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Summary of Theory of Superconductivity

Article Description

(J. Bardeen, PR V.108 N.5)

Background

The phenomenon of superconductivity was first discovered by Onnes[1] in 1911. At that time and for many years after, it was though of simply as the vanishing of all electrical resistance below the transition temperature.

The next major discovery regarding superconductivity was the discovery of the Meissner Effect[2] in 1933. It was shown that a superconductor is a perfect diamagnet; the Magnetic flux is excluded from all but a thin penetration region near the surface of the material.

London and London [3] expanded on it by proposing a phenomenological theory of the electromagnetic properties of super conductors in which the diamagnetic aspects assumed to be basic in 1935.

F. London[4] in 1935, suggest a *quantum-theoretic approach to a theory in which it was *assumed that there is somehow a coherence or rigidity in the superconducting state such that the wave functions are not modified very much when a magnetic field is applied.

Pippard[5] in 1953 proposed a nonlocal modification of the aforementioned London equations in which a coherence distance, ξ_0, is introduced. **The modification was based on experiments on penetration phenomena.**

One of the current authors, J. Bardeen [6] pointed out in 1955, that an energy-gap model would most likely lead to the Pippard theory.

The preceding theory for metals, the **Sommerfiled-Bloch theory** states,

i In the first approximation one may neglect correlations between the positions of the electrons and assume that each electron moves independently in self consistent field determined by the conduction electrons and ions.

ii Wave functions of the metal as a whole are designated by occupation of Bloch individual-particle states of energy $\epsilon(k)$ defined by wave vector k and spin σ

iii In the ground state all levels with energies below the Fermi energy, $\mathscr{E}_F$ are occupied and above are unoccupied.

One of the key motivators of the paper and BCS theory is pointed out in the article as the deficiencies of the **Sommerfield-Bloch Individual Particle Model**.

They can be characterized as:

i Although a fairly good description of normal metals, the model fails to account of superconductivity

ii The correlations between electrons brought about by coulomb forces and interactions between electrons and lattice vibrations (phonos) are neglected.

Notes

Transition Temperature:
Diamagnet:
Phenomenological:
Coherence or Rigidity:
Superconducting State:
Coherence Distance:
First Approximation:
Conduction Electron:
Bloch Individual Particle State:
Electron Correlation:
Lattice Vibrations (Phonons):

References

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