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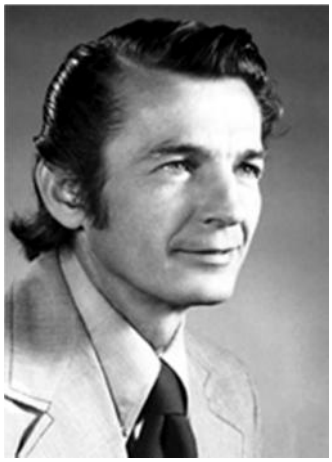
Nobel Prize in Physics 1973


Leo Esaki


Ivar Giaever


Brian David Josephson

The Nobel Prize in Physics 1973 was divided, one half jointly to Leo Esaki and Ivar Giaever *"for their experimental discoveries regarding tunneling phenomena in semiconductors and superconductors, respectively"* and the other half to Brian David Josephson *"for his theoretical predictions of the properties of a supercurrent through a tunnel barrier, in particular those phenomena which are generally known as the Josephson effects"*.

Information about winners:

Leo Esaki, USA,

Ivar Giaever, USA and

Brian D Josephson, UK.

RESEARCH INFORMATION:

The award is for their discoveries regarding tunneling phenomena in solids. Half of the prize is divided equally between Esaki and Giaever for their experimental discoveries regarding tunneling phenomena in semiconductors and superconductors respectively. The other half is awarded to Josephson for his theoretical predictions of properties in a supercurrent flowing through a tunnel barrier, in particular the phenomena generally known as the Josephson effects.

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THE LAWS OF MODERN PHYSICS

Tunneling phenomena are among the most direct consequences of the laws of modern physics. According to quantum physics electrons behave both like particles and like waves and are described by the solutions to the so-called Schroedinger equation. These waves can penetrate a barrier that would be a forbidden area if the particle was considered in the classical way. The term tunneling phenomenon refers to this property - the particle "tunnels" through the forbidden area. The best-known case of tunneling is the alpha decay of heavy atomic nuclei, which was explained as early as 1928.

The possible existence of many interesting tunneling phenomena in solids was anticipated at an early stage, but theory and experiments often gave contradictory results. The discovery of the transistor and the consequent development of semiconductor physics intensified the search for new tunnel effects, but it was unsuccessful for many years.

PIONEERING WORK

Thanks to the pioneering work of Esaki, Giaever and Josephson, this year's physics laureates, the study of tunneling phenomena in solids has developed into a large and very active field of research that has led to many important results of a fundamental character and has opened new doors for technical applications. The initial work was done by Leo Esaki, who at that time was working in the Sony Corporation research laboratory in Japan. By means of some deceptively simple experiments he proved in a paper published in 1958 the existence of a new kind of tunneling phenomenon in a semiconductor. His discovery also showed that this effect could be used technically in so-called tunnel diodes. Esaki's discovery opened up a new field of research and initiated intensive and successful developments at many international research laboratories.

The next important step was taken in 1960 by Ivar Giaever at General Electrics research laboratory at Schenectady. He demonstrated the tunnel effect through a very thin layer of oxide surrounded on both sides by metal in a superconducting or normal state. His experiment gave very direct evidence of the existence of the so-called energy gap in superconductors, which was one of the most important predictions of the theory of

superconductivity developed by Bardeen, Cooper and Schrieffer (awarded the Nobel Prize in 1972). In his later work Giaever developed his tunnel experiments into an extremely accurate spectroscopic method for studying superconductors.

THEORETICAL DESCRIPTION – THE JOSEPHSON EFFECTS

Giaever's tunnel experiments inspired the young English physicist Brian D Jospehson to analyse more closely the theoretical description. In 1962 this led to the prediction of completely new phenomena in superconductors and in particular to the effects generally known as the Josephson effects. One of these effects means that a supercurrent can flow through a tunnel barrier even when no voltage is applied to the barrier. The second effect is even more peculiar, showing that a constant difference of voltage across the barrier results in a high-frequency tunnel current in the microwave range. Josephson's theoretical predictions were confirmed by experiments within a year or so and have had a strong influence on developments in physics in recent years.

INDEPENDENT WORK

The discoveries of these three physicists were made quite independently but are closely related. Esaki's pioneering work in 1958 provided the basis for Giaever's tunnel experiments with superconductors in 1960. In turn, Giaever's work created the basis and stimulus for Josephson's theoretical discoveries in 1962. Their discoveries have opened up new areas for research and have recently led to a number of important applications, to which a large number of physicists have contributed. Examples of applications in the field of semiconductors are tunnel diodes and tunnel detectors, tunnel transistors and certain forms of semiconductor lasers. The Jospehson effects have resulted in a revision of the values of the fundamental constants, a new method for accurately measuring voltages and an extremely sensitive interferometric method which has many applications in the technology of precision measurement.

ESAKI – GIAEVER – JOSEPHSON

Leo Esaki was born in 1925 in Osaka, Japan. He took his doctoral degree in physics in Tokyo in 1959. He has worked at the Kobe-Kogyo Corporation and the Sony Corporation.

Since 1960 he has been at the Thomas J Watson Research Center, IBM Corporation, Yorktown Heights, USA. Ivar Giaever was born in 1929 in Bergen, Norway. He took his doctoral degree in physics in 1964 and is working at the General Electric Corporation, Schenectady, USA. Brian D Josephson was born in 1940 and is a doctor of physics. He was educated at Cambridge, England, where since 1967 he has been assistant head of research at the Department of Physics.

For more details please visit:

http://www.nobelprize.org/nobel_prizes/physics/laureates/1973/press.html