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Nobel Prize in Physics 1911

Wilhelm Wien

The Nobel Prize in Physics 1911 was awarded to Wilhelm Wien *"for his discoveries regarding the laws governing the radiation of heat"*.

RESEARCH INFORMATION:

The Royal Academy of Sciences has awarded the Nobel Prize for Physics, for the year 1911, to Wilhelm Wien, Professor at the University of Würzburg, for his discoveries concerning the laws of heat radiation.

Ever since the beginning of the last century and, in particular, since spectrum analysis reached an advanced stage of development as a result of the fundamental work by Bunsen and Kirchhoff, the problem of the laws of heat radiation has occupied the attention of physicists to an exceptionally high degree.

The solution of this problem has presented immeasurable difficulties both in the theoretical and experimental respects, and it would hardly seem possible to solve this task without a knowledge of certain laws which embrace a wide diversity of radiating bodies.

One of these is the famous Kirchhoff law of the relationship between the ability of substances to emit and to absorb radiation energy. It relates the laws of radiation of all bodies so far as their radiation is dependent on temperature to those laws which are valid for the radiation emitted by a completely black body.

The search for the latter laws has therefore been one of the most fundamental problems of radiation theory. These laws have been discovered in the last decades and, by virtue of the great importance that attaches to them, belong to the major achievements of modern physics.

The difficulty in investigating the laws of radiation of black bodies was, firstly, that no completely black body exists in nature. In accordance with Kirchhoff's definition, such a body would reflect no light at all, nor allow light to pass. Even substances such as soot, platinum black etc. reflect part of the incident light.

This difficulty was only removed in 1895, when Wien and Lummer stated the principles according to which a completely black body could be constructed, and showed that the radiation which issues from a small hole in a hollow body whose walls have the same temperature behaves in the same manner as the radiation emitted by a completely black body. The principle of this arrangement is based on the views of Kirchhoff and Boltzmann and had already been applied in part by Christiansen in 1884.

With the assistance of this apparatus it now became possible to investigate black body radiation. In this manner, Lummer, together with Pringsheim and Kurlbaum, succeeded in substantiating the so-called Stefan-Boltzmann law which indicates the relationship between the quantity of heat radiated by a black body and its temperature.

This solved in a highly satisfactory manner one of the major problems of radiation theory, i.e. that which touches total black body radiation.

However, the thermal energy that radiates from a body contains rays of different wavelengths whose intensities differ and change with the temperature of the body. It therefore remained to investigate the manner of change in intensity with wavelength and temperature.

An important step towards the solution of this question had been taken as early as 1886 by Langley who, with his famous spectrobolometer, investigated the distribution of radiation in the spectrum of a number of heat sources of high and low temperature. Inter alia these classical researches showed that the radiation had a maximum for a certain wavelength and that the maximum shifted in the direction of the shorter waves with increasing temperature.

In 1893 Wien published a theoretical paper which was destined to acquire the utmost importance in the development of radiation theory. In this paper he presented his so-called displacement law which provides a very simple relationship between the wavelength having the greatest radiation energy and the temperature of the radiating black body.

The importance of Wien's displacement law extends in various directions. As we shall see, it provides one of the conditions which are required for the determination of the relationships between energy radiation, wavelength and temperature for black bodies, and thus represents one of the most important laws in the theory of heat radiation. Wien's displacement law has however acquired the greatest possible importance in other contexts as well. Lummer and Pringsheim have shown that the radiation of bodies other than black bodies obeys the displacement law, with the sole difference that the constant which forms part of the formula has a different value.

Thus it became possible to determine the temperature of bodies, within fairly narrow limits, simply by seeking the wavelength at which radiation is greatest. The method has successfully been applied to the determination of the temperature of our light sources, of the sun and of some of the fixed stars, and has yielded extremely interesting results.

The Stefan-Boltzmann law and the Wien displacement law are the most penetrating statements on a secure theoretical foundation that have been discovered with respect to thermal radiation. They do not solve the central problem, i.e. the question as to the distribution of radiation energy over the various wavelengths at different black body temperatures. We can however say that Wien's displacement law provides half the answer to the problem. We have one condition for determining the desired function. One more would be sufficient for solving the problem.

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It was only natural that Wien who had contributed so much to the advancement of radiation theory should make an attempt to find an answer to the last remaining question also, i.e. that of the distribution of energy in radiation. In 1894 he indeed deduced a black body radiation law. This law has the virtue that, at short wavelengths, it agrees with the above-mentioned experimental investigations by Lummer and Pringsheim.

By a different approach from that used by Wien, Lord Rayleigh also succeeded in discovering a law of radiation. By contrast with that discovered by Wien, it agrees with experiment for long wavelengths.

The problem now became to bridge the gap between these two laws each of which had been shown to be valid in a specific context. It was Planck who solved this problem; as far as we are aware, his formula provides the long sought-after connecting link between radiation energy, wavelength and black body temperature.

These remarks show that we now know, with considerable accuracy, the laws that govern thermal black body radiation.

A magnificent and unique task has thus been undertaken and brought to a certain conclusion - a task which has claimed the liveliest interest and energy of the leading physicists of our time.

Among the researchers in this field now living it was Wilhelm Wien who made the greatest and most significant contribution, and the Academy of Sciences has therefore decided to award- to him the Nobel Prize for Physics for the year 1911.

Professor Wien. The Swedish Academy of Sciences has awarded to you this year's Nobel Prize for Physics for your discoveries concerning the laws of thermal radiation. You have devoted your researches to one of the most difficult and spectacular problems of physics, and among the researchers now living it is you who has succeeded in making the greatest and most significant contributions to the solution of the problem. In admiration of the completed task and with the wish that further success may be granted to you in future work, the Academy now calls upon you to receive the prize from the hands of his Majesty the King.

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