



Presentation of the Nobel Prize and Medal by His Majesty King Gustav Adolf, Stockholm, 10 December, 1971.

Présentation du Prix Nobel et de la Médaille par sa Majesté le Roi Gustav Adolf, à Stockholm, le 10 décembre 1971.

2. Dr. Gerhard Herzberg **1971 Nobel Laureate in Chemistry**

The history of physics and chemistry over the last two hundred years is, in large measure, the history of man's efforts to understand the nature of matter. It has been and continues to be a long and complex struggle in which victories have been won by new techniques, painstaking observations and bold theories.

As one of the leaders in this search for an understanding of matter, Dr. Gerhard Herzberg, former Director of NRC's Division of Physics and now Distinguished Research Scientist at NRC, became Canada's first Nobel Prize winner in the natural sciences.

The 1971 Nobel Prize for Chemistry was awarded to Dr. Herzberg "for his contributions to the knowledge of electronic structure and geometry of molecules, particularly free radicals".

In presenting Dr. Herzberg at the award ceremony in Stockholm, Professor Stig Claesson of the Swedish Royal Academy of Sciences stated:

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2. Le Dr. Gerhard Herzberg, Prix Nobel de Chimie 1971

L'histoire de la physique et de la chimie au cours des 200 dernières années concerne, dans une large mesure, les tentatives de l'homme pour découvrir la nature même de la matière. Il s'agit toujours d'une lutte longue et complexe où les victoires ne sont données que par des techniques nouvelles, des observations laborieuses et des théories hardies.

C'est en tant que savant faisant grande autorité dans ce domaine que le Dr. Gerhard Herzberg, ancien directeur de la Division de physique du CNRC et actuellement «Scientifique de haute distinction» au CNRC, est devenu le premier Prix Nobel canadien en sciences pures.

Le Prix Nobel de chimie 1971 a été décerné au Dr. Herzberg pour «ses contributions aux connaissances de l'homme sur la structure électronique et la géométrie des molécules et plus particulièrement des radicaux libres».

En présentant le Dr. Herzberg, le Professeur Stig Claesson, de l'Académie royale des sciences de Suède, à Stockholm, a déclaré:



Nobel Medal for Chemistry

Médaille du Prix Nobel de chimie

"This year's Nobel Prize winner in Chemistry, Dr. Gerhard Herzberg, is generally considered to be the world's foremost molecular spectroscopist and his large institute in Ottawa is the undisputed center for such research. It is quite exceptional, in the field of science, that a single individual, however distinguished, in this way can be the leader of a whole area of research of general importance. A noted English chemist has also said that the only institutions that have previously played such a role were the Cavendish laboratory in Cambridge and Bohr's institute in Copenhagen.

"Herzberg began as a physicist and his first contributions to molecular spectroscopy were published at the end of the 1920's. In such investigations one measures how molecules absorb light-energy—also outside the visible region—i.e. in the ultraviolet and infrared. Since light-energy is packaged as quanta, these measurements can provide accurate information about energy contents in molecules. From this information their size, shape and other properties can be derived. Such calculations must be based on the description of matter given by quantum mechanics. The development of this subject during the 1920's and 30's is regarded as one of the most exciting periods in the history of physical science. Herzberg's elegant experimental investigations combined with his theoretical insight into their interpretation contributed to the progress of quantum mechanics while being decisive for the rapid development of molecular spectroscopy.

"One may now ask why Herzberg—originally a physicist and even famous as an astrophysicist—finally was awarded the Nobel prize in chemistry.

"The explanation is that around 1950 molecular spectroscopy had progressed so far that one could begin to study even complicated systems of great chemical interest. This is brilliantly demonstrated by Herzberg's pioneering investigations of free radicals. Knowledge of their properties is of fundamental importance to our understanding of how chemical reactions proceed.

"For a chemical reaction to occur the original molecules must in some way break up into fragments which rearrange to form the new molecules. These fragments, or intermediates, are called free radicals.

"Free radicals are very difficult to study due to their short life-times—measured in millionths of a second. Herzberg therefore had ample opportunity to repeatedly demonstrate his exceptional experimental skill when the necessary spectroscopic technique was worked out.

"Herzberg had so far performed extensive precision determinations of the properties of over thirty free radicals among which are to be found the radicals methyl and methylene—well known from organic chemistry. Among his exciting discoveries may be mentioned that radicals drastically change their shape with increasing energy. For example, methylene is linear in its ground state but bent in states of higher energy. Many of the most important results were only achieved after several years' work and some of the most exciting as late as at the end of the 1960's. One can therefore note that this year's prize is truly an award for contributions of great current interest."

Gerhard Herzberg was born in Hamburg, Germany, in 1904, just a few years after the discovery of the electron had given the first clue to the structure of the atom. By

the time he was ready to undertake a serious study of physics, the new quantum mechanics had come into being and by 1928 when he started independent research work at Göttingen, this new mechanics had supplied the key to a full understanding of the electronic structures of atoms. Although quantum mechanics could also be applied to the problems of molecular structure, the much greater difficulties in this field caused it to lag behind work on atoms. It was the study of molecular structure, through a quantum mechanical interpretation of molecular spectra, which first attracted his attention and has, in a large measure, retained it over the past thirty-five years. At Göttingen, and in the following five years at Bristol and Darmstadt, the results of his numerous experimental studies of molecular spectra established this young man as one of the leading scientists in the field of molecular structure.

The mid-thirties were the years of the Nazi purges of the German universities and Gerhard Herzberg was one of the many professors who found it impossible to live under the Hitler regime. His reputation was such that, in more normal times, he would have had no difficulty in moving to one of the large universities outside Germany. But these were the years of the great depression when new university appointments were rare indeed and it was through his acquaintance with Dr. J. W. T. Spinks, then a junior staff member at Saskatoon, that Gerhard Herzberg found a place at the University of Saskatchewan—a university which had no suitable research equipment, no funds to buy such equipment, and no advanced graduate students to use it.

In spite of its unpromising appearance, Herzberg's stay at the University of Saskatchewan was a most fruitful one. Encouraged by a friendly staff and administration, if not by the physical resources of the university, he completed the measuring of plates and the calculation of results obtained in Germany. He devoted a large portion of his time to writing a book on the structure and spectra of diatomic molecules. With the help of a variety of small grants, he slowly secured some equipment for research and, working with candidates for masters degrees, he produced a number of significant papers on molecular spectra before the war put an end to all research activities.

The war found Herzberg still legally an alien and he was not allowed to play a major role in wartime research activities. During the war years he devoted a large part of his time to writing his second definitive book, a book on the infrared and Raman spectra of polyatomic molecules.

In 1945, Herzberg, who had always had an interest in astronomy, was offered a post as professor of the University of Chicago at Yerkes Observatory. This was an invitation to return to a major research institute, with advanced graduate students, with colleagues working in his field and with vastly increased technical and scientific facilities at his disposal. He reluctantly left Saskatoon and enthusiastically took up his new work at Yerkes where within two years he built up a laboratory capable of unique and important experiments involving long absorption paths. This period at Yerkes brought Herzberg in touch with some of the world's leading astronomers and heightened his interest and his knowledge of this subject.

In 1948 Herzberg was invited to set up a research laboratory in spectroscopy at the National Research Council laboratories in Ottawa. At this time the political atmosphere in the universities of the United States was not a happy one and Herzberg, who was now a Canadian citizen, accepted the invitation. In the following year he was appointed director of the physics division. With a speed and energy already demonstrated at the Universities of Saskatchewan and Chicago, he soon set up one of the world's most productive spectroscopy laboratories. But now his activities were not confined to spectroscopy and molecular structure. He was able to build up all sections of the physics division into productive research laboratories. At the same time his advice on scientific matters, on senior appointments and on matters of policy were sought far beyond the bounds of his own division and beyond the boundaries of his country.

Herzberg's work has been characterized by great breadth as well as depth. He has long had an interest in astronomy and has contributed greatly to that field. Many of his analyses of spectra have become the standard working data for astrophysicists. He was the first to produce in the laboratory and to analyze the bands of the C_3 molecule which for many years had remained 'mystery' bands in cometary and stellar spectra. He identified the interstellar lines of CH^+ and produced these lines in the laboratory. His studies of the infrared absorption of hydrogen were successful in showing the presence of this gas in the atmosphere of planets and his studies of the absorption spectra of atmospheric gases have proved to be of widespread interest to astronomers.

In any evaluation of Herzberg's work, a prominent place must be reserved for the books he has written. They have been translated into Russian and other languages and are known throughout the world. His earlier two books on molecular spectra and molecular structure have become standard works on the subject. The report on notation for the spectra of polyatomic molecules issued by the International Union of Pure and Applied Physics starts by noting that, 'fortunately the system used in Herzberg's well-known book on infrared and Raman spectra is already very generally accepted and forms a suitable basis for the standard notation proposed here.' His more recent book will, without doubt, have a similar unifying effect on the field of electronic spectra.

Today, Gerhard Herzberg is Canada's outstanding scientist; he is a well-known science writer and teacher, he is an adviser to many scientific bodies, and he is Canada's international ambassador in the world of science.