



## Color change allows harm-free health check of living cells by C.V Raman

- Prof. Vijay Wankhade

Raman was enormously enthusiastic about science. On vacations he would demonstrate experiments to his younger brothers and sisters.

He completed his degree in 1904, winning medals in physics and English. His British lecturers encouraged him to study for a master's degree in the United Kingdom. Madras's civil surgeon, however, told him that his health was not robust enough to withstand the British climate; he advised Raman to stay in India.

This was probably excellent advice. The brilliant mathematician Srinivasa Ramanujan, born just a year before Raman, traveled from Madras to work at the University of Cambridge in 1914. Although this led to the creation of some exceptional mathematics, it had a severe impact on Ramanujan's health.

Nobel Prize Winner Mistakes 18-year Old Raman for a Professor of Physics

Raman was awarded a scholarship and he remained at Presidency College to study for his master's degree. His outstanding potential was recognized, and he was given unlimited access to the laboratories, where he pursued investigations of his own design.

In November 1906, aged 18, Raman had his first academic paper published. He had initially given it to one of his professors to read, but the professor had not bothered. Raman sent his paper directly to *Philosophical Magazine* and it was accepted. Its title was Unsymmetrical diffraction-bands due

to a rectangular aperture: it was about the behavior of light.

Following the publication of his second paper in *Philosophical Magazine*, Raman received a letter from Lord Rayleigh, the eminent British physicist. Rayleigh, unaware that Raman was just a teenage student, sent his letter to "Professor Raman."

In 1907, aged 19, Raman graduated with a master's degree in physics, awarded with the highest distinction.

Full-time Government Administrator, Part-time Scientist

Although Raman was intent upon a scientific career, his brother persuaded him to take the civil service exams. Civil service jobs were highly paid and Raman's family was deeply in debt.

For 10 years Raman worked as a civil servant in the Indian Finance Department in Calcutta (now Kolkata), rising quickly to a senior position. In his free time he carried out research into the physics of stringed instruments and drums. He did this work at the Indian Association for the Cultivation of Science (IACS).

The IACS had been in a state of hibernation until Raman stumbled upon it and set about reviving it. In addition to his research work, Raman gave public lectures in Calcutta popularizing science.

At Last, Full-time Science

Raman's part-time research work and his lectures were impressive, establishing his reputation as a highly talented physicist. In 1917, the University of Calcutta sought him out and offered him the Palit Chair of Physics. Although it meant a substantial cut in pay, Raman, now aged 28, accepted – the prospect of devoting all of his time to science was worth more to him than money.

Although it was a research professorship, Raman also chose to give lecture courses: he was an exciting lecturer and he inspired his students.


### **The Raman Effect -**

Raman and Rayleigh Scattering

Lord Rayleigh, who had believed the teenage Raman's papers were the work of a professor, had been one of the great physicists of his day. He had won the 1904 Nobel Prize in Physics.

His importance to Raman's story is that Rayleigh had been





the first to explain why the sky is blue. He had then explained the sea's color by saying it was simply a reflection of the sky's color.

One day, in the summer of 1921, Raman was on the deck of a ship in the Mediterranean Sea en route to the Congress of Universities of the British Empire at Oxford. He looked at the beautiful blue color of the Mediterranean Sea and began to doubt Rayleigh's explanation of its color.

Rayleigh had correctly explained that the sky looks blue because of a phenomenon now called Rayleigh scattering.

An approximate representation of Rayleigh scattering in Earth's atmosphere.

If Earth had no atmosphere, anyone who happened to be around in such circumstances would see a white sun and a black sky. However, this is not what we see, because sunlight interacts with the gases in Earth's atmosphere.

Rather than coming straight to our eyes from the sun, sunlight is scattered in all directions by the atmosphere. Blue light is scattered most, meaning that it comes to our eyes from everywhere in the sky, therefore the sky looks blue. Yellow and red light are scattered least, so we usually see a yellow sun, and sometimes a red sun.

Rayleigh scattering is *elastic*. This means that photons of light lose no energy when they interact with gas molecules. The light, therefore, stays the same color.

### **Raman Discovers that the Sea Scatters Light -**

When he sailed back to India in September 1921 Raman, an indefatigable scientist, had with him some simple physics apparatus: a prism, a miniature spectroscope, and a diffraction grating. He used these to study the sky and the sea and concluded that the sea was scattering light.

Hence when Rayleigh said the sea's color is simply a reflection of the sky's color, he was not wholly correct. Raman reported his findings in a letter to the journal *Nature*.

When he returned to his laboratory, Raman and his students began an exhaustive program of research into light scattering.

### **Some Personal Details and the End -**

Raman married Lokasundari Ammal in 1907. The couple had two sons: Radhakrishnan, who became a distinguished

astrophysicist, and Chandrasekhar.

Raman was knighted in 1929 for his discovery of the Raman Effect, becoming Sir Chandrasekhara Venkata Raman.

Raman's Nobel Prize winning work was initially inspired by observations he made on a sea voyage. Coincidentally, it was on a sea voyage that another Indian Nobel Prize winner, Subrahmanyan Chandrasekhar, actually carried out most of his Nobel Prize winning work. And, even more coincidentally, C.V. Raman was Chandrasekhar's uncle!

Raman had supreme confidence in his own ability. When the Palit Chair of Physics was endowed at the University of Calcutta, one of the conditions was that the holder would carry out research in other countries to increase Indian expertise. Raman refused to do this. He said that scientists should come from other countries to learn from *him*. He was so sure he would win the 1930 Nobel Prize that he booked tickets to Sweden four months before the winner was announced.

In 1933, Raman became the first Indian director of the Indian Institute of Science in Bangalore. In 1947, he became independent India's first National Professor. In 1948, he founded the Raman Research Institute in Bangalore, where he worked until the end of his life.

Raman was suspicious of governments playing any role in fundamental science, refusing government funding for his work:

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