Gerhard Herzberg – An obituary

N. A. Narasimham

Gerhard Herzberg, the most distinguished spectroscopist of the present century, passed away at his home in Rockcliff, Ontario, Canada on 3 March 1999. He is widely known as the Father of Modern Molecular Spectroscopy, in recognition of which he was awarded the Nobel Prize in Chemistry in 1971.

He was born in Hamburg on the Christmas Day in 1904. He did his schooling at the Realgymnasium of the Johanneum and the graduate programme (1924–28) at the Technische Hochule in Darmstadt. On completion of his Ph D, he spent one year in Gottingen with Max Born and James Franck. There he collaborated with W. Heitler and reviewed Rassetti's work on rotational Raman spectrum of N_2 and observed that nitrogen nuclei follow Bose statistics which meant that electrons are not present in the nitrogen nucleus, contrary to the prevailing belief at that time. The discovery of neutron later clearly showed that only neutrons and protons occur inside the nucleus, as postulated by Heisenberg.

Later in September 1929, he went to Bristol at the invitation of Lennard-Jones to have discussions with him on molecular orbital theory and to take spectra of some diatomic molecules. His visit coincided with the Faraday Society Discussions on Molecular Spectra and Molecular Structure; this provided him the opportunity of listening to the lectures from O. W. Richardson, C. V. Raman, R. T. Birge and J. Lecomte and interacting with them. He was very much impressed by Raman and used to meet him often during Faraday Society meetings. Herzberg studied the spectra of P_2, where he observed an interesting case of predissociation and similar one in N_2, which provided clear cut dissociation limits.

Herzberg returned to Germany in 1930 and joined as a Privatdozent in Darmstadt University. He planned to use 3-meter grating spectrograph for studies of forbidden transitions in diatomic molecules. For this purpose, he set up in the basement of the building an absorption tube 12.5 m long, which with a reflecting mirror gave a path length of 25 m. With such a setup, he observed new absorption bands in O_2 consisting of a single well resolved Q branch converging to the dissociation energy of O_2. This is the $^3\Sigma_u^+ - {}^3\Sigma_g^-$ forbidden transition.

Another interesting experiment concerns the absorption peak of O_2 at 1.261 μ. Herzberg conducted this experiment directing the sunlight from the roof of the laboratory into the 3 m grating spectrograph. Using the new Agfa infrared plates, Herzberg succeeded in photographing the solar spectrum and found the $^1\Delta_g - {}^3\Sigma_g^-$ transition with all its branches. Thus, the $^1\Delta_g$ state predicted by Mulliken was established.

In the meantime, the Nazi regime in Germany debarred from the universities people with Jewish wives. Herzberg decided to migrate to Canada and accordingly left Germany in August 1935. Herzberg joined the University of Saskachewan as a Research Professor. An exceptionally gifted student, Alex Douglas, joined him for his Master's degree. Together they obtained B_2 spectrum which enabled them to determine the nuclear spins of ^{10}B and ^{11}B and statistics of these nuclei. Another important discovery was that of CH^+. The R(O) lines of the newly-obtained spectrum coincided with the interstellar lines, thus establishing the presence of CH^+, the first molecular ion in interstellar medium.

The Director of the Yerkes Observatory, O. Struve invited Herzberg to join their Observatory (under Chicago University) and set up a spectroscopy laboratory to study spectra of astrophysical importance. Herzberg welcomed this opportunity to be associated with distinguished astronomers, and in particular S. Chandrasekhar, a mathematical genius. Herzberg recalls many memorable discussions with him on their contributions and perspectives of physics and astronomy.

Finally Herzberg moved over to National Research Council in Canada in 1949. Fortunately A. E. Douglas joined him and together they built one of the finest spectroscopy laboratories in the world. Herzberg set up a long absorption tube of 22 m length and using White system of mirrors, he could obtain 5000 m of absorbing path that enabled him to observe the quadrupole spectrum of hydrogen. He recalls, he was stimulated by a remark by Edward Teller in 1937 that the H_2 (and N_2) could be detected in planetary atmospheres if the quadrupole rotation-vibration spectrum could be photographed using suitable path lengths of absorption.

Throughout his scientific career, Herzberg was interested in the spectra of atomic and molecular hydrogen. He planned to determine the Lamb shift in the ground state of atomic hydrogen for which an accurate determination of the wavelength of Lyman-α was necessary. However, in the case of deuterium, Herzberg did obtain a value of 0.26 cm^{-1} for Lamb shift in 1S state and this agrees with the value predicted by quantum electrodynamics. He had also determined the Lamb shift for He, a two electron system, by making measurements on the 3 m vacuum grating spectrograph in the 10th order. The experimental value is in good agreement ($\pm$ 0.05 cm^{-1}) with the prediction of quantum electrodynamics. He could also obtain precise values of the ionization potential of ^4He and ^3He. Douglas and Herzberg obtained the spin and statistics of ^3He from the spectrum of $^3He_2$.

In the case of H_2 molecule, the dissociation energy is the most important quantity. From the vacuum ultraviolet spectrum, Herzberg determined D_0

(H_2) = 36118.0 cm^{-1}. He determined also the ionization potentials of H_2 and also of HD and D_2.

At NRC, there was an intense activity in the study of spectra of free radicals using different excitation methods including flash photolysis. Herzberg and Ramsay started the studies with NH_2 radical produced by photolysis of ammonia. The second free radical was HCO. Herzberg using flash photolysis of diazomethane, obtained the first (true) spectrum of CH_2 at 1415 Å. One may recall how the 4050 Å band observed in Comet Halley was later produced in the laboratory by Herzberg. He attributed it to CH_2; the emitter of the 4050 Å band was found to be C_3 by Douglas much later in 1954. In this connection, it is worthwhile to refer to another case of cometary spectrum (Kohoutek comet). Italian astronomers Benvenuti and Wurmi photographed the spectrum of Kohoutek comet and while examining the spectrum, they could not identify certain features. On reference to Herzberg, they learnt that they belong to H_2O^+, the spectrum of which was studied earlier by Herzberg and Hin Lew at NRC. Among the spectra of free radicals, Herzberg found it easier to obtain that of methyl radical rather than methylene. He did photograph the spectrum of CH_3 which has two diffuse peaks around 2160 Å. In the case of CD_3 he found a simple fine structure near 2144 Å. Herzberg gave an excellent account of his work on CH_3 and CH_2 in the Bakerian Lecture to the Royal Society of London.

Herzberg realized the importance of H_3^+ in interstellar chemistry. So he decided to look for it in emission while his colleague T. Oka in absorption. Oka did obtain its absorption spectrum while Herzberg obtained a spectrum due to H_3 in Rydberg states.

Herzberg wrote excellent books on atomic and molecular spectroscopy. He published the German edition of *Atomic Spectra and Atomic Structure* and with the help of John Spinks he could submit the English translation of this book to Prentice-Hall by the end of 1936. His three volumes on molecular spectra are all time classics: Vol. I, *Spectra of Diatomic Molecules* (1939), Vol. II, *Infrared and Raman Spectra of Polyatomic Molecules* (1945) and Vol. III, *Electronic Spectra of Polyatomic Molecules* (1966).

Herzberg was the first Canadian to win a Nobel prize in science. During his lifetime, Herzberg received countless honours, some of these are: Companion of the Order of Canada, an Academician of the Pontifical Academy of Sciences at the Vatican, a Fellow of the Royal Societies of London and Canada and a Member of the Canadian Science and Engineering Hall of Fame. He also gave his name to NRC's Herzberg Institute of Astrophysics (HIA), created in his honour in 1975. In 1987, asteroid 3316 was officially named after him, as was a street in Kanata, Ontario. Herzberg was appointed as a member of the Queen's Privy Council for Canada on 1 July 1992.

Herzberg visited India several times and each time he made it a point to visit the Himalayan mountains and also old historical monuments. He was elected an Honorary Foreign Fellow of Indian Academy of Sciences in 1955 and also of Indian National Science Academy in 1974. He was conferred honorary doctorate by Delhi, Osmania and Andhra universities. He delivered the first R. K. Asundi Memorial Lecture of Indian National Science Academy in 1984.

N. A. NARASIMHAM
18, Saras Baug,
Deonar, Mumbai 400 088

M. J. Thirumalachar (1914–1999) – An obituary

In the passing away of M. J. Thirumalachar on 21 April 1999 at Walnut Creek, CA, USA, the world of biological sciences has lost a veteran researcher of over 60 years whose original contributions embraced a wide spectrum of scientific disciplines like botany, mycology, microbiology, antibiotic fermentations and chemotherapy of human, animal and plant infections. Best known as an outstanding mycologist of international standing, his contributions to the study of Indian fungi have been phenomenal. Through his publications on several new genera and species of fungi belonging to all the major groups of the mycological kingdom, Thirumalachar has indeed placed his footprints firmly on the sands of time. His earlier contributions monographing the rusts published jointly with B. B. Mundkur, description of new genera of smuts like *Mundkurella, Narasimhania* and *Franzpetrakia* (along with M. S. Pavgi) and *Georgefischeria* (along with

M. J. Narasimhan, M. C. Srinivasan and H. C. Govindu), erecting *Sclerophthora* as a new genus of downy mildew for the destructive crazy top of corn and other graminaceous hosts (along with M. J. Narasimhan and Charles Gardner Shaw), establishing the morphological basis for differentiating *Entomophthora* from *Conidiobolus* on the basis of cultural studies (along with M. C. Srinivasan and M. J. Narasimhan) and the studies on the life cycle of an edible rust causing malformation on *Acacia eburnea* and identifying it as *Ravenelia esculenta* (along with M. J. Narasimhan) rediscovered sixty years after Barclay had described *Aecidium esculentum* from Maharashtra are just a few examples of his most notable contributions to mycology.

In the field of antibiotics, Thirumalachar is well recognized for his discovery of Hamycin, Dermostatin and Aureofungin which are potent antifungal antibiotics therapeutically useful in the control of human mycoses and com-