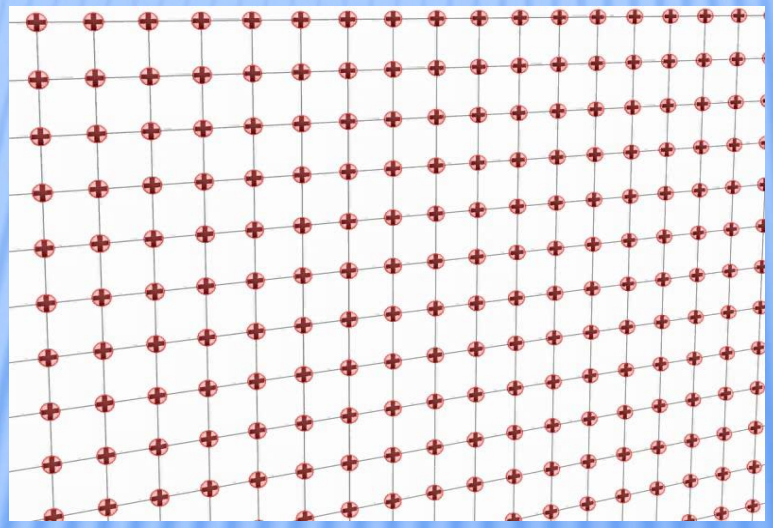
BCS - Theory

Cooper-Pairs
Formation of Pairs
Origin of Attractive Interaction

BCS Theory of Superconductivity



BCS Theory of Superconductivity

The properties of Type I superconductors were modeled successfully by the efforts of John Bardeen, Leon Cooper, and Robert Schrieffer in what is commonly called the BCS theory. A key conceptual element in this theory is the pairing of electrons close to the Fermi level into Cooper pairs through interaction with the crystal lattice. This pairing results from a slight attraction between the electrons related to lattice vibrations; the coupling to the lattice is called a phonon interaction.

Pairs of electrons can behave very differently from single electrons which are fermions and must obey the Pauli exclusion principle. The pairs of electrons act more like bosons which can condense into the same energy level. The electron pairs have a slightly lower energy and leave an energy gap above them on the order of .001 eV which inhibits the kind of collision interactions which lead to ordinary resistivity. For temperatures such that the thermal energy

In 1957 Bardeen and Cooper assembled these ingredients and constructed such a theory, the BCS theory, with Robert Schrieffer. The theory was first published in April 1957 in the letter, "Microscopic theory of superconductivity".[4]The demonstration that the phase transition is second order, that it reproduces the Meissner effect and the calculations of specific heats and penetration depths appeared in the December 1957 article, "Theory of superconductivity".[5] They received the Nobel Prize in Physics in 1972 for this theory. The 1950 Landau-Ginzburg theory of superconductivity is not cited in either of the BCS papers.