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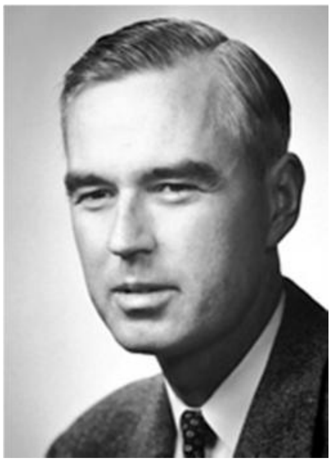
Nobel Prize in Physics 1955




Willis Eugene Lamb **Polykarp Kusch**

The Nobel Prize in Physics 1955 was divided equally between Willis Eugene Lamb *"for his discoveries concerning the fine structure of the hydrogen spectrum"* and Polykarp Kusch *"for his precision determination of the magnetic moment of the electron"*.

RESEARCH INFORMATION:

The Nobel Prize winners in Physics of this year were both employed shortly before the war at the Physics Laboratory of Columbia University in New York. Lamb was at first engaged in theoretical research and published several important investigations in this field. Kusch was soon one of the most active collaborators of Professor Rabi, when the latter worked out his resonance method, for which he was awarded the Nobel Prize in Physics of 1944. In this method the spectra of the atoms are studied by radio waves and the details of the spectra can thereby be investigated much more accurately than before. Kusch and Lamb participated during the war in the extensive work on radar technique which was then being performed. Because of the great progress in this field the resonance method could be much improved. It was used by Kusch and, in an essentially modified form, by Lamb when in 1947 they made their great discoveries as leaders of two separate research groups. Not only were the discoveries made independently of each other in the same laboratory and in the same year, but it was also soon found that the explanation of both phenomena is the same, namely the interaction of the electrons and the electromagnetic radiation.

Lamb's discovery refers to the hydrogen atom, where one single electron moves around the nucleus in one of a series of orbits, each having a definite energy. These energy levels exhibit a fine structure which means that they are arranged in groups of neighbouring levels, the groups being widely separated. An explanation of the fine structure which for a long time was thought to be correct, was given in 1928 by the English physicist Dirac, when he proposed a theory of the electron based on the requirements of the theory of relativity as well as the quantum theory.

Using optical methods many attempts were made during the next decade to check the Dirac theory of the fine structure but no definite results were obtained. Some investigations made it probable, however, that the theory was not entirely correct and the guess was made that there occur deviations which are similar to those later found by Lamb.

Lamb was aware of the great importance that a careful check of the Dirac theory would have. He began his experimental investigations of the fine structure shortly after the war. His technique was based on Rabi's resonance method which had to be much modified, however. Lamb planned his difficult experiment guided by a thorough theoretical analysis of the experimental arrangements.

In 1947 his experiments were successful. He found that two fine structure levels in the next lowest group which should coincide according to the Dirac theory are in reality shifted relative to each other by a certain amount which is now called the Lamb shift. He succeeded in measuring this shift with great accuracy and later made similar measurements on heavy hydrogen.

The discovery of Kusch refers directly to an important property of the electron, namely its magnetic moment. It had been known since long that the electron is a small magnet. The strength of this magnet is measured by its moment. The magnitude of the moment should be uniquely determined by the electron theory of Dirac, mentioned before.

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At the beginning of 1947 Rabi together with several collaborators found that a property of the lowest hydrogen level (namely its so-called hyperfine structure) does not entirely conform with theory. It was suggested by the American physicist Breit that the reason for this could be that the magnetic moment of the electron is somewhat different from the value assumed until then which is called a Bohr magneton.

Starting from this idea Kusch made a series of very careful investigations and found in 1947 that the magnetic moment of the electron is larger than the Bohr magneton by about one part in a thousand.

The effects discovered by Lamb and Kusch are exceedingly small. They were revealed only with the help of a very refined technique. As has happened before it was now found that the discovery of minute deviations from existing theories can be offer-reaching importance. The discoveries of Lamb and Kusch resulted in a reshaping of the theory of the interaction of the electrons and the electromagnetic radiation, the so-called quantum electrodynamucs.

Lamb reported on his results at a physics meeting which was held in the neighbourhood of New York in the early summer of 1947. Many prominent theoretical physicists were present and among them Professor Kramers from Holland, who died a few years ago. During the discussion it was made probable that the Lamb shift could be explained using certain general ideas of Kramers, the purpose of which was to improve the theories just mentioned.

A rough estimate which agreed rather well with Lamb's measurements was soon made and somewhat later Lamb himself and many others carried out more accurate calculations. It was also found by Professor Schwinger at Harvard University that the anomaly in the magnetic moment of the electron found by Kusch could be similarly explained. In both cases the measurements as well as the calculations have since been considerably improved and agree now very well

Professor Willis Lamb. Professor Polykarp Kusch. Your discoveries which the Royal Swedish Academy of Sciences wishes to recognize on this occasion have been made by applying radiohrequency spectroscopy of the highest achievable precision to the study of the properties of the electron. Your work is marked not only by the beauty of your experiments but equally by the profound significance of your results. It does not often happen that experimental discoveries exert an influence on physics as strong and invigorating as did your work. Your discoveries led to a re-evaluation and a re-shaping of the theory of the interaction of electrons and electromagnetic radiation, thus initiating a development of utmost importance to many of the basic concepts of physics, a development the end of which is not yet in sight.

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