Preface

In this monograph, within the approximations of our approach to polaron theory, we stress the importance of introducing the time ordering T-product, which results in a very convenient theoretical procedure for the calculation of thermodynamical averages.

We begin with an investigation of the so-called 'linear polaron Hamiltonian' and present in detail, calculations of the correlation functions, spectral functions and Green's functions for this linear system. It is shown that the linear polaron Hamiltonian renders possible an exact solution for the model system. The result obtained with this approach holds true for an arbitrary coupling constant describing the interaction strength between electrons and lattice vibrations. Then, with the help of a variational technique, we show the possibility of reducing the real polaron Hamiltonian to a trial or approximate model Hamiltonian.

We also consider the exact calculation of free energy by a special technique which reduces calculations with the help of the T-product. This, in our opinion, is much better and easier than analogous procedures using, for example, the Feynman path integral.[1,2]

Here, we also review our work,[3] where it was shown that the results of papers[4,5] concerning impedance calculations in the polaron model may be obtained directly without the use of path integrals.

The study of the thermodynamics of the polaron system is also done in the framework of functional methods. Calculations of the free energy and momentum distribution functions are proposed.

One also notes that polaron systems with strong coupling have proven to be useful in different quantum field models involving the construction of dynamical models of composite particles. A rigorous solution of the special strong coupling polaron problem describing the interaction of non-relativistic particles with a quantum field has been given by N. N. Bogolubov.[6] The work of A. N. Tavkhelidze, V. K. Fedyanin, O. A. Khrustalev and others,[7–10] led to further development and generalisations of N. N. Bogolubov's method. One notes further that effects of the electron-phonon interaction play an important role in many problems of modern solid state theory.[11,12–17]

The present monograph consists of a set of lectures delivered as a special course in the Physics Department of the Moscow State University.

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