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Ph.D. thesis

Superconductivity in disordered systems

Abstract

We study some aspects of the superconductivity in disordered systems - namely the superconductivity in a boron-doped diamond. We also apply theoretical methods originally developed in the field of the disordered systems to the theory of superconductivity.

In the case of the boron-doped diamond we focus on the question of the dependence of the critical temperature T_c on boron doping. We discuss the impact of the boron distribution correlations on the T_c as well. First, we evaluate the density of states at the Fermi energy N_0 within the dynamical cluster approximation. We discuss the T_c as a function of N_0 within the BCS, the McMillan and the Belitz theory. In the case of 100 samples, the simplified Belitz theory gives the best agreement with experimental data. For 111 samples the McMillan theory is sufficient. We also show that the difference of 100 and 111 samples in the N_0 dependence of T_c can be explained as given by attractive correlations in the boron distribution.

Applying the concept of the coherent potential approximation, we remove a self-interaction from the Galitskii-Feynman T-matrix approximation. This correction has no effect in the normal state but makes the theory applicable to the superconducting state. Our correction does not violate the two-particle symmetry of the T-matrix, therefore the present theory is conserving in the Baym-Kadanoff sense. The theory is developed for retarded interactions leading to the Eliashberg theory in the approximation of a single pairing channel. We also show that contrary to the Kadanoff-Martin approximation this theory describes a condensate, which is stable against excitations of noncondensed Cooper pairs.

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