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Absorption Spectra of Inorganic Compounds

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Abstract: *Spectroscopy is the study of absorption and emission of light and other radiation by matter. It is the branch of science concerned with the spectra of electromagnetic radiation as a function of its wavelength or frequency measured by spectrographic equipment, and other techniques in order to obtain information concerning the structure and properties of matter. It is an experimental method which aims at obtaining molecular information on the system under study. The link between observation and information is provided by the theory of the molecular interaction between electromagnetic or particle radiation and matter. In the present study, we are going to study in detail the scope, principle and applications of UV spectroscopy where in the lambda max of various compounds were determined.*

Keywords: Spectroscopy, Electronic Transitions, UV –Visible Spectroscopy

I. INTRODUCTION

Spectroscopy is the study of the properties of matter through its interaction with various types of radiation (mainly electromagnetic radiation) of the electromagnetic spectrum. Spectrometric techniques are a large group of analytical methods that are based on atomic and molecular spectroscopy. Spectrometry and spectrometric methods refer to the measurement of the intensity of radiation with a photoelectric transducer or other types of electronic device. The UVVIS spectrometry is one of the oldest instrumental techniques of analysis and is the basis for a number of ideal methods for the determination of micro and semi micro quantities of analytes in a sample. It concerns with the measurement of the consequences of interaction of Electromagnetic radiations in the UV and/or visible region with the absorbing species like, atoms, molecules or ion. [1] Spectroscopy as a science began with Isaac Newton splitting light with a prism and was called optics. Therefore, it was originally the study of visible light which we call color that later under the studies of James Clerk Maxwell came to include the entire electromagnetic spectrum. Spectroscopy is the branch of science dealing with the study of interaction of electromagnetic radiation with matter. The most important consequence of such interaction is that energy is absorbed or emitted by the matter in discrete amounts called quanta. The absorption or emission processes are known throughout the electromagnetic spectrum ranging from the gamma region (nuclear resonance absorption or the Mossbauer effect) to the radio region (nuclear magnetic resonance). When the measurement of radiation frequency is done experimentally, it gives a value for the change of energy involved and from this one may draw the conclusion about the set of possible discrete energy levels of the matter. The ways in which the measurements of radiation frequency (emitted or absorbed) are made experimentally and the energy levels deduced from these comprise the practice of spectroscopy.[2]

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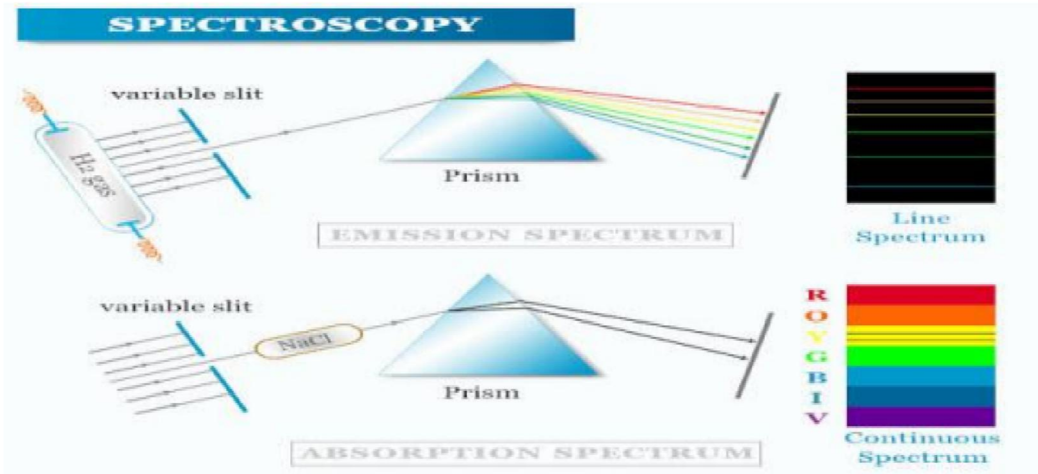

Fig. 1 Spectroscopy

II. TYPES OF SPECTROSCOPY

A. Absorption Spectroscopy

Absorption spectroscopy refers to spectroscopic techniques that measure the absorption of electromagnetic radiation, as a function of frequency or wavelength, due to its interaction with a sample. The sample absorbs energy, i.e., photons, from the radiating field. The intensity of the absorption varies as a function of frequency, and this variation is the absorption spectrum. Absorption spectroscopy is performed across the electromagnetic spectrum. Absorption spectroscopy is employed as an analytical chemistry tool to determine the presence of a particular substance in a sample and, in many cases, to quantify the amount of the substance present. Infrared and ultraviolet– visible spectroscopy are particularly common in analytical applications. Absorption spectroscopy is also employed in studies of molecular and atomic physics, astronomical spectroscopy and remote sensing.[3]

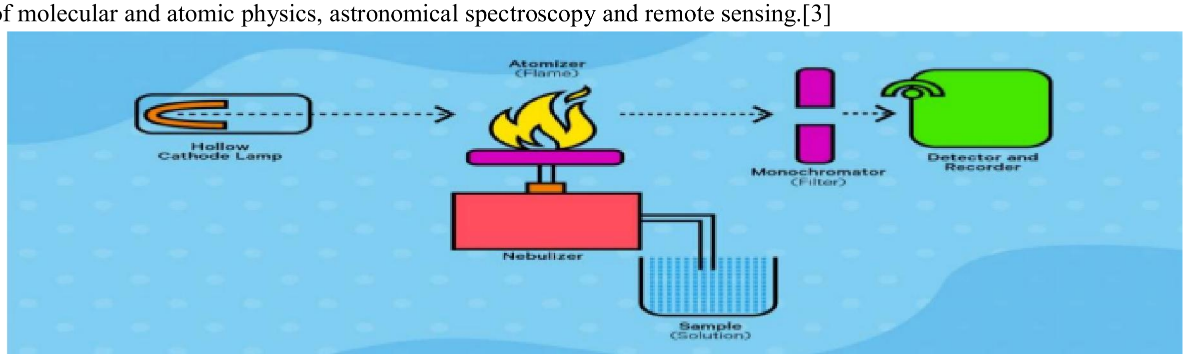

Fig. 2 Absorption Spectroscopy

B. Fluorescence Spectroscopy

Fluorescence spectroscopy (also known as fluorimetry or spectrofluorometry) is a type of electromagnetic spectroscopy that analyzes fluorescence from a sample. It involves using a beam of light, usually ultraviolet light, that excites the electrons in molecules of certain compounds and causes them to emit light; typically, but not necessarily, visible light. A complementary technique is absorption spectroscopy. In the special case of single molecule fluorescence spectroscopy, intensity fluctuations from the emitted light are measured from either single fluorophores, or pairs of fluorophores.[4] Devices that measure fluorescence are called fluorimeters.

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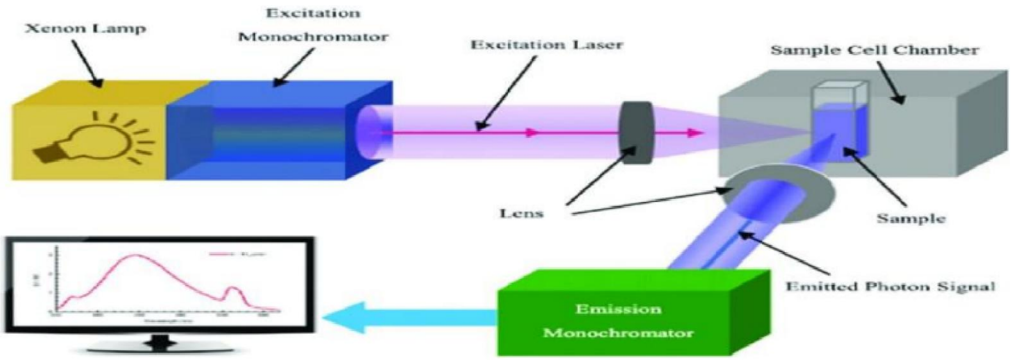

Fig 2: Fluorescence Spectroscopy

C. Infrared Spectroscopy

Infrared spectroscopy (IR spectroscopy or vibrational spectroscopy) is the measurement of the interaction of infrared radiation with matter by absorption, emission, or reflection. It is used to study and identify chemical substances or functional groups in solid, liquid, or gaseous forms. It can be used to characterize new materials or identify and verify known and unknown samples. The method or technique of infrared spectroscopy is conducted with an instrument called an infrared spectrometer (or spectrophotometer) which produces an infrared spectrum.[5]

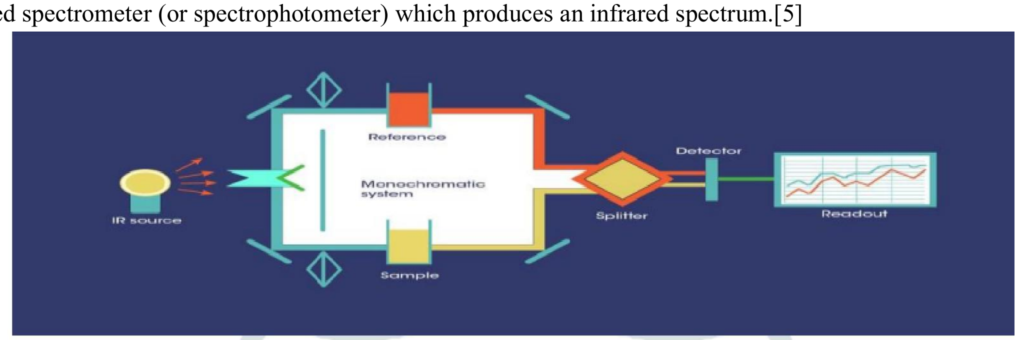

Fig 2: Infrared Spectroscopy

D. Raman Spectroscopy

Raman spectroscopy (named after Indian physicist C. V. Raman) is a spectroscopic technique typically used to determine vibrational modes of molecules, although rotational and other low-frequency modes of systems may also be observed. Raman spectroscopy is commonly used in chemistry to provide a structural fingerprint by which molecules can be identified. Raman spectroscopy relies upon inelastic scattering of photons, known as Raman scattering. A source of monochromatic light, usually from a laser in the visible, near infrared,or near ultraviolet range is used, although Xrays can also be used. The laser light interacts with molecular vibrations, phonons or other excitations in the system, resulting in the energy of the laser photons being shifted up or down. The shift in energy gives information about the vibrational modes in the system.[6]

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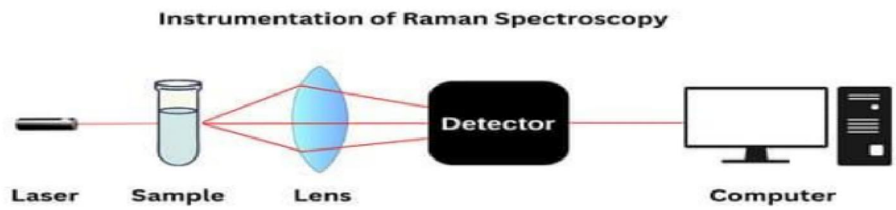

Fig 3: Raman Spectroscopy

III. INSTRUMENTATION

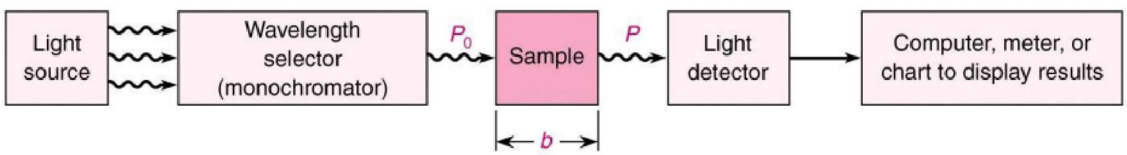

Fig 4: Single Beam Spectrophotometers

Component of spectrophotometer

Source of Light

Continuous sources emit radiation of all wavelengths within the spectral region for which they are to be used.

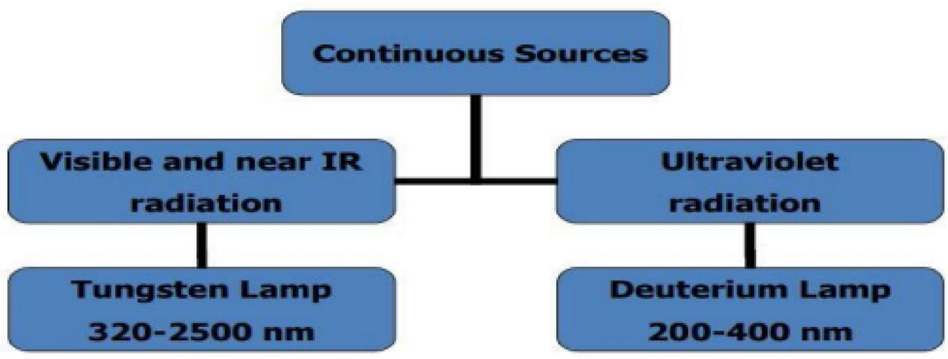

Fig 5: Continuous sources emit radiation

SAMPLE CELLS (CUVETTES):

For visible and uv spectrophotometry , a liquid sample is usually contained in a cell called a cuvette. Glass is suitable for visible but not for uv spectroscopy because it absorbs uv radiation. Quartz can be used in uv as well as in visible spectrophotometry.

Detectors:

It is a device that converts Radiant energy into Electrical signal. A Detector should be sensitive, and has a fast response over a considerable range of wavelengths. In addition, the electrical signal produced by the detector must be directly proportional to the transmitted intensity (linear response). There are three examples of the widely-used detectors: Photo tube, Photomultiplier tube, and Photodiode array. A. Photo tube: When the Photosensitive Cathode is Bombarded by a Photon, it emits an Electron. Emitted electron is attracted to the Anode producing current, its Intensity is proportional to radiation intensity.

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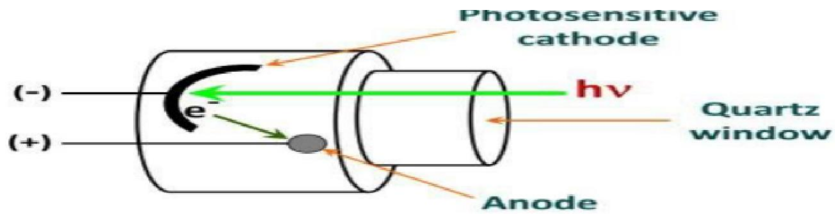

Fig 7: Phototubes

A very sensitive device in which electrons emitted from the photosensitive cathode strike a second surface called dynode which is positive with respect to the original cathode. Electrons are accelerated and can emit more than one electron from the dynode. If the above process is repeated several times, more than 10^6 electrons are finally collected at the anode for each photon striking the first cathode.

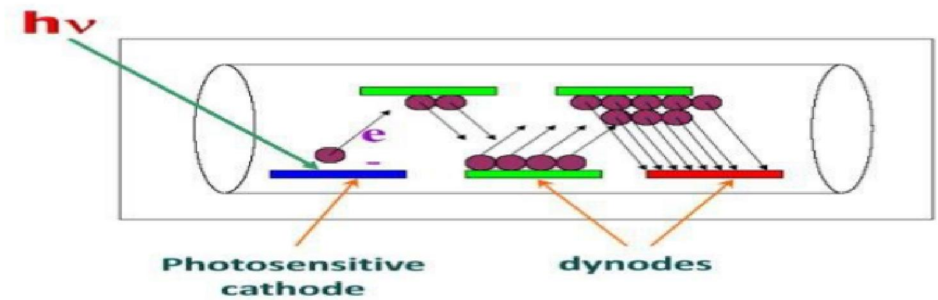

Fig 8: Photomultiplier Tube

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