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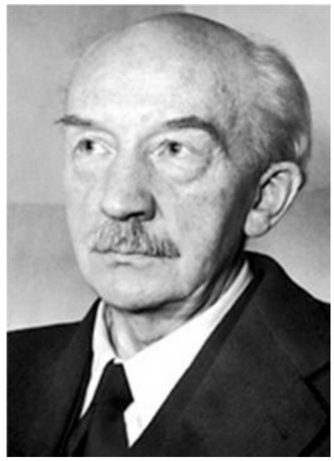
Nobel Prize in Physics 1954

Max Born **Walther Bothe**

The Nobel Prize in Physics 1954 was divided equally between Max Born *"for his fundamental research in quantum mechanics, especially for his statistical interpretation of the wavefunction"* and Walther Bothe *"for the coincidence method and his discoveries made therewith"*.

RESEARCH INFORMATION:

Research into the laws valid for the movement of the electrons around the nucleus in the centre of the atom has been a central problem for physics during this century. Niels Bohr made a start on the solution to the problem in 1913. But his theory was of a provisional nature. Professor Max Born took an active part in striving to improve it, as did the many followers who gathered round him in Göttingen. During the twenties of this century, Göttingen, together with Copenhagen and Munich, was a place of pilgrimage for researchers in the field of atomic theory. When the young Heisenberg, formerly a pupil of Sommerfeld in Munich and of Bohr in Copenhagen, published his epoch-making preliminary work on the exact laws for atomic phenomena in 1925, he was Born's assistant in Göttingen. His work was immediately continued by Born, who gave logical mathematical form to the Heisenberg theory. Owing to this progress, Born, in collaboration with his pupil

Jordan and later with Heisenberg also, was able to expand the latter's original results into a comprehensive theory for atomic phenomena. This theory was called *quantum mechanics*.

The following year Born got a new result of fundamental significance. Schrödinger had just then found a new formulation for quantum mechanics. Schrödinger's work expanded the earlier ideas of De Broglie which imply that atomic phenomena are connected with a wave undulation. However, Schrödinger had not solved the problem of how it is possible to make statements about the positions and velocities of particles if one knows the wave corresponding to the particle.

Born provided the solution to the problem. He found that the waves determine the probability of the measuring results. For this reason, according to Born, quantum mechanics gives only a statistical description. This can be illustrated by a simple example. When you shoot at a target it is possible in principle - according to the older conception - to aim the shot from the start so that it is certain to hit the target in the middle. Quantum mechanics teaches us to the contrary - that in principle we cannot predict where a single shot will hit the target. But we can achieve this much, that from a large number of shots the average point of impact will lie in the middle of the target. In contradiction to the deterministic predictions of the older mechanics, quantum mechanics accordingly poses laws which are of a statistical character, and as regards single phenomena will only determine the probabilities that one or another of various possibilities will occur. For material bodies of ordinary dimensions the uncertainty of the predictions of quantum mechanics is practically of no significance. But in atomic phenomena, on the other hand, it is fundamental. Such a radical break with older ideas could not of course prevail without opposition. But Born's conception is now generally accepted by physicists, with a few exceptions.

In addition to these achievements, which have been rewarded with the Nobel Prize, Born has made fundamental contributions to many fields of physics. In the first place he dedicated his interest to the theory of crystals and has been one of the great pioneers in that field.

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After Born had left Göttingen in 1933 he continued his famous researches in Britain, especially as a Professor at Edinburgh.

Professor Walther Bothe, who shares this year's Nobel Prize with Professor Born, began his scientific activity as a theoretical physicist.

The work for which he has now been rewarded with the Nobel Prize was carried out by him in Berlin actually as an experimental physicist. These labours were based on a new use of counter tubes. A counter tube has the property of transmitting an electric current when a charged particle, e.g. an electron, passes through it; and also, with special contrivances, when a light particle collides with it. Bothe's idea was to use two counter tubes in such a manner that the two tubes would only register simultaneous collisions. Such coincidences can only come from two particles emitted in the same elemental process, or from a particle which has travelled through both tubes at high velocity so that the time it takes for the particle's passing from one tube to the other can be neglected.

Bothe used this coincidence method in 1925 and also with improved apparatus about ten years later in order to decide whether the energy rule as well as its complement, the so-called impulse rule, is valid for every collision between a light particle and an electron - as Einstein and Compton assumed - or whether those rules are valid only on average for a large number of collisions - as Bohr and his collaborators had inferred. By investigating light particles and electrons by the coincidence method, Bothe and his co-workers were able to show convincingly that the rules mentioned are valid for every individual collision. This result was of great significance in principle. The coincidence method has been widely used in the study of cosmic radiation and is one of the most important experimental aids in the investigation of cosmic radiation. This method was first used in this way by Bothe when he was working with Kolhörster who had already given important contributions in the field of cosmic radiation. Bothe and Kolhörster used the coincidence method to pick out those particles in the cosmic radiation which had travelled through two counter tubes. The absorption of cosmic radiation into various materials was determined by placing layers of these substances between the tubes and studying the corresponding reduction in the number of coincidences. It was found that these particles are absorbed at about the same extent as the total cosmic radiation. From the experiments the particularly important result was obtained, that at sea level, cosmic radiation consists in the main of particles of very high penetration.

Bothe and other researchers later improved the coincidence method and extended its field of application. This method has now become one of the most important aids in the study of both nuclear reactions and cosmic radiation.

By many other discoveries and penetrating investigations also, Bothe has enriched our knowledge in these fields in very great measure and has provided an important stimulus to other researchers.

For more details please visit:

http://www.nobelprize.org/nobel_prizes/physics/laureates/1954/press.html