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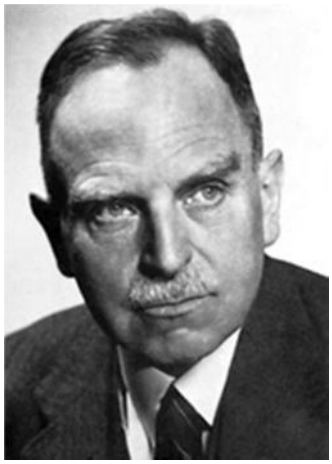
Nobel Prize in Chemistry 1944



Otto Hahn

The Nobel Prize in Chemistry 1944 was awarded to Otto Hahn *"for his discovery of the fission of heavy nuclei"*.

RESEARCH INFORMATION:

When chemical compounds form or decompose, interaction takes place between the outer parts of the electron shells. In view of the fact that, up to recent times, chemistry was nearly entirely concerned with the study of the combining of atoms and their release from combined units, it can be said that up till recently it was the science of the peripheral parts of the atom. But today a new discipline has grown up, that of nuclear chemistry, which deals with the centre parts of atoms, their nuclei, and which to judge from its recent achievements, promises to revolutionize science.

An atomic nucleus is a very small thing. Rutherford found that its diameter is about ten thousand times smaller than that of the atom, or about one billionth (10^{-12}) of a centimetre. And yet, by means of the particles charged with energy of the radioactive elements, particles which act as projectiles, he succeeded in detaching small fragments from certain nuclei. The fragments detached in this way were found to be hydrogen nuclei or protons, which showed that these atomic nuclei, despite their minute dimensions, were

composite structures made up of protons. Later, Joliot and his wife Irène Joliot-Curie studied in greater detail what happens when different kinds of elements are exposed to radiation by positive particles rich in energy. Here transmutations of elements may occur, but the atoms which then form are generally unstable and break up spontaneously with the emission of different kinds of elementary particles.

Fermi used the neutron discovered by Chadwick as a projectile to obtain nuclear syntheses. The neutron has the same mass as the proton, but as its name indicates it differs from it through bearing no charge. Thus it is not repelled by the positive atomic nuclei and will combine with them more easily than the projectiles with a positive charge used previously. In this way Fermi was able to produce a large number of new kinds of radioactive atoms.

All these researches into nuclear chemistry were concerned with relatively slight modifications to the mass of the reactive nuclei. Here it was simply a question of the addition or loss of different sorts of elementary particles. The reaction processes discovered by Otto Hahn are of quite a different nature. They involve the splitting of heavy atomic nuclei into two parts of more or less equal size.

In collaboration with Lise Meitner, with whom he has worked for nearly thirty years, Hahn studied from 1936 to 1938 the products obtained by projecting neutrons on to the heaviest elements, thorium and uranium. According to Fermi, elements would appear which would form a continuation of the Periodic Table of the elements. Hahn and Meitner believed they could confirm this assumption. But towards the end of 1938, Hahn, in an investigation carried out with one of his young colleagues, F. Strassmann, found that one of the products formed through the reaction of uranium with neutrons and which had been assumed to be a kind of radium, behaved chemically in fact like barium. In January 1939 Hahn announced this discovery and expressed in very discreet terms the daring opinion that on being allied with neutrons, the atoms of the heaviest elements could split in half as it were and produce elements belonging to the middle of the Periodic Table of the elements. After a month he was able to provide proof of his theory, which was confirmed

almost simultaneously in research carried out in different parts of the world by scientists using different methods.

Hahn's discovery caused great surprise and evoked lively interest among the world's scientists. It was immediately made the object of important theoretical investigations by Lise Meitner and Frisch, who based their study on the theory of the structure of atomic nuclei developed by Bohr. These investigators pointed out that nuclear fission should take place with an enormous generation of energy, due to the conversion of matter into energy. Calculations showed that the fragments produced in this break-up would disperse in all directions with immense force. Frisch demonstrated this experimentally. In connection with Joliot's observation that certain products of nuclear fission break up with the emission of neutrons, this discovery indicated that it was possible by splitting uranium to produce a chain reaction generating a very large amount of energy. The outlook for later research thus became very promising.

Without equal in the art of the chemical identification of radioactive elements in minute quantities, Hahn, together with his colleagues, paved the way for the chemical research which had to be carried out on the numerous products of the splitting of heavy atomic nuclei. Fission can be carried out in many ways, depending on the structure of the reactive nuclei and the energy of the splitting neutrons. The primary products of fission are unstable and they gradually decompose, emitting elementary particles, so that each of them acts as the starting-off point for more or less long series of different sorts of atoms. So far, the presence has been demonstrated of about one hundred bodies which are the direct or indirect products of the processes of the splitting of matter; these products are connected with 25 elements which lie between selenium and praseodymium in the Periodic Table of the elements.

The discovery of nuclear fission is very momentous and indeed dangerous, but even more, it is full of promise. In autumn 1943, Hahn read a paper to the Swedish Academy of Sciences on his latest work in nuclear chemistry, and there referred to the possibility of splitting uranium by means of a chain reaction. In this process such enormous quantities of

energy would be produced in a short instant that the effect would exceed any explosion phenomenon so far known. Hahn doubted however whether it was possible to surmount the technical difficulties involved. "Providence has not wanted the trees to reach to the sky", he said, and his hearers guessed from the passion in his voice that he wished that this conquest of atomic energy had been made at a much later date. He certainly shuddered at the thought that the atomic bomb was nearer at hand than the use of atomic energy for peaceful purposes.

Hahn's work has been inspired throughout by an invincible desire to solve the problems which he has encountered. Unlike Prometheus, who gave fire to Man, he has never dreamed of giving Man control over atomic energy. May humanity weigh deeply the responsibility which the gift of this discovery has imposed on it. Then this will be a blessing and a step towards the improvement of the conditions of human life.

The Academy of Sciences has decided to award to Professor Hahn the Nobel Prize in Chemistry for the year 1944 in reward for his discovery of the fission of heavy atomic nuclei. Professor Hahn has expressed his gratitude, but he has informed us that he is regrettably unable to attend this ceremony. Therefore the decision of the Academy cannot at present be implemented by the awarding of the prize.

For more details please visit:

http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1944/press.html