ISSN:2249-5347

IJSID

International Journal of Science Innovations and Discoveries

An International peer Review Journal for Science

Nobel Prize in Physics 1913

Heike Kamerlingh Onnes

The Nobel Prize in Physics 1913 was awarded to Heike Kamerlingh Onnes *"for his investigations on the properties of matter at low temperatures which led, inter alia, to the production of liquid helium"*.

RESEARCH INFORMATION:

At its meeting on the 11th November the Royal Academy of Sciences decided to award the Nobel Prize for Physics for the year 1913 to Dr. Heike Kamerlingh Onnes, Professor at the University of Leyden "for his investigations on the properties of matter at low temperatures which led, inter alia, to the production of liquid helium".

As early as 100 years ago research into the behaviour of gases at various pressures and temperatures gave a great impetus to physics. Since this time the study of the connection between the pressure, the volume and the temperature of gases has played a very important part in physics, and particularly in thermodynamics - one of the most important disciplines of modern physics.

In the years 1873 and 1880 Van der Waals presented his famous laws governing gases which, owing to their great importance for thermodynamics, were rewarded by the Royal Academy of Sciences in 1910 with the Nobel Prize for Physics.

The thermodynamic laws of Van der Waals were laid down on atheoretical basis under the assumption that certain properties could be attributed to molecules and molecular forces. In the case of gases the properties of which are changed by pressure and temperature, or in one way or another do not agree with Van der Waals' hypothesis, deviations from these laws occur.

A systematic experimental study of these deviations and the changes they undergo due to temperature and the molecular structure of the gas must therefore contribute greatly to our knowledge of the properties of the molecules and of the phenomena associated with them.

It was for this research that Kamerlingh Onnes set up his famous laboratory at the beginning of the 1880's, and in it he designed and improved, with unusual success, the physical apparatus needed for his experiments.

It is impossible to report briefly here on the many important results of this work. They embrace the thermodynamic properties at low temperatures of a series of monatomic and diatomic gases and their mixtures, and have contributed to the development of modern thermodynamics and to an elucidation of those associated phenomena which are so difficult to explain. They have also made very important contributions to our knowledge of the structure of matter and of phenomena related to it.

Whilst important on its own account, this research has gained greater significance because it has led to the attainment of the lowest temperatures so far reached. These lie in the vicinity of so-called absolute zero, the lowest temperature in thermodynamics.

The attainment of low temperatures in general was not possible until we learnt to condense the so-called permanent gases, which, since Faraday's pioneer work in this field in the middle of the 1820's, has been one of the most important tasks of thermodynamics.

After Olszewski, Linde, and Hampson had prepared liquid oxygen and air in a variety of ways, and after Dewar, having overcome great experimental difficulties, had

ISSN:2249-5347
IJSID
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succeeded in condensing hydrogen, all temperatures down to -259°C, i.e. all temperatures down to 14° from absolute zero, could be attained.

At these low temperatures all known gases can easily be condensed, except for helium, which was discovered in the atmosphere in the year 1895.

Thus, by condensing this it would be possible to reach still lower temperatures. After both Olszewski and Dewar, Travers, and Jacquerod had tried in vain to prepare liquid helium, using a variety of met hods it was generally assumed that it was impossible.

The question was solved in 1908, however, by Kamerlingh Onnes, who then prepared liquid helium for the first time.

I should have to cover too much ground if I were to report here on the experimental equipment with which Kamerlingh Onnes was at last successful in liquefying helium, and on the enormous experimental difficulties which had to be overcome. I would only mention here that the liquefaction of helium represented a continuation of the long series of investigations into the properties of gases and liquids at low temperatures which Kamerlingh Onnes has carried out in so praiseworthy a manner. These investigations finally led to the determination of the so-called isotherms of helium and the knowledge gained here was the first step towards the liquefaction of helium. Kamerlingh Onnes has constructed cold baths with liquid helium which permit research to be done into the properties of substances at temperatures which lie between 4,3° and 1,15° from absolute zero.

The attainment of these low temperatures is of the greatest importance to physics research, for at these temperatures both the properties of the substances and also the course followed by physical phenomena, are generally quite different from those at our normal and higher temperatures, and a knowledge of these changes is of fundamental importance in answering many of the questions of modern physics.

Let me mention one of these particularly here.Various principles borrowed from gas thermodynamics have been transferred to the so-called theory of electrons, which is the

ISSN:2249-5347
IJSID
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guiding principle in physics in explaining all electrical, magnetic, optical, and many heat phenomena.

The laws which have been arrived at in this way also seem to be confirmed by measurements at our normal and higher temperatures. That the situation is at very low temperatures not the same, however, has, amongst other things, been shown by Kamerlingh Onnes' experiments on resistance to electrical conduction at helium temperatures and by the determinations which Nernst and his students have carried out in relation to specific heat at liquid temperatures.

It has become more and more clear that a change in the whole theory of electrons is necessary. Theoretical work in this direction has already been begun by a number of research workers, particularly by Planck and Einstein.

In the meantime new supports had to be created for these investigations. These could only be obtained by a continued experimental study of the properties of substances at low temperatures, particularly at helium temperatures, which are the most suitable for throwing light upon phenomena in the world of electrons. Kamerlingh Onnes' merit lies in the fact that he has created these possibilities and at the same time opened up a field of the greatest consequence and significance to physical science.

Owing to the great importance which Kamerlingh Onnes' work has been seen to have for research in physics, the Royal Academy of Sciences has found ample grounds for bestowing upon him the Nobel Prize for Physics for the year 1913.

<u>For more details please visit:</u>

http://www.nobelprize.org/nobel_prizes/physics/laureates/1913/press.html