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Nobel Prize in Physics 1972


John Bardeen


Leon Neil Cooper


John Robert Schrieffer

The Nobel Prize in Physics 1972 was awarded jointly to John Bardeen, Leon Neil Cooper and John Robert Schrieffer *"for their jointly developed theory of superconductivity, usually called the BCS-theory"*.

Information about winners:

JOHN BARDEEN,

born 1908, professor of electrical engineering and physics at the University of Illinois Urbana.

LEON N. COOPER,

born 1930, professor of physics at Brown University, Providence, Rhode Island.

JOHN ROBERT SCHRIEFFER,

born 1931, professor of physics at the University of Pennsylvania, Philadelphia.

RESEARCH INFORMATION:

The award is given **for their jointly developed theory of superconductivity, usually called the BCS-theory**.

The phenomenon of superconductivity was discovered by the Dutch physicist Kamerling Onnes already in 1911. Already his first measurements indicated that one had

found a fundamentally new state of matter. The term superconductivity refers to the complete disappearance of the electrical resistance. Many remarkable properties were discovered in the following decades. However, the central problem, the question about the underlying mechanism for superconductivity, remained a mystery up to the late 50:s. The difference in energy between the superconducting and the normal state in a metal is extremely small in comparison with all typical energies in a metal and therefore many different mechanisms might a priori be possible. A significant step forward was taken around 1950 when it was found theoretically and experimentally that the mechanism for superconductivity had to do with the coupling of electrons to the vibrations of the crystal lattice. Starting from this mechanism, Bardeen, Cooper and Schrieffer developed in 1957 a theory of superconductivity, which gave a complete theoretical explanation of the phenomenon.

The new theory demonstrated that the interaction between the electrons and the lattice leads to the formation of bound pairs of electrons, which are often called Cooper-pairs. The different pairs are strongly coupled to each other which leads to a complex collective pattern in which a considerable fraction of the total number of conduction electrons are coupled together to form the superconducting state. Because of the characteristic coupling between all the electrons, one cannot break up a single pair of electrons without perturbing also all the others and this requires an amount of energy which must exceed a critical value. Many of the remarkable properties of superconductors can be understood qualitatively from the structure of this correlated many-electron state.

The theory developed by Bardeen, Cooper and Schrieffer together with extensions and refinements of the theory, which were developed by many authors soon after the key discovery, was indeed very successful in explaining in considerable detail the properties of superconductors. The theory also predicted new effects and it stimulated an intensive activity in theoretical and experimental research, which opened up new areas for research. One may as examples mention the use of the quantum mechanical tunnel phenomena to study superconductors, the discovery of magnetic flux quantization and the remarkable

Josephson effects. These more recent developments are intimately connected with the fundamental theory of superconductivity and have confirmed in a striking way the validity of the theoretical concepts and ideas developed by Bardeen, Cooper and Schrieffer.

For more details please visit:

http://www.nobelprize.org/nobel_prizes/physics/laureates/1972/press.html