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Nobel Prize in Chemistry 1926

The (Theodor) Svedberg

The Nobel Prize in Chemistry 1926 was awarded to The Svedberg *"for his work on disperse systems"*.

RESEARCH INFORMATION:

The Academy of Sciences has decided to award the Nobel Prize in Chemistry for 1926 to The Svedberg, Professor of Physical Chemistry at the University of Uppsala, for his work on disperse systems.

Almost a hundred years ago, or more accurately in 1827, the English botanist Robert Brown discovered with the aid of an ordinary microscope that small parts of plants, e.g. pollen seeds, which are slurried in a liquid, are in a state of continuous, though fairly slow movement in different directions. A more detailed study of this phenomenon during the last few decades has led to extremely interesting results. By means of the ultramicroscope it has been possible to observe a similar, only much livelier movement with very much smaller particles of a colloidal nature. As we have recently heard, Einstein evolved a theory for this so-called Brownian movement which was then developed to a high degree by the now late Smoluchowski. According to these scientists, the movement arises through the impacts of the molecules of the liquid against the particles slurried in the liquid, provided that the latter are sufficiently small. Taking a crude analogy: if a fly or a gnat flies against an elephant, the elephant will not noticeably alter its position, but this can occur if the fly or gnat collides only with a bee.

The theory in question has been confirmed convincingly by experimental investigations of several colloid scientists among whom especially two of today's prize-winners, Perrin and Svedberg, have occupied and still occupy a leading position. Should it now be true that the movement of particles suspended in a liquid, which we can actually observe with the aid of our extremely highly magnifying instruments, can be explained only as a result of the movement of molecules beyond the limits of direct human vision, then this provides visual evidence for the real existence of molecules and consequently also for that of atoms, evidence which is all the more remarkable as not so long ago an influential school of scientists declared these particles of matter to be unreal fictions representing an obsolete viewpoint of science.

It is known that the opposition conducted by the colloid scientists so successfully against this so-called energetic view has been continued by others who have gone much farther in that according to this view not only what we call matter, but also electricity occurs solely as particles of a definite size - the so-called electrons - and even that energy at all is regarded as bound to larger or smaller multiples of a smallest unit, the so-called elementary quantum.

If one has once become convinced of the existence of atoms and molecules, the question as to their real size is naturally - this hardly needs stressing - a question of the very greatest interest. Whereas it was formerly possible to calculate this size only roughly from the properties of gases and in connection with the theory applying to them, the position was now, as happens so often in the history of science, that almost simultaneously several new and considerably more precise methods for determining the natural constant in question appeared. Among these methods those based on colloid-chemical phenomena occupy a special position through their vividness and persuasive power, even though they may be for the time being slightly superseded by other methods in regard to accuracy. Also in this field Svedberg and the school of eminent scientists trained by him, Swedes as well as nationals from more or less distant countries, have achieved extremely valuable results. This has been done in several ways, among others, by determining the speed at which colloidal particles migrate by themselves, or diffuse in a liquid, or by measuring the distribution of such particles in a column of liquid, the latter according to a method proposed originally by Perrin.

In accordance with the theory for the movement of gas and liquid molecules which, as just indicated, has also been applied to colloidal particles, it is assumed that the mean value of the momentum of molecules or particles has a definite magnitude at each temperature, but that the speeds of the individual particles can vary within wide limits. If we now consider a very small volume fraction, the result is that, as Smoluchowski has calculated in detail, the number of particles present simultaneously within this volume can change from one moment to another. Svedberg and his collaborators have been able to confirm this extremely interesting conclusion that a "few-molecular" system having definite limits within a large volume of a material with a definite mean temperature may contain a varying number of particles, *partly* by counting the colloidal particles, *partly* in the case of solutions of radioactive substances by counting the number of so-called scintillations, i.e. light flashes, which radioactive particles produce when they impinge upon a screen coated with zinc sulphide.

With the last investigation, however, we have gone beyond the field of actual colloid chemistry, although the solution of a radioactive substance, e.g. polonium chloride, can naturally be called a disperse system, though more accurately it is molecular-disperse because the substance dissolved in the solvent occurs here as molecules, not as molecular aggregates, as is the case in a colloidal solution.

During the last few years Svedberg has completed an extremely ingenious invention, the so-called ultracentrifuge, which enables highly interesting investigations to be made also on such molecular-disperse systems. We know that when a slurry, an emulsion, is put into a rapidly rotating motion, its heavier constituents are thrown outwards in the direction of the periphery of the motion. This happens in the most used of all centrifuges, the milk separator, where the skimmed milk is pressed outwards whilst the lighter fat particles, the cream, accumulate inwards and can therefore be separated. Similarly in a solution, when centrifuging is sufficiently rapid, the molecules of the dissolved substance must accumulate outwards if they are considerably heavier than the molecules of the solvent. After overcoming exceptional experimental difficulties Svedberg succeeded in demonstrating this with the aid of an apparatus which allows the enormous speed of rotation of 40,000 revolutions per minute, and in which through a highly refined arrangement the progressive distribution of the particles within the extremely rapidly whirling solution can be observed and recorded photographically. The molecular weight of the dissolved material can be calculated from this distribution. This has already been done for certain proteins essential for organic life and for other substances allied to them. For example, the molecular weight of the red colouring agent of the blood, haemoglobin, has been determined as approximately 67,000 which assumes that there are in the region of 10,000 atoms in such a molecule.

In view of the fact that this year not less than three Nobel Prizes have been awarded for work in the field of colloid research, some people may ask whether this field really has a corresponding importance "for mankind".

By way of answer the following few remarks may be made.

Inorganic chemistry has revealed more and more cases where only a colloid-chemical approach was able to clarify the observed phenomena.

For physical chemistry colloids form a rich and rewarding field of research.

In organic chemistry we meet the perhaps most important colloids, the proteins and the polymeric carbohydrates, which cannot be studied without the aid of colloid research.

As all living matter is built up largely from organic colloids, the importance of colloid research for physiology and the medical sciences is obvious.

Finally, colloids play an important part in the various branches of chemical industry, such as in dyeing and tanning, in the cellulose, nitrocellulose, celluloid and textile industry,

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in rubber manufacture, in the pottery and cement industry, in the photographic industry, etc.

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