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Nobel Prize in Physics 1910

Johannes Diderik van der Waals

The Nobel Prize in Physics 1910 was awarded to Johannes Diderik van der Waals *"for his work on the equation of state for gases and liquids"*.

RESEARCH INFORMATION:

The Academy of Sciences has resolved to award this year's Nobel Prize for Physics to the world-famous Dutch physicist, Johannes Diderik van der Waals for his studies of the physical state of liquids and gases.

As far back as in his inaugural dissertation "The relationship between the liquid and the gaseous state". Van der Waals indicated the problem to which he was to devote his life's work and which still claims his attention today. In the dissertation to which I have referred he sought to account for the discrepancies from the simple gas laws which occur at fairly high pressures. He was led to the assumption that these discrepancies are partly associated with the space occupied by the gas molecules themselves, and partly with the attraction which the molecules exert on one another, owing to which the pressure acting on the interior of the gas is greater than the external pressure. These two factors become more and more pronounced with increasing compression of the gas. At a sufficiently high pressure, however, the gas becomes liquid, unless the temperature exceeds a certain value, the critical temperature as it is termed. Van der Waals showed that it is possible to apply the same considerations and calculations to liquids as to gases. When the temperature of a liquid is raised to beyond the critical temperature without the liquid being allowed to volatilize, it is in fact converted continuously from the liquid to the gaseous form; and close to the critical temperature it is impossible to distinguish whether it is liquid or gas.

The force preventing the separation of the molecules in a liquid is their mutual attraction, owing to which a high pressure prevails in the interior of the liquid. Van der Waals calculated this pressure, the existence of which had already been vaguely perceived by Laplace, for water. It amounts to not less than about 10,000 atmospheres at normal temperature. In other words the internal pressure, as it is called, of a drop of water would be about ten times greater than the water pressure at the greatest depth of the sea known to us.

However, this was not the most important result of Van der Waals' studies. His calculations led him to consider that once we are acquainted with the behaviour of a single type of gas and the corresponding liquid, e.g. that of carbon dioxide, at all temperatures and pressures, we are able by simple proportioning to calculate for any gas or liquid its state at any temperature and pressure, provided that we know it at only one, i.e. the critical, temperature.

On the basis of this law of what are known as "corresponding states" for various gases and liquids Van der Waals was able to provide a complete description of the physical state of gases and, more important, of liquids under varying external conditions. He showed how certain regularities can be explained which had earlier been found by empirical means, and he devised a number of new, previously unknown laws for the behaviour of liquids.

It appeared, however, that not all liquids conformed precisely to the simple laws formulated by Van der Waals. A protracted controversy arose around these discrepancies which were ultimately found to be attributable to the molecules in these liquids not all being of the same character; the older Van der Waals laws apply only to liquids of uniform composition. Van der Waals then extended his studies to mixtures of two or more types of molecules and here too he managed to find the laws and these, of course, are more complex than those which apply to substances composed of molecules of a single type. Van der Waals is still occupied with working out the details of this great investigation.

Nevertheless, he has successfully surmounted the difficulties that were initially in his path.

Van der Waals' theory has also been brilliantly successful through its predictions which made it possible to calculate the conditions for converting gases to liquids. Two years ago Van der Waals' most prominent pupil, Kamerlingh Onnes, in this way succeeded in compelling helium-the last previously uncondensed gas - to assume the liquid state.

Yet Van der Waals' studies have been of the greatest importance not only for pure research. Modern refrigeration engineering, which is nowadays such a potent factor in our economy and industry, bases its vital methods mainly on Van der Waals' theoretical studies

Professor Van der Waals. The Royal Academy of Sciences has awarded you this year's Nobel Prize for Physics in recognition of your pioneering studies on the physical state of liquids and gases.

Hamurabi's and Moses' laws are old and of great importance. The laws of Nature are older still and even more important. They apply not just to certain regions on this Earth, but to the whole world. However, they are difficult to interpret. You, Professor, have succeeded in deciphering a few paragraphs of these laws. You will now receive the Nobel Prize, the highest reward which our Academy can give you.

For more details please visit:

http://www.nobelprize.org/nobel_prizes/physics/laureates/1910/press.html