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Date: 01/11/2025
Time: 10: 00 am

III/MPHYCC10 Atomic and Molecular Physics

Continue.....

- February 28 is celebrated every year as National Science Day since 1987 in the honour of CV Raman, who discovered the Raman Effect and for which he was awarded the Nobel Prize of Physics in 1930.

With the objective;

- Spread the significance of science in daily life of the people.
- Display all the activities, efforts and achievements in the field of science for welfare of human being.
- Discuss the issues and implement new technologies for the development of science.
- Give an opportunity to the scientific minded citizens in the country.
- Encourage the people and to popularize the science and technology.

With a targeted theme for every year.....

- 2018 - Science and Technology for a sustainable future.
- 2019 - Science for the People, and the People for Science
- 2020 - Women in Science
- 2021 - Future of STI: Impact on Education Skills and Work
- 2022 - integrated approach in science and technology for a sustainable future**

From the year 2013, the “Raman Effect” has been designated as an International Historic Chemical Landmark by The American Chemical Society.

Brief history and scientific contribution of Sir C V Raman



Novel prize for an
Indian for the work done on
Indian soil.

- (7 November 1888 – 21 November 1970).
- BA – 1904 (At the age of 16).
- MA – Published first paper in 1904.
- Could not chose scientific career because he was not having degree from abroad.
- Then joined Finance service in Calcutta in 1907..
- 1907 -1917 – Published about 30 original articles and was recognized as a scientist.
- 1917 – 1932 - Palit Professor (Calutta University).
- His first project was on acoustics (sound and vibrations), which gave him international recognition. Fellow of Royal Society in 1924.
- Optics was the second field in which dedicated major interest.
- Discovered the inelastic scattering phenomenon in 1928.
- Was awarded the Nobel Prize for Physics in 1930.

Discovery of Raman Effect

- Rayleigh scattering was known since late 19th century.
- Austrian physicist Adolf Smekal predicted in 1923 that a small part of light should be scattered inelastically.
- During early formulation of quantum mechanics Kramers, Heisenberg, Born Jorden etc confirmed inelastic scattering theoretically.
- Raman started looking for light scattering during his first trip abroad in 1921. Blue colour of sea is due to scattering of sunlight by water.
- Raman along with Krishnan and others continued his work with simple equipments containing filtered sun light/ mercury lamp with purified liquids (benzene), spectroscope/ spectrograph and a focusing lens till he discovered Raman effect in 1928 (Published in Nature).
- 1933 – Director of IISc 1934 – Founded the Indian Academy of Science
1948 – National Professor in Gov of India.
- 1948 – Established Raman Research Institute.

Vibrational Modes of Water and Carbon dioxide molecule

- Number of modes:

Linear $3n - 5$ modes

- Types of vibrations:

Stretching (symmetric and asymmetric)

Bending (wagging, twisting, rocking and scissoring)

- Examples:

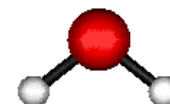
– CO_2 has $3 \times 3 - 5 = 4$ normal modes

- IR active modes require change in dipole moment

- Raman -active modes require polarizability to change during rotations and vibrations

Non-linear $3n - 6$ modes

H_2O has $3 \times 3 - 6 = 3$ normal modes

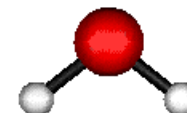
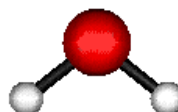


Symmetric stretching
Raman active and IR active
 3835 cm^{-1}



Symmetric stretching
No change in dipole
IR-inactive But Raman active
 1353.6 cm^{-1}

Asymmetric stretching
Change in dipole
IR-active
Raman active
 2396.3 cm^{-1}

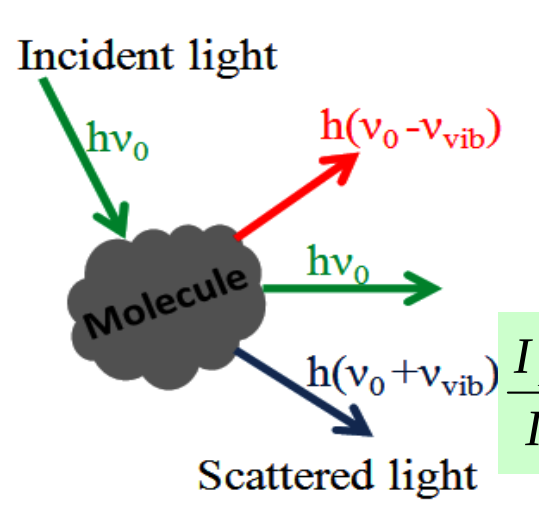


Symmetric (Scissoring)
bending (degenerate, in-plane
and out of plane) Change in
dipole
 672.6 cm^{-1}

Asymmetric stretching
Raman active and
IR-active
 3939 cm^{-1}

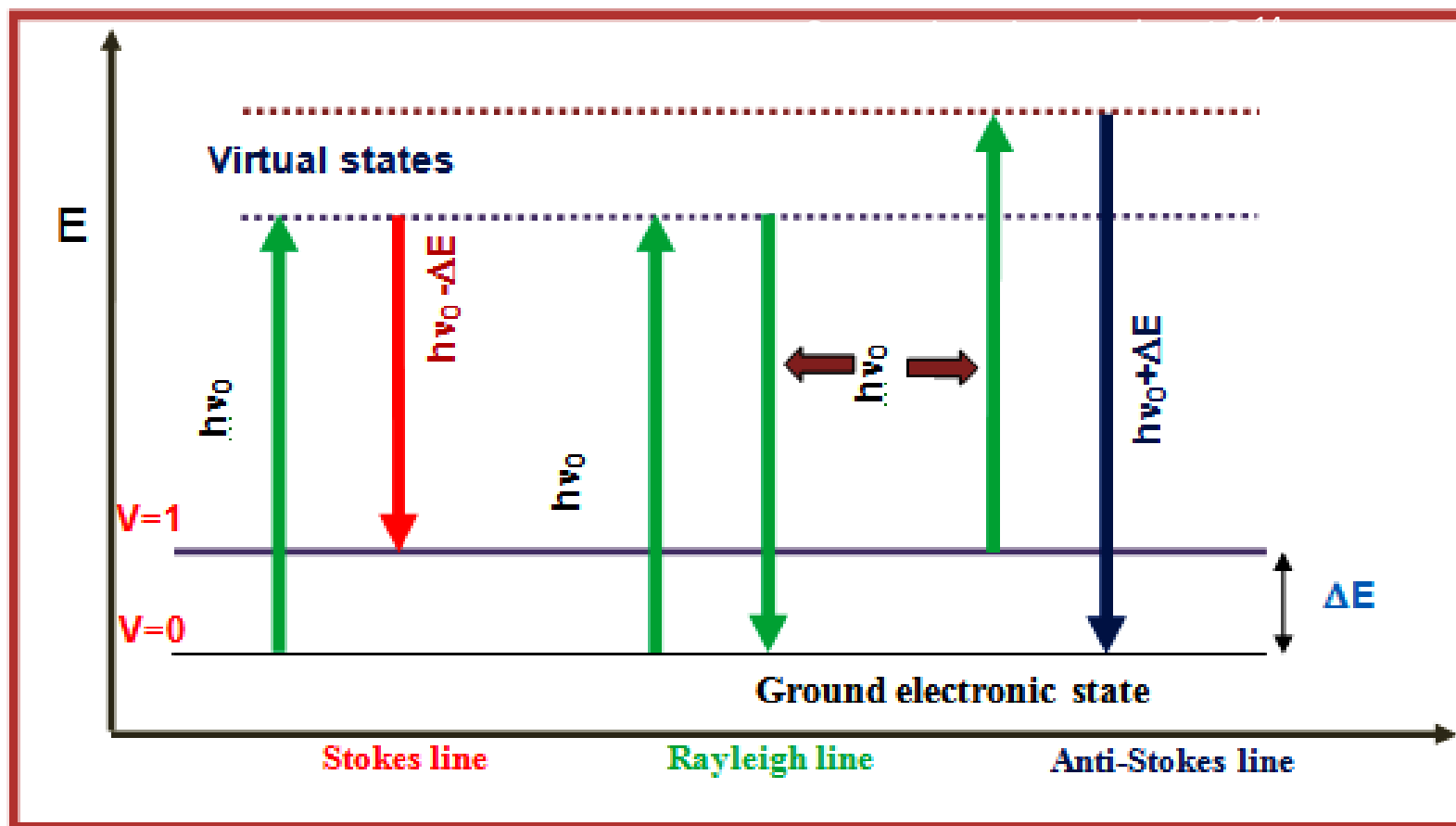
Symmetric (Scissoring)
bending Raman active and
IR-active
 1648 cm^{-1}

Raman scattering process



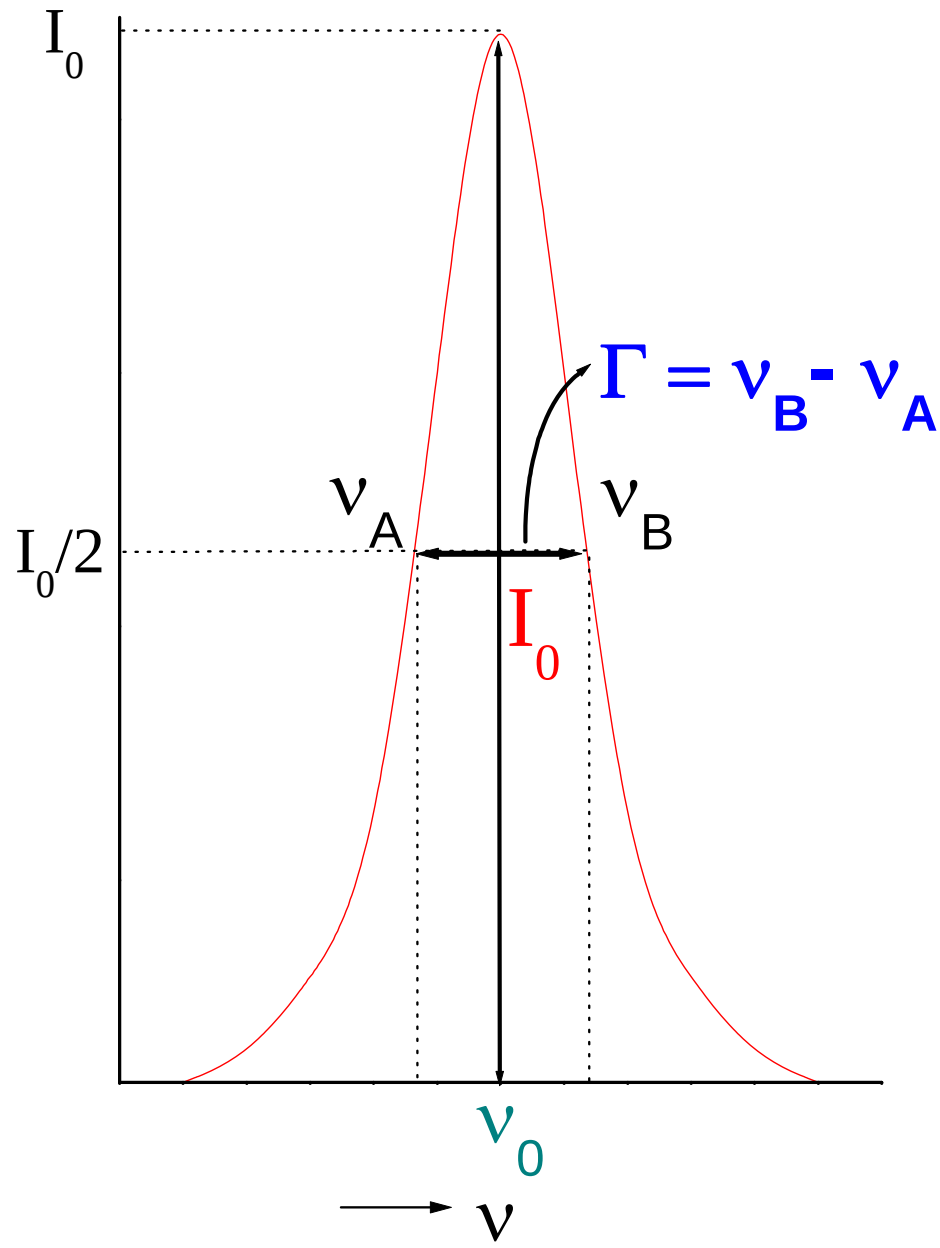
$$\frac{I_{AS}}{I_S} = \left[\frac{\nu_0 + \nu_{vib}}{\nu_0 - \nu_{vib}} \right] 4 \exp\left(\frac{-\Delta E}{KT}\right)$$

Selection rule: $\left(\frac{\partial \alpha}{\partial q}\right) \neq 0$



Scattering timescale
 $\sim 10^{-14}$ sec
 (fluorescence $\sim 10^{-8}$ sec)

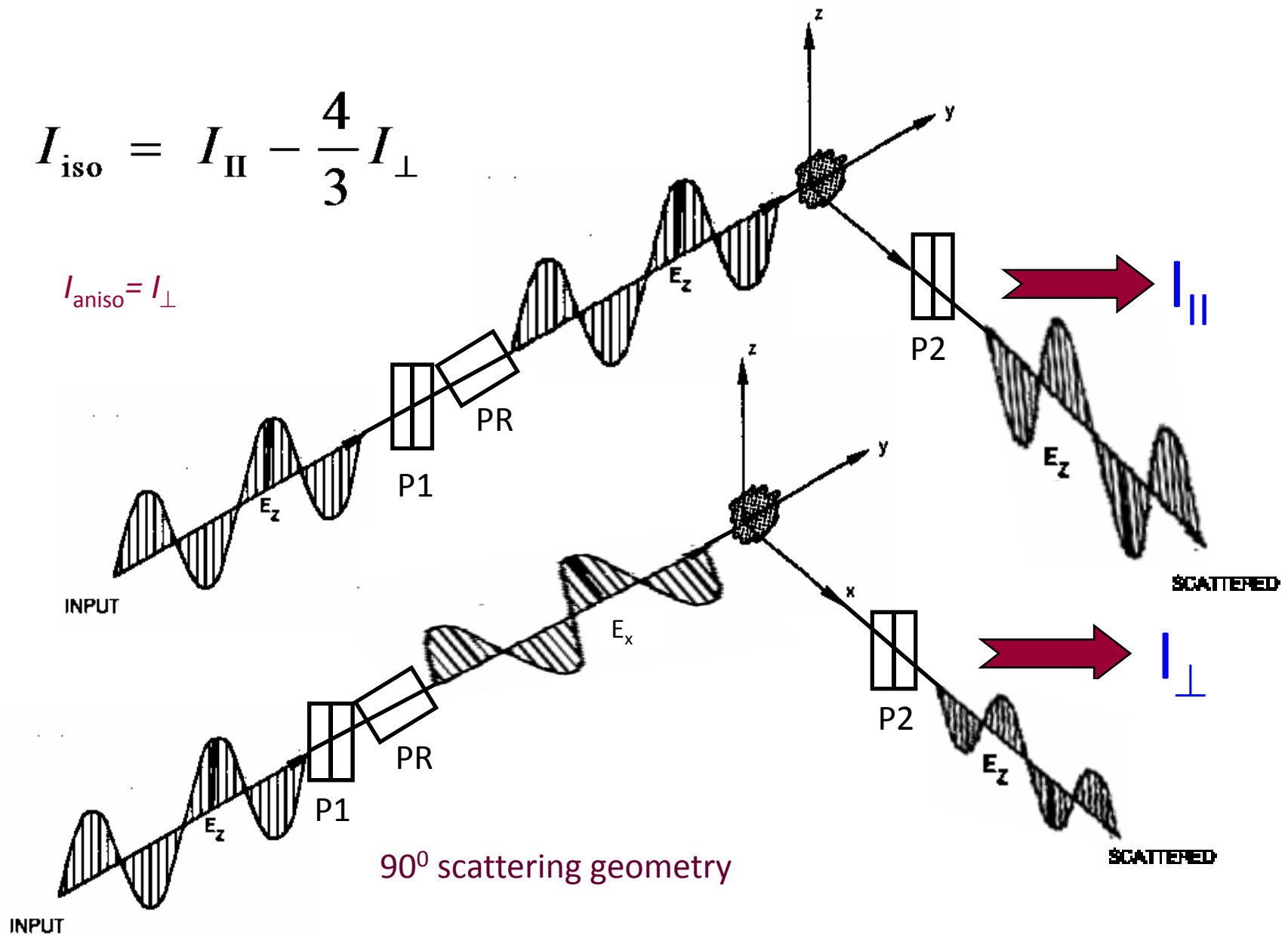
Basic parameter related to Line Shape



Polarized Raman measurement

$$I_{\text{iso}} = I_{\text{II}} - \frac{4}{3} I_{\perp}$$

$$I_{\text{aniso}} = I_{\perp}$$



Metabolism continue.....

