamical operators in terms of the creation and annihilation operators. After introduction of the Heisenberg picture, equations of motion are obtained which describe the evolution of operator function in time. Equations of the self-consistent field are then derived for operator functions. The

relations to the Vlasov equation in classical statistical mechanics are analyzed. Pseudo-operators of binary collisions are introduced to study the dynamics of a system of elastic spheres enclosed in a macroscopic volume. The Boltzmann-Enskog equation is shown to possess microscopic solutions.

In the third part, problems of the equilibrium theory of ideal Bose and Fermi systems, as well as diagonalization of a quadratic forms in Bose and Fermi operators, are considered. A theorem by Bloch and de Dominicis on calculating the expectation value of the product of creation and annihilation operators is formulated. Problems on diagonalization of general quadratic forms both for the Bose and Fermi statistic are also considered.

In the fourth part, problems related to the theory a non-ideal Bose gas are analyzed. An explanation of the phenomenon of superfluidity is given at microscopic level. Fundamental problems of the theory of quasi-averages in problems of statistical physics are also considered. Some questions related to the problem of the foundation of statistical mechanics are discussed. The momentum probability density for a polaron model system is found.

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