Introduction to Spectroscopy

Spectroscopy is the study of the interaction of electromagnetic radiation with matter. The most important consequence of such an interaction is that energy is either absorbed or emitted by the matter. Depending on the nature of electromagnetic radiation which is absorbed or emitted by the matter and also on the effect of such absorption or emission produced on the matter there are a number of types into which the spectroscopic technique may be classified. Thus the main branches of spectroscopy involves the measurement of energy of the radiation absorbed or emitted and the intensity of such absorption or emission.

Spectroscopy may be applied to atoms as well as to the molecules. Thus spectroscopy may also be classified as atomic or ~~molecules~~ molecular spectroscopy. Atomic spectra are used to detect as well as to quantitate atoms (particularly matter) but molecular spectra are used to reveal the molecular structure. Sometimes molecule can be interact with radiation by scattering it. The spectra obtained due to such an interaction are called Raman spectra.

Absorption spectroscopy

Here the sample capable of absorbing light is placed exposing it to the source of radiation and the percentage of radiation absorbed is recorded again the frequency or wavelength of the incident radiation. Alternatively the percentage of radiation transmitted may also be recorded. A graphical record of the radiation absorbed versus the wavelength or frequency of the radiation is known as absorption spectrum.

Emission Spectroscopy

Here, the matter is subjected to intense heat or electric discharge so as to absorb energy and to become excited. On returning to the lower energy state the matter now emits radiation which is graphically plotted to obtain what is known as the emission spectra. Normally atoms are studied in emission spectroscopy technique:

Raman Spectroscopy

Here, the structure of a molecule is explored by studying the radiation ~~emitted~~ scattered by a molecule causes frequencies which are different from that of the incident radiation. A molecule after scattering the light undergoes vibrational and rotational transition and hence Raman spectroscopy, which is based on the scattering experiment helps in the determination of molecular structure.

However another type of spectroscopy technique known as magnetic resonance spectroscopy where the species under study interacts with an external magnetic field to give rise to no digenerate magnetic energy level. Exposed to appropriate electromag radiation can cause transition betn the mag. energy level. A study of such transition betn nuclear energy level is called nuclear resonance spectroscopy and a similar one involve in transition betn the magnetic energy level of unpaired electros is called electron spin resonance spectroscopy.

Regions of electromagnetic radiation

Spectral region	wavelength (nm) (μ)	Freq/ wavenu	Energy KJmol^{-1}	Effect produced
Far UV	45 — 200	666,667 — 50,000	8000 — 600	Electronic excitation
Near UV	200 — 400	50,000 — 25,000	600 — 300	,,
visible light	400 — 800 (·8 μ)	25,000 — 12,500	300 — 150	,,
Near IR	0·8 — 2·5 μ	12,500 — 4000	150 — 48	vibrational
vibrational IR	2·5 — 25 μ (·025 mm)	4000 — 400	48 — 4·8	
Far IR	0·025 mm — 0·5 mm	400 — 200	4·8 — 2·4	
micro wave	0·5 — 300 mm	200 — 0·033	2·4 — $2·2 \times 10^{-4}$	Rotation
Radio wave	·3 m — 3 km	×	$2 \cdot 2 \times 10^{-4}$ —	Nuclear mag excitation