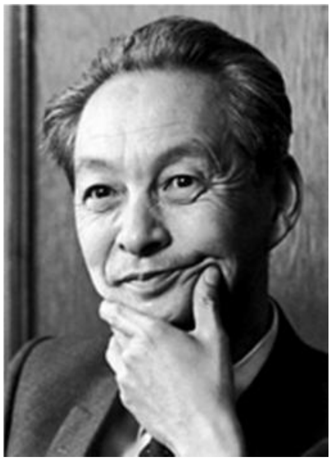
ISSN:2249-5347
IJSID
International Journal of Science Innovations and Discoveries
An International peer Review Journal for Science

Nobel Prize in Physics 1965



Sin-Itiro Tomonaga

Julian Schwinger

Richard P. Feynman

The Nobel Prize in Physics 1965 was awarded jointly to Sin-Itiro Tomonaga, Julian Schwinger and Richard P. Feynman *"for their fundamental work in quantum electrodynamics, with deep-ploughing consequences for the physics of elementary particles"*.

RESEARCH INFORMATION:

The electrons of an atom move according to the laws of quantum mechanics established in 1925 and the next following years. For the hydrogen atom, which has only one electron and consequently is the simplest atom to investigate theoretically, the calculation of the motion of the electron in the electric field of the nucleus led to results of such accuracy that 20 years elapsed until any error of the theory could be found experimentally. This occurred, however, in 1947 when Lamb and his collaborator Retherford discovered that some energy levels of hydrogen which should coincide theoretically were in fact somewhat shifted relative to each other.

One important result of the work of this year's Nobel Prize winners Sinitiro Tomonaga, Julian Schwinger and Richard Feynman was the explanation of the Lamb-shift. Their work is, however, much more general and of deep general significance to physics. It has explained and also predicted several important phenomena. It is the continuation of

ISSN:2249-5347
IJSID
International Journal of Science Innovations and Discoveries
An International peer Review Journal for Science

some investigations performed in the late 1920's in order to find the general quantum mechanical laws according to which the atoms and in particular the electrons give rise to electromagnetic fields, e.g. emit light, and are influenced by such fields. By applying quantum mechanics not only to matter but also to the electromagnetic field Dirac, Heisenberg, and Pauli managed in those years to formulate a theory, called quantum electrodynamics, which contains the quantum mechanical laws for the interaction of charged particles, in particular electrons, and the electromagnetic field. It satisfies the important condition of being in agreement with the theory or relativity.

It was soon realized, however, that this theory had serious defects. When one tried to calculate a quantity of such importance as the contribution to the mass of an electron originating in its interaction with the electromagnetic field an infinite and therefore useless result was obtained. A similar difficulty occurred for the charge of the electron.

Because of the fundamental importance of having a more useful quantum electrodynamics many theoretical physicists tried during the 1930's to over come those difficulties. Some indications were forthcoming how this should be accomplished. It lasted, however, until the 1940's for decisive progress to be made.

A new area was then initiated by investigations first performed by Tomonaga. His work was primarily related to the demands imposed by the theory of relativity. In a paper published in 1943 and in later work published together with his collaborators, Tomonaga managed to give a new formulation of quantum electrodynamics and other similar theories, which marked an important progress.

Definite progress was only made as a consequence of the discovery of the Lamb-shift mentioned earlier. When this discovery was discussed at a conference the idea was accepted that the new effect could be explained by quantum electrodynamics provided the proper interpretation was given to this theory. The correctness of this idea was supported by a provisional calculation of the Lamb - shift which was published by Bethe shortly after the conference.

ISSN:2249-5347
IJSID
International Journal of Science Innovations and Discoveries
An International peer Review Journal for Science

As soon as Tomonaga knew about the Lamb experiment and Bethe's paper he realized that an essential step to be taken was to substitute the experimental mass for the fictive mechanical mass which appeared in the equations of quantum electrodynamics and to perform a similar renormalization of the electric charge. The compensating terms which had then to be introduced in the equations should cancel the infinities. Tomonaga managed to carry out this difficult program on the basis of his earlier investigations mentioned above. He deduced further a correct formula for the Lamb-shift which was found to give results in good agreement with the measurements.

Almost simultaneously with the discovery of the Lamb-shift another peculiarity was found by Kusch and his collaborator Foley, which made it clear that the magnetic moment of the electron is somewhat larger than had been assumed before. Using the method of renormalization which he also developed Schwinger was able to prove that a small anomalous contribution should be added to the value of the magnetic moment accepted until then. His calculation agreed with the experiments. Schwinger's calculation was indeed earlier than and very important for the proper interpretation of these measurements.

Schwinger had developed the formalism of the new quantum electrodynamics in several fundamental papers using partially methods similar to those of Tomonaga. He has also made this formalism more useful for practical calculations.

Feynman used more radical methods for solving the problems of quantum electrodynamics. He created a new formalism which he made very useful for practical calculations by introducing a graphical interpretation called Feynman diagrams, which have become an important feature of modern physics. In the description used by Feynman the electromagnetic field did not any more appear explicitly. His description has been very valuable in elementary particle physics where it is necessary to consider besides the electromagnetic also other interactions.

When considering the truth of quantum electrodynamics in its new form one has first of all to realize the extraordinary success of this theory in giving results in agreement with the experiments. For the Lamb-shift and for the anomalous part of the magnetic

ISSN:2249-5347
IJSID
International Journal of Science Innovations and Discoveries
An International peer Review Journal for Science

moment of the electron the agreement is within some parts in one hundred thousand respectively in a million and no disagreement has yet been found. Quantum electrodynamics is indeed one of the most accurate of all the theories of physics. Further evidence in this respect is given by the applications of the theory to the positronium atom and to the mu-particle. The new formalism has also been very important for other parts of physics in particular elementary- particle physics, but also solid-state physics, nuclear physics and statistical mechanics.

Professor Tomonaga has unfortunately been prevented by an accident from receiving his prize here in Stockholm. It will be presented to him by intermediary of the ambassador of Sweden in Tokyo, and it is accompanied by the congratulations of the Royal Academy of Science

Professor Schwinger and Professor Feynman. By introducing new ideas and methods into an old theory you have, together with Professor Tomonaga, created a new and most successful quantum electrodynamics, which occupies a central position in physics. This theory has been unique in stimulating modern research. You have yourself contributed to the extension of its methods to other fields of physics where it has also been essential for recent progress.

On behalf of the Royal Academy of Science I congratulate you on your work and ask you to receive your Nobel Prize from the hands of His Majesty the King.

For more details please visit:

http://www.nobelprize.org/nobel_prizes/physics/laureates/1965/press.html