Spectroscopy-2

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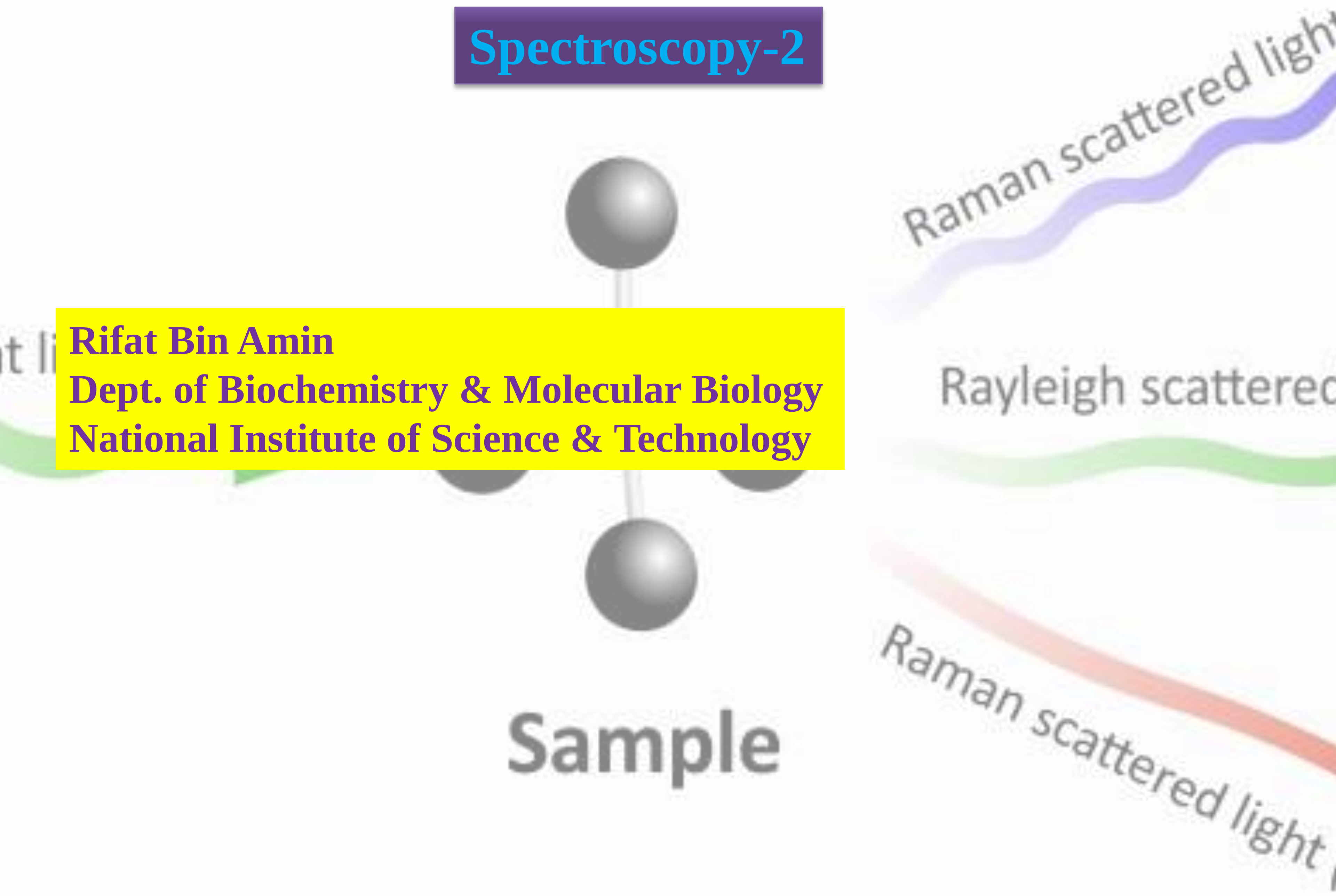
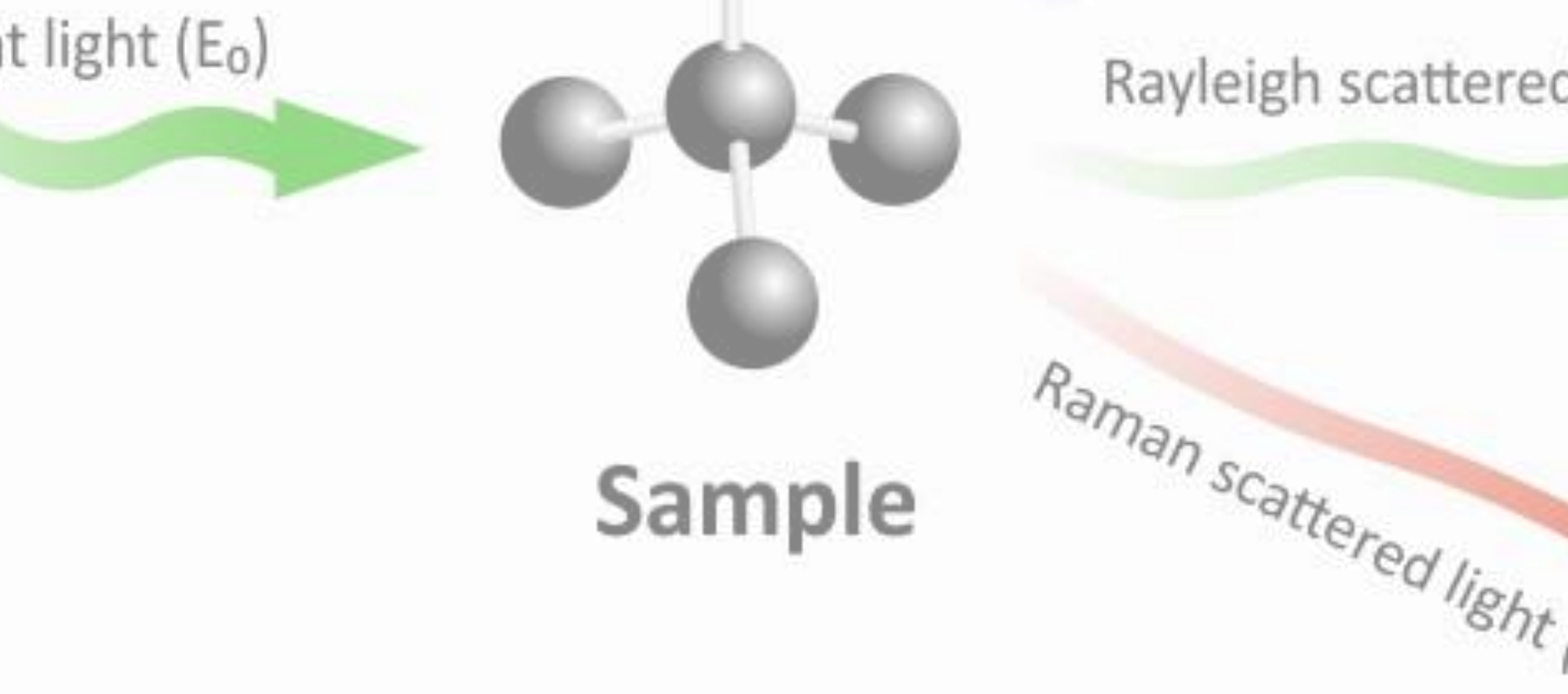


What is Spectroscopy

Spectroscopy, study of the absorption and emission of light and other radiation by matter, as related to the dependence of these processes on the wavelength of the radiation.

Spectroscopy is the investigation and measurement of spectra produced by matter interacting with or emitting electromagnetic radiation. Originally, spectroscopy was defined as the study of the interaction between radiation and matter as a function of wavelength. Now, spectroscopy is defined as any measurement of a quantity as a function of wavelength or frequency. During a spectroscopy experiment, electromagnetic radiation of a specified wavelength range passes from a source through a sample containing compounds of interest, resulting in absorption or emission. **During absorption, the sample absorbs energy from the light source. During emission, the sample emits light of a different wavelength than the source's wavelength**.

Spectroscopy is the study of the absoprtion and emission of light and other radiation by matter. It involves the splitting of light(or more precisely electromagnetic radiation) into its constituent wavelengths (a spectrum), which is done in much the same way as a prism splits light into a rainbow of colours. In fact, old style spectroscopy was carried out using a prism and photographic plates.



ELECTROMAGNETIC RADIATION

Electromagnetic radiation is a type of energy that is transmitted through space at enormous velocities. It takes many forms, the most easily recognizable being light and radiant heat. Less obvious manifestations include X-ray, Ultraviolet, microwave and radio radiations.

Lambert's law

Lambert's law states that **"when a beam of monochromatic radiation is passed through a homogeneous absorbing medium, the rate of decrease of intensity of the radiation 'dI' with thickness of absorbing medium 'dx' is proportional to the intensity of the incident radiation '*I*' ".**

$$\frac{-dI}{dx} = k\,I$$

Beer-Lambert's law

Beer's Law or the Beer-Lambert Law states that the amount of energy absorbed or transmitted by a solution is proportional to the solution's molar absorptivity and the concentration of solute.

Thus Beer-Lambert's law states that, "when a beam of monochromatic radiation is passed through a solution of an absorbing substance, the rate of decrease of intensity of radiation 'dI' with thickness of the absorbing solution 'dx' is proportional to the intensity of the incident radiation 'I' as well as the concentration of the solution 'C'.

$$\frac{-dI}{dx} = k\, I\, C$$

Beer-Lambert's Law

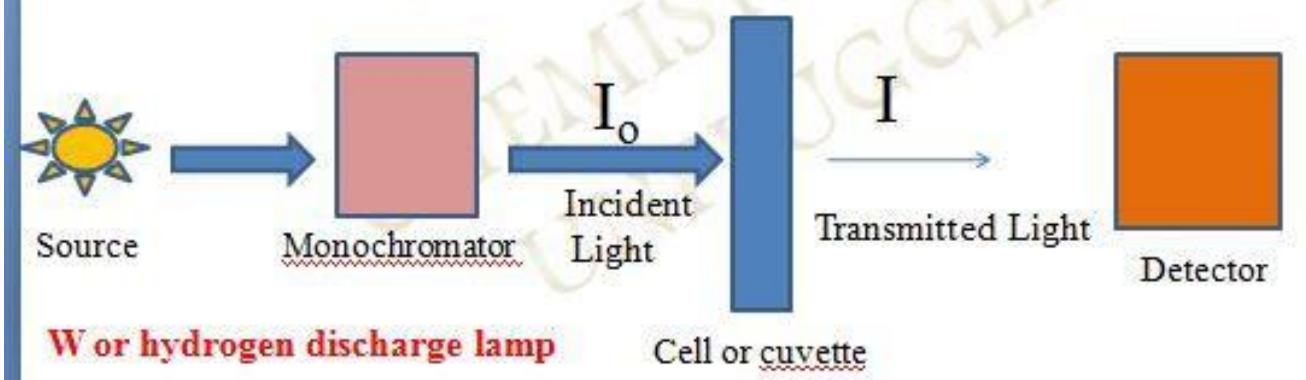
- Absorbance is directly proportional to concentration of the solution.

$$A = \varepsilon c l = \log(I_o/I)$$

where, c= concentration (mol/litre)

l = length of light path through the cell (cm)

ε = molar absorption coefficient ($L\ mol^{-1}\ cm^{-1}$)



Let I_0 be the radiant power of a beam incident upon a section of solution that contains c moles of an absorbing substance per liter. Let I be the power of the beam after it has traversed x centimeters of the solution. As a consequence of absorption, I will be smaller than I_0. Beer's law relates these quantities as

$$\log\left(\frac{I}{I_0}\right) = -\varepsilon cx = A$$

In this equation "e" is called as the molar absorptivity. The logarithm (to base 10) of the ratio between the incident and the transmitted power is called the absorbance of the solution.

When the monochromatic radiation passes through a sample containing an absorbing species, the radiant power of a beam is progressively decreased as more energy is absorbed by the particles of that species. The decrease in power depends upon the concentration of the absorber and the length of the path traversed by the beam. The relationship is expressed by Beer's law.

Examples of Spectroscopy Applications

1. Determining the atomic structure of a sample
2. Determining the metabolic structure of a muscle
3. Monitoring dissolved oxygen content in freshwater and marine ecosystems
4. Studying spectral emission lines of distant galaxies
5. Altering the structure of drugs to improve effectiveness
6. Characterization of proteins
7. Space exploration
8. Respiratory gas analysis in hospitals

Limitations of the Beer-Lambert law

- Deviations in absorptivity coefficients at high concentrations (>0.01M) due to electrostatic interactions between molecules in close proximity
- Interaction with solvent: hydrogen bonding
- Scattering of light due to particulates in the sample
- Changes in refractive index at high analyte concentration
- Shifts in chemical equilibria as a function of concentration
- Non-monochromatic radiation, deviations can be minimized by using a relatively flat part of the absorption spectrum such as the maximum of an absorption band