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Nobel Prize in Physics 1902

Hendrik Antoon Lorentz

Pieter Zeeman

The Nobel Prize in Physics 1902 was awarded jointly to Hendrik Antoon Lorentz and Pieter Zeeman *"in recognition of the extraordinary service they rendered by their researches into the influence of magnetism upon radiation phenomena"*

RESEARCH INFORMATION:

The Royal Swedish Academy of Sciences has decided to award this year's Nobel Prize for Physics to Professor Dr. Hendrik Antoon Lorentz of Leiden and Professor Dr. Pieter Zeeman of Amsterdam for their pioneering work on the connection between optical and electromagnetic phenomena.

Since the law of the conservation of energy was recognized as the first basic principle of modern physics, no realm of that science during the remarkable developments which have been based on this foundation has proved more fruitful than that which has had as its object the investigation of the connection between the phenomena of light and electricity.

Faraday, the great founder of the modern science of electricity, suspected this connection and devoted a great part of his experimental research to this very question. However, Maxwell was the first to take up Faraday's ideas again and develop them into a

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complete mathematical theory. According to this theory electrodynamic effects are transmitted through space at a finite speed and cause electrical currents, so-called displacement currents, even in non-conductors. Hence, every electrical current of periodically changing direction gives rise to an electrical wave motion, and light consists of just such a wave motion with an extremely short period.

This so-called electromagnetic theory of light of Maxwell's at first aroused comparatively little interest. Twenty years after its first appearance however it led to a scientific discovery which demonstrated its great significance in no uncertain manner. The German physicist Heinrich Hertz then succeeded in demonstrating that the electrical vibrations - which are generated under certain conditions when an electrically charged body is discharged - are propagated through the surrounding space in the form of a wave motion, and that the wave motion spreads at the speed of light and also possesses its properties. This gave a firm experimental basis for the electromagnetic theory of light.

In certain respects however Maxwell's theory of light was inadequate, in that it left individual phenomena unexplained. The greatest credit for the further development of the electromagnetic theory of light is due to Professor Lorentz, whose theoretical work on this subject has borne the richest fruit. While Maxwell's theory is free from any assumptions of an atomistic nature, Lorentz starts from the hypothesis that in matter extremely small particles, called electrons, are the carriers of certain specific charges. These electrons move freely in so-called conductors and thus produce an electrical current, whereas in non-conductors their movement is apparent through electrical resistance. Starting from this simple hypothesis, Lorentz has been able not only to explain everything that the older theory explained but, in addition, to overcome some of its greatest shortcomings.

Alongside the theoretical development of the electromagnetic theory of light, experimental work also continued without interruption, and attempts were made to demonstrate in every detail the analogy between electrical wave motion and light. However, it was not sufficient to show a complete analogy between these phenomena; scientists wished far more to show that they were identical in nature, and to this end they

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attempted to demonstrate that magnetic forces act upon light in the same way as upon electric currents. It is this that Faraday was trying to prove, and the relevant experiments carried out by him led to the discovery of the rotation of the polarization plane of light by the effect of magnetic forces. His attempt to demonstrate the influence of magnetism on the radiation from a source of light - the last experiment with which Faraday was occupied - was, however, unsuccessful.

Professor Zeeman has recently succeeded in solving just this problem, which has up till now been the object of fruitless exertions on the part of many perspicacious research workers. Guided by the electromagnetic theory of light, Zeeman took up Faraday's last experiment, and, after many unsuccessful attempts, finally succeeded in demonstrating that the radiation from a source of light changes its nature under the influence of magnetic forces in such a way that the different spectral lines of which it consisted were resolved into several components. The consequences of this discovery give a magnificent example of the importance of theory to experimental research. Not only was Professor Lorentz, with the aid of his electron theory, able to explain satisfactorily the phenomena discovered by Professor Zeeman, but certain details which had hitherto escaped Professor Zeeman's attention could also be foreseen, and were afterwards confirmed by him. He showed, in fact, that the spectral lines which were split under the influence of magnetism consisted of polarized light, or in other words that the light vibrations are orientated in one particular way under the influence of the magnetic force, and in a way which varies according to the direction of the beam of light in relation to this force.

For the physicist this discovery - the Zeeman effect - represents one of the most important experimental advances that recent decades have to show. For, through the demonstration that light is affected by magnetism in accordance with the same laws as vibrating electrically charged particles, clearly not only has the strongest support been given to the electromagnetic theory of light, but the consequences of Zeeman's discovery promise to yield the most interesting contributions to our knowledge of the constitution of spectra and of the molecular structure of matter. For these reasons the Swedish Royal

Academy of Sciences has come to the conclusion that the discovery outlined here is of such great importance for the understanding of the connection between the forces of Nature and for the development of physical science that its recognition by the award of the Nobel Prize for Physics is justified. The Academy also bore in mind the great part which Professor Lorentz has played in the following up of this discovery through his masterly theory of electrons, which is moreover of the greatest significance as a guiding principle in various other realms.

Since the discovery in physics which the Royal Academy of Sciences wishes to recognize on this occasion represents the result of the most perspicacious research, both theoretical and experimental, the Academy considers that a division of the Nobel Prize for Physics between the two outstanding research workers, Professor Lorentz and Professor Zeeman, for their work on the connection between light and magnetism, is not only justified, but just.

For more details please visit:

http://www.nobelprize.org/nobel_prizes/physics/laureates/1902/press.html