Johannes Diderik van der Waals

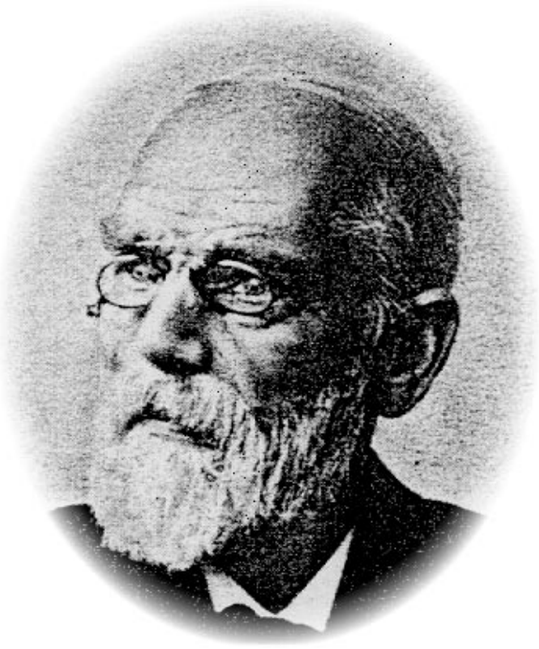
1837 - 1923

Awarded the Nobel Prize for Physics in 1910

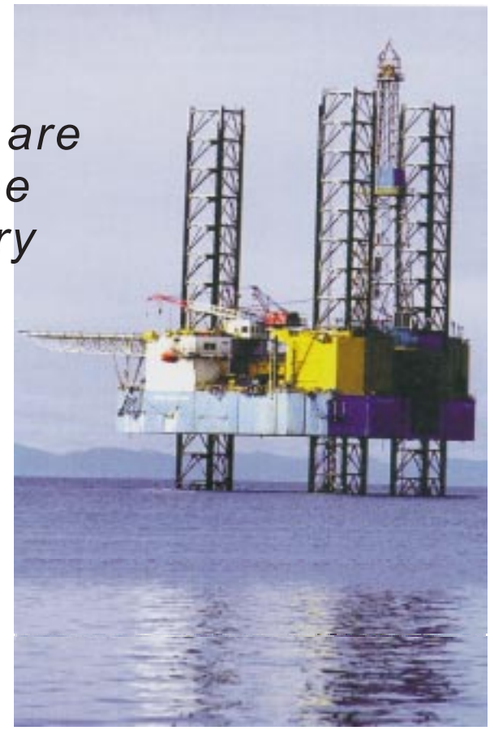
At a time when the existence of molecules was still held in doubt by at least some respectable scientists, Johannes Diderik van der Waals developed a model of molecular interactions. His equation of state had the basic features needed for the understanding of a great variety of phenomena occurring in fluids and fluid mixtures. He received the Nobel Prize in 1910. He is considered the founder of molecular science.

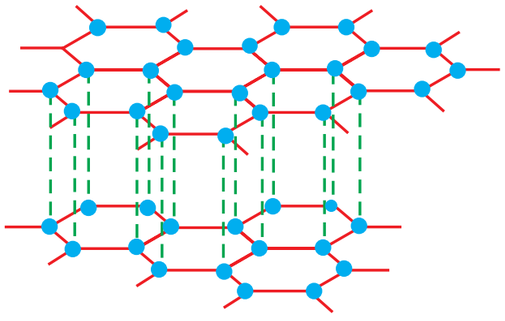
Van der Waals was born in Leiden, Netherlands, the son of a carpenter and the eldest of ten children. After finishing middle school at the age of fifteen, he started working as an apprentice elementary school teacher. For over 20 years, van der Waals climbed through the teachers' ranks by taking evening classes and, eventually, university courses. After repairing the deficiencies of his early schooling, he was allowed to defend his Ph.D. thesis in 1873. He was a Professor of Physics at the University of Amsterdam, Netherlands, from 1877 to 1908.

The thesis was immediately recognised as very significant: James Clerk Maxwell learned Dutch in order to read it. Van der Waals considered the molecules as hard spheres surrounded by a sphere of attraction. With this model, he could describe the properties of both gases and liquids. A liquid and its vapour are separated by an interface, and the liquid is much denser than the vapour. Van der Waals showed, however, that only below its 'critical point' may a gas be liquefied. Above this point, the transition from vapour-like to liquid-like densities is continuous, without the appearance of an interface. By expressing fluid properties in terms of the critical-point parameters, Van der Waals obtained the law of corresponding states which maps properties from one fluid to another. This law allowed him to predict the critical point of helium, which, in turn, enabled his friend, Heike Kamerlingh Onnes, to liquefy helium in Leiden in 1908.



His ideas are used in the oil industry





carbon atom

covalent bond

Van der Waals bond

Graphite works as a lubricant because the planes,held together by strong chemical (covalent) bonds between the carbon atoms, can slide across each other with only weak Van der Waals bonds between the planes being broken.

Another major achievement of Van der Waals was the 1890 generalisation of the law of corresponding states to fluid mixtures of two and more components. Depending on the nature of the components, mixtures may display complex phase behavior, with several liquid and gaseous phases present. Van der Waals' mixture equation of state represented most of the types of phase separations which scientists such as Kamerlingh Onnes were finding in the laboratory. The methods worked out by Van der Waals and the `Dutch School' are widely used in modern chemical process technology, such as the gas and oil industry, and geophysics.

Van der Waals used the concept of continuity of states to develop a theory of capillarity (1893), which describes the structure of the interface between two fluid phases as well as surface tension. **This work was not widely known, and the theory was reinvented in the middle of the 20th century both in the then USSR and in the U.S.A.**

Van der Waals lost his young wife in 1881 and never remarried. His eldest daughter helped him raise the three younger children. His son became a professor of theoretical physics and one daughter was a well known poet.

J.M.H.L.S.