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Nobel Prize in Physics 1945

Wolfgang Pauli

The Nobel Prize in Physics 1945 was awarded to Wolfgang Pauli *"for the discovery of the Exclusion Principle, also called the Pauli Principle"*.

RESEARCH INFORMATION:

Rutherford gave an impulse of fundamental importance to research in atomic structure when in 1911 he found that an essential part of an atom is a positively charged nucleus in which practically the whole of the mass of the atom is concentrated, the electrons, which were discovered earlier, being grouped around the nucleus. During the first two decades following on Rutherford's discovery, the attention of most atomic physicists was focussed on the phenomena connected with the electronic configuration. According to the theory established by Bohr in 1913, and afterwards developed by him and by other scientists, we may describe those states of the atom for which its energy has a definite value by saying that each electron revolves around the nucleus. The energy corresponding to an electron orbit is defined by whole numbers, called "quantum numbers", which so to speak enumerate the energy states of the electrons. The famous theory of the atomic structure of all atoms advanced by Bohr in 1921 asserts that the

electrons of an atom are arranged in groups which have different mean distances from the nucleus and are each characterized by two quantum numbers.

Important contributions to the solution of the problem of electronic configuration were made in the following years by Landé and Stoner.

At this stage of the development of atomic theory, Wolfgang Pauli made a decisive contribution through his discovery in 1925 of a new law of Nature, the *exclusion principle* or *Pauli principle*. The 1945 Nobel Prize in Physics has been awarded to Pauli for this discovery.

Pauli based his investigation on a profound analysis of the experimental and theoretical knowledge in atomic physics at the time. He found that four quantum numbers are in general needed in order to define the energy state of an electron. He then pronounced his principle, which can be expressed by saying that there cannot be more than one electron in each energy state when this state is completely defined. Three quantum numbers only can be related to the revolution of the electron round the nucleus. The necessity of a fourth quantum number proved the existence of interesting properties of the electron.

Other physicists found that these properties may be interpreted by stating that the electron has a "spin", i.e. that it behaves to some extent as if it were rapidly rotating round an axis through its centre of gravity.

Pauli showed himself that the electronic configuration is made fully intelligible by the exclusion principle, which is therefore essential for the elucidation of the characteristic physical and chemical properties of different elements. Among those important phenomena for the explanation of which the Pauli principle is indispensable, we mention the electric conductivity of metals and the magnetic properties of matter.

In 1925 and 1926 essential progress of another kind was made in the quantum theory, which is the foundation of atomic physics. New and revolutionary methods were developed for the description of the motion of particles. The fundamental importance of Pauli's discovery could now be seen more clearly. His principle proved to be an

independent and necessary complement to the new quantum theory. Another way of expressing the principle, simpler and of wider applicability than the original one, was given. In this respect Pauli himself made an important contribution which has also had other far-reaching consequences.

During the last two decades atomic research has been more and more focussed on the properties of the atomic nuclei. In this connection it has been even more fully confirmed than before that the Pauli principle must be characterized as a fundamental law of Nature. The principle, first discovered for electrons, has proved to be valid for the nuclei of hydrogen, called *protons*, and also for the *neutrons* which are formed in many nuclear reactions. The neutrons are particles which have no charge but have approximately the same masses as the protons. According to present views any atomic nucleus consists of protons and neutrons. The Pauli principle is therefore essential for the description of the properties of atomic nuclei.

Pauli occupies a leading position in present theoretical physics. He has made many other important contributions to different branches of his science, among them several to nuclear physics.

The Royal Swedish Academy of Sciences much regrets that Professor Pauli has not had the opportunity of being present on this occasion to receive in person his Nobel Prize. The prize will now instead be delivered to the *chargé d'affaires* of the Legation of the United States of America.

For more details please visit:

http://www.nobelprize.org/nobel_prizes/physics/laureates/1945/press.html