

The Raman effect

Rajinder Singh and Falk Reiss¹ point out that there was much skepticism in Germany about the reality of the phenomenon Raman and his collaborators announced in February of 1928. I wish to add a few comments.

The skepticism is not surprising because much of the earlier part of the researches by the Raman school (which finally led to the discovery of the Raman effect), was made visually with filters, polarizers and a direct vision spectroscope using sunlight as the source. In defence, Raman used to say that Nature had endowed man with a very powerful and precise optical instrument in the form of the eye. It is, therefore, not inappropriate for scientists to use this exceptional tool for scientific study.

As pointed out by the authors, Arnold Sommerfeld came to India in October 1928. He wrote in his diary at that time:

'Eventually saw the Raman effect visually—on 7th of October heard a wonderful lecture by Raman. Also the rotation of molecules can be seen (unresolved) as the modified radiation.'

On subsequent days:

'Saw the blue green in an ice block. Obviously modified scattering.'

The renowned editor Richard A. Gregory, who made *Nature* into the distinguished journal it is today, is known to have remarked when he came to India in 1933 that the paper sent in by Raman which was later published, (reproduced in *Current Science*, 1998, 74, 383–386) was not recommended for publication by the referee. But Gregory published it in his journal (*Nature*, 1928, 121, 619). His argument was that Raman had always sent in very reliable and scientifically sound papers, which *Nature* had published regularly. He was, therefore, reluctant to believe that this paper alone had a serious flaw in the observation reported in it. He was also very happy that the publication of this paper paved the way to Raman being awarded the Nobel Prize.

Later, R. W. Wood, the distinguished optical physicist, sent a paper to *Nature* by cable entitled 'Wavelength shift in scattered lights' (1928, 122, 349). We give extracts from this brief paper which occupied about half a column in *Nature*:

'Prof. Raman's brilliant and surprising discovery ... I have verified his dis-

covery in every particular. Raman's discovery thus makes it possible to investigate remote infrared regions hitherto little explored.

'It appears to me that this very beautiful discovery which resulted from Raman's long and patient study of the phenomenon of light scattering is one of the most convincing proofs of the quantum theory of light.'

It was Sommerfeld's visual verification of the Raman effect in Calcutta in 1928 and the paper by R. W. Wood which convinced the western scientific world of the reality of the Raman effect as a new phenomenon. Sommerfeld's visit was also important for India from another point of view. It was he who directed the attention of young Subrahmanyam Chandrasekhar (then only 18 years old) to the newly formulated Fermi-Dirac statistics. Chandrasekhar went on to apply this statistics to astrophysical problems which too ended in his famous paper, for which he received the Nobel Prize, almost 50 years later, in 1983. The paper by Rajinder Singh and Falk Reiss also gives the names of those who proposed Raman for Nobel Prize. These include Ernest Rutherford, Neils Bohr, Louis de-Broglie, Jean Perrin, E. Stark, C. T. R. Wilson and Charles Fabry. One could wonder why such a galaxy of scientists proposed Raman for the Nobel Prize. The reason seems to be the surprising nature of the discovery and its importance to physics and chemistry. Indeed in a letter dated 18 September 1929, by Neils Bohr to Raman, written almost 15 months before he was awarded the Nobel Prize, Bohr says:

'I take this opportunity to express my most cordial congratulations to your great discovery of the new radiation phenomenon which has added so immensely to our knowledge of optics and atomic physics.'

As Einstein pointed out:

'C. V. Raman was the first to recognize and demonstrate that the energy of a photon can undergo partial transformation within matter. I still vividly recall the deep impression that this discovery made on us all.'

In fact, this aspect of the quantum theory and the access to infrared spectroscopy, as pointed out by R. W. Wood,

was brought out by Raman himself in the lecture that he gave to the South Indian Association on 16 March 1928 when he publicly announced the discovery of the Raman effect.

'As a tentative explanation, we may adopt the language of the quantum theory, and say that the incident quantum of radiation is partially absorbed by the molecule, and that the unabsorbed part is scattered. ... If we accept the idea indicated above, then the difference between the incident and scattered quanta would correspond to a quantum of absorption by the molecule. The measurement of the frequencies of the new spectral lines thus opens a new pathway of research into molecular spectra, particularly those in the infrared region.'

The authors of the paper also stress the fact that Raman was completely convinced of the quantum theory of light and photon theory postulated by Einstein. It is noteworthy that when Raman started his researches on the scattering of light in 1921, he put his faith in the Einstein concept of the photon when scientists everywhere were vacillating about accepting the very existence of the photon.

'Even when Einstein's photoelectric law was accepted almost no one but Einstein himself would have anything to do with light quanta.'

In 1935, Max Born seems to have told Nagendra Nath who worked both with Raman and also with Born when he was in India that:

'He was impressed with Raman's strong advocacy of Einstein's concept of the light quantum even in 1921, that he was very pleasantly surprised at Raman's grasping the subtle theoretical implications of the Kramers-Heisenberg process, but was truly astounded by Raman's insight as early as 1922 that Maxwell's field equations would have to be modified to suit the quantum theory!'

1. Rajinder Singh and Falk Reiss, *Curr. Sci.*, 1998, 74, 1112–1115.

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