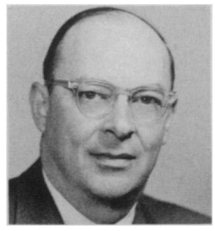
Physics: Warm regard for an ultracold theory


Cooper


Bardeen


Schrieffer

Superconductivity, the resistanceless flow of electric current in certain metals when they are cooled to temperatures near absolute zero, was discovered by Heike Kammerlingh Onnes in 1911. For nearly 50 years it eluded theoretical explanation. A theory to explain it that was propounded in 1957 has won the 1972 Nobel Prize in Physics for John Bardeen of the University of Illinois, Leon N. Cooper of Brown University and Robert Schrieffer of the University of Pennsylvania.

The breakthrough came as physicists understood more and more that the phenomena associated with superconductivity represent macroscopic quantum effects, and that an explanation must be sought by appyling quantum theory. About 1950 a group working at Rutgers University under E. Maxwell discovered that the temperature at which a metal became superconducting depended upon its atomic weight. This so-called isotope effect led Bardeen, Cooper and Schrieffer to conclude that the atoms in the metal as well as the conduction electrons played a role in superconductivity.

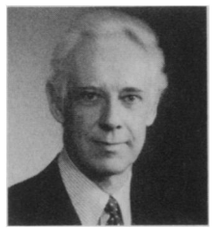
The key to the understanding was that electrons in a superconducting state act in pairs. Electrons all have negative electric charge and normally repel each other. However in a superconductor, an interaction with vibrations of the crystal lattice produces a net attraction between electrons. Thus there appear pairs of electrons with oppositely directed spins and momenta. If a current flows, the total momentum of each pair will be different from zero, but the total momentum of all pairs will be exactly the same.

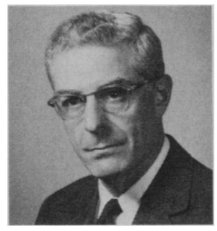
The common momentum of the pairs is not affected by random scattering of individual electrons, so there is no effective electrical resistance. A current once started will flow on indefinitely unless a force that can affect all the pairs at once, such as an electric field, is applied.

The value of the award is $100,000, which the three physicists will share equally. It makes Bardeen the first man to win two Nobel Prizes in science. He shared the 1956 award with William Shockley and Walter H. Brattain for the invention of the transistor. (Marie Curie was the only woman to win twice.)

The Nobel Prizes will be presented in Stockholm on Dec. 10, Alfred Nobel's birthday. □

Chemistry: Untangling the strands of ribonuclease


Moore


Stein


Anfinsen

Enzymes are proteins that catalyze myriad biochemical reactions in the cells of humans and of lower organisms.

Three American scientists have won the 1972 Nobel Prize for Chemistry for being the first to unravel the chemistry and structure of an enzyme. They are Stanford Moore and William H. Stein of Rockefeller University and Christian B. Anfinsen of the National Institutes of Health.

The enzyme they elucidated is ribonuclease. It breaks down ribonucleic acid (RNA) in a cell after the RNA has translated the genetic material in deoxyribonucleic acid (DNA) into requisite proteins. In 1959 Moore and Stein determined the full sequence of ribonuclease. They found that the protein molecule contains 124 amino acids and determined the location of the 1,876 atoms contained in the amino acids. These achievements were based on techniques they and others had developed—chromatography for separating and quantitatively determining amino acids, automatic fraction collectors and automatic amino acid analyzers.

Anfinsen was honored for determining how the ribonuclease molecule develops its three-dimensional structure and is locked in place by four disulfide bridges. He showed that when the 124-amino-acid chain is assembled in proper sequence, interactions among the various amino acids coax the molecule into the proper configuration for the sulfide bonds to take hold.

This elucidation of ribonuclease, and the methods developed by Moore, Stein and Anfinsen, have assisted other scientists in unraveling other enzymes. The sequencing and structural determination of ribonuclease also opened the door for the synthesis of ribonuclease. Such a synthesis should help investigators learn more about enzyme disorders that are at the root of various genetic diseases, and, in fact, may set the stage for eventual repair of defective enzymes in patients.

At an NIH press conference the day he won, Anfinsen said, "This is groundwork in a sense, but all scientific work requires basic groundwork first. It's pretty mundane stuff when it comes to practical applications, but without the tools you can't have any application." Only 20 or 25 enzymes have been elucidated to date, but, said Moore at a Rockefeller press conference, at the rate things are going, as many as 2,000 enzymes might be elucidated by the year 2000. □