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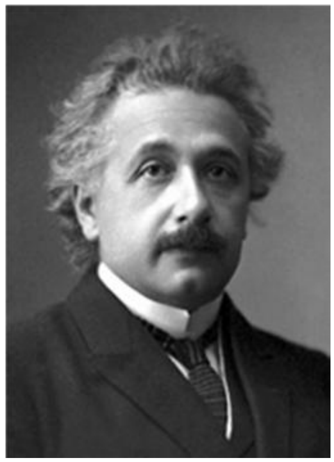
Nobel Prize in Physics 1921



Albert Einstein

The Nobel Prize in Physics 1921 was awarded to Albert Einstein *"for his services to Theoretical Physics, and especially for his discovery of the law of the photoelectric effect"*.

RESEARCH INFORMATION:

There is probably no physicist living today whose name has become so widely known as that of Albert Einstein. Most discussion centres on his theory of relativity. This pertains essentially to epistemology and has therefore been the subject of lively debate in philosophical circles. It will be no secret that the famous philosopher Bergson in Paris has challenged this theory, while other philosophers have acclaimed it wholeheartedly. The theory in question also has astrophysical implications which are being rigorously examined at the present time.

Throughout the first decade of this century the so-called Brownian movement stimulated the keenest interest. In 1905 Einstein founded a kinetic theory to account for this movement by means of which he derived the chief properties of suspensions, i.e. liquids with solid particles suspended in them. This theory, based on classical mechanics, helps to explain the behaviour of what are known as colloidal solutions, a behaviour which

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has been studied by Svedberg, Perrin, Zsigmondy and countless other scientists within the context of what has grown into a large branch of science, colloid chemistry.

A third group of studies, for which in particular Einstein has received the Nobel Prize, falls within the domain of the quantum theory founded by Planck in 1900. This theory asserts that radiant energy consists of individual particles, termed "quanta", approximately in the same way as matter is made up of particles, i.e. atoms. This remarkable theory, for which Planck received the Nobel Prize for Physics in 1918, suffered from a variety of drawbacks and about the middle of the first decade of this century it reached a kind of impasse. Then Einstein came forward with his work on specific heat and the photoelectric effect. This latter had been discovered by the famous physicist Hertz in 1887. He found that an electrical spark passing between two spheres does so more readily if its path is illuminated with the light from another electrical discharge. A more exhaustive study of this interesting phenomenon was carried out by Hallwachs who showed that under certain conditions a negatively charged body, e.g. a metal plate, illuminated with light of a particular colour - ultraviolet has the strongest effect - loses its negative charge and ultimately assumes a positive charge. In 1899 Lenard demonstrated the cause to be the emission of electrons at a certain velocity from the negatively charged body. The most extraordinary aspect of this effect was that the electron emission velocity is independent of the intensity of the illuminating light, which is proportional only to the number of electrons, whereas the velocity increases with the frequency of the light. Lenard stressed that this phenomenon was not in good agreement with the then prevailing concepts.

An associated phenomenon is photo-luminescence, i.e.phosphorescence and fluorescence. When light impinges on a substance the latter will occasionally become luminous as a result of phosphorescence or fluorescence. Since the energy of the light quantum increases with the frequency, it will be obvious that a light quantum with a certain frequency can only give rise to the formation of a light quantum of lower or, at most, equal frequency. Otherwise energy would be created. The phosphorescent or fluorescent light hence has a lower frequency than the light inducing the photo-

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luminescence. This is Stokes' rule which was explained in this way by Einstein by means of the quantum theory.

Similarly, when a quantum of light falls on a metal plate it can at most yield the whole of its energy to an electron there. A part of this energy is consumed in carrying the electron out into the air, the remainder stays with the electron as kinetic energy. This applies to an electron in the surface layer of the metal. From this can be calculated the positive potential to which the metal can be charged by irradiation. Only if the quantum contains sufficient energy for the electron to perform the work of detaching itself from the metal does the electron move out into the air. Consequently, only light having a frequency greater than a certain limit is capable of inducing a photo-electric effect, however high the intensity of the irradiating light. If this limit is exceeded the effect is proportional to the light intensity at constant frequency. Similar behaviour occurs in the ionisation of gas molecules and the so-called ionisation potential may be calculated, provided that the frequency of the light capable of ionising the gas is known.

Einstein's law of the photo-electrical effect has been extremely rigorously tested by the American Millikan and his pupils and passed the test brilliantly. Owing to these studies by Einstein the quantum theory has been perfected to a high degree and an extensive literature grew up in this field whereby the extraordinary value of this theory was proved. Einstein's law has become the basis of quantitative photo-chemistry in the same way as Faraday's law is the basis of electro-chemistry.

For more details please visit:

http://www.nobelprize.org/nobel_prizes/physics/laureates/1921/press.html