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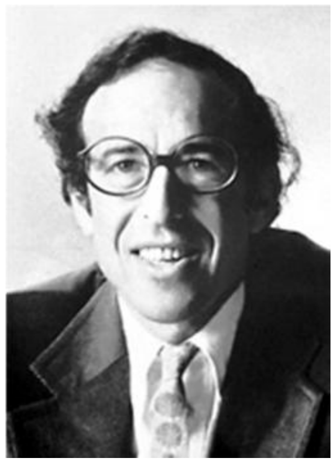
Nobel Prize in Physics 1975

Aage Niels Bohr



Ben Roy Mottelson

Leo James Rainwater

The Nobel Prize in Physics 1975 was awarded jointly to Aage Niels Bohr, Ben Roy Mottelson and Leo James Rainwater *"for the discovery of the connection between collective motion and particle motion in atomic nuclei and the development of the theory of the structure of the atomic nucleus based on this connection"*.

Information about winners:

Aage Bohr,

Denmark,

Ben Mottelson,

Denmark

James Rainwater,

USA,

RESEARCH INFORMATION:

At the end of the Forties nuclear physics had advanced to a stage where a more detailed picture of the structure of the atom nucleus was beginning to emerge and it was becoming possible to assess its properties. The models scientists were working with then were, however, fairly deficient and contradictory to a certain extent. The oldest was the

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drop model, in which the nucleus was regarded as a drop of liquid, where the nucleons correspond to the atoms in the liquid. Some properties of the nucleus, particularly those associated with the "magic numbers", show however that the individual nucleons definitely affect the behaviour of the nucleus. This discovery, which is demonstrated in the scale model, was awarded the 1963 Nobel Prize in Physics.

As time passed it was found that the nucleus has properties, which cannot be explained by these theories. Perhaps the most striking were the very marked aberrations from spherical symmetry in the distribution of charge observed in certain nuclei. It was also pointed out by several research scientists that this might indicate that certain nuclei are not spherical but are deformed as an ellipsoid, but no one could give a reasonable explanation of this phenomenon

The solution of the problem was first presented by James Rainwater of Columbia University, New York, in a short paper sent for publication in April 1950. In this he observes the interplay between the greater proportion of the nucleons, which form an inner nucleus, and the outer, the valence nucleons, and he points out that the valence nucleons can influence the shape of the inner nucleus. Since the valence nucleons move in a field which is determined by the distribution of the inner nucleons, this influence is mutual, If several valence nucleons move in similar courses, this polarizing effect on the rest of the nucleus can be so great that the nucleus as a whole becomes permanently deformed Expressed very simply, it can be said that as a result of their rotation certain nucleons expose the "walls" of the nucleus to such high centrifugal pressure that it becomes deformed, Rainwater also attempted to calculate this effect theoretically and got results that corresponded with experimental late on the distribution of the charge.

Aage Bohr, working in Copenhagen, but at this time on a visit to Columbia University, had, quite independently of Rainwater, been thinking along the same lines In a paper, sent for publication about a month after Rainwater's, he formulates the problem in a more general, but from the physical viewpoint loss lucid, way

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These relatively vague ideas were further developed by Bohr in a famous work from 1951, in which he gives a very comprehensive study of the coupling of oscillations of the nuclear surface to the movements of the individual nucleons. By means of an analysis of the theoretical formula for the kinetic energy of the nucleus he could predict the different types of collective excitations: vibrations obtained by a periodic change of the shape of the nucleus around a certain mean value and the rotation of the whole nucleus around an axle at right angles to the symmetry axle.

Up to then advances made had been purely theoretical and the new ideas largely lacked experimental foundation. The very important comparison with experimental data was done in three works, written jointly by Bohr and Mottelson, and published in the years 1952-1953. The most spectacular finding was the discovery that the position of energy levels in certain nuclei could be explained by the assumption that they form a rotation spectrum. The conformity between theory and experiment was so complete that there could be no doubt of the accuracy of the theory. This gave stimulus to new theoretical studies, but above all to very many experiments to prove the theoretical predictions. This dynamic development very soon led to a deepened understanding of the structure of the atomic nucleus.

In the research done since then, Bohr and Mottelson have been central figures, and have definitely inspired research in this field, although they themselves have not published many works. However, when it comes to principles, perhaps the most important discovery during this period originates from them (in collaboration with Pines). This concerns the fact that nuclear matter has properties reminiscent of superconductors.

For more details please visit:

http://www.nobelprize.org/nobel_prizes/physics/laureates/1975/press.html