OPTICS LABORATORY

This laboratory includes the experiments of Optics. It is a good opportunity for students to think about the phenomena of reflection, refraction, interference, and diffraction through various optical apparatus like prism, bi-prism, single and double slit, and plane diffraction grating.

Facilities in the lab: For performing experiments, a separate laboratory, well equipped with the following apparatus is provided to B.Sc. II (non-med) and B.Sc. II (Honors) students. Each equipment has 4-5 sets. In this lab, five tables exclusively for the experiments based on the spectrometer are allotted to students. Along with this, separate corner for laser-based experiments is provided to students.

35 students can perform the experiments at a time in the laboratory in the small groups. Students are provided with the digital manuals, and are guided to make assignments based on practical.

Mission: The mission of this lab is to make students well trained in this field, so that they can practically understand the concepts of optics and lasers and can pursue their research in the same field.

EQUIPMENT

1	Lissajous Figures
2	Spectrometer
3	Sodium lamp
4	Mercury lamp
5	Fresnel Biprism
6	Newton’s Rings
7	Single Slit
8	Double slit
9	Plane diffraction Grating
10	He-Ne Laser
11	Poiseuille’s method Kit
12	Melde’s Experiment Kit

Details of some of the instruments are as below:

1. The **Lissajous Figures** experiment is performed to observe the superposition of two perpendicular simple harmonic oscillations. In this experiment, two function generators are used to generate two simple harmonic waves of certain frequencies and amplitudes. The superimposed picture is seen on the CRO with different ratios such as 1:1, 2:1, 3:2 and many more.

2. The **spectrometer** is an optical instrument used to study the spectra of different sources of light and to measure the refractive indices of materials. The angle of prism is also calculated by placing the prism on the prism table of spectrometer. Alongwith this, experiments related to grating element, single and double slit can also be performed on the spectrometer. It consists of basically three parts. They are collimator, prism table and telescope.

Collimator

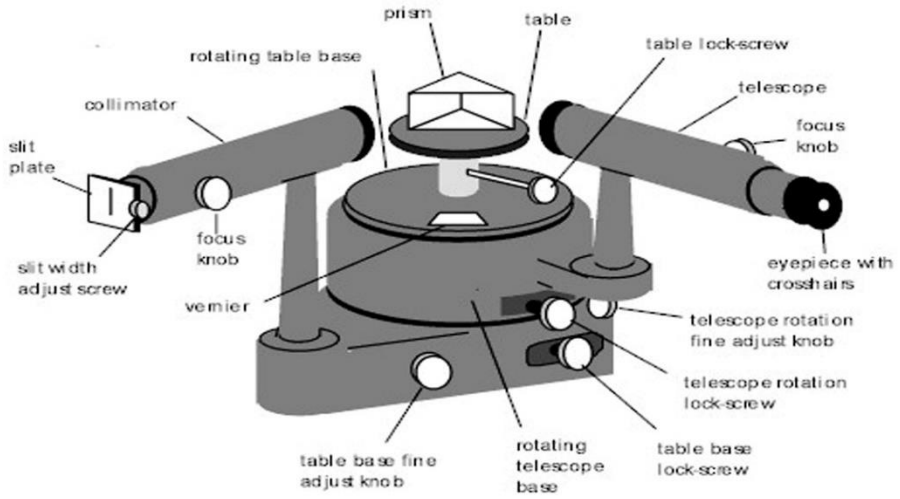
The collimator is an arrangement to produce a parallel beam of light. It consists of a long cylindrical tube with a convex lens at the inner end and a vertical slit at the outer end of the tube. The distance between the slit and the lens can be adjusted such that the slit is at the focus of the lens. The slit is kept facing the source of light. The width of the slit can be adjusted. The collimator is rigidly fixed to the base of the instrument.

Prism table

The prism table is used for mounting the prism, grating etc. It consists of two circular metal discs provided with three levelling screws. It can be rotated about a vertical axis passing through its centre and its position can be read with verniers V_1 and V_2. The prism table can be raised or lowered and can be fixed at any desired height.

Telescope

The telescope is an astronomical type. It consists of an eyepiece provided with cross wires at one end of the tube and an objective lens at its other end co-axially. The distance between the objective lens and the eyepiece can be adjusted so that the telescope forms a clear image at the cross wires, when a parallel beam from the collimator is incident on it.



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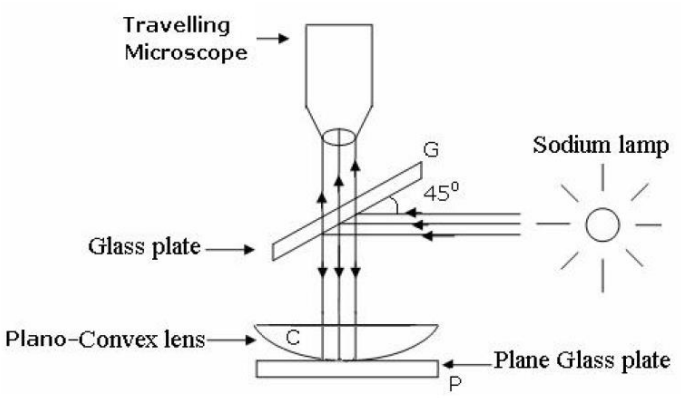
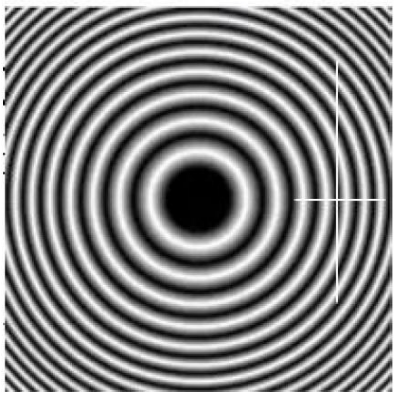
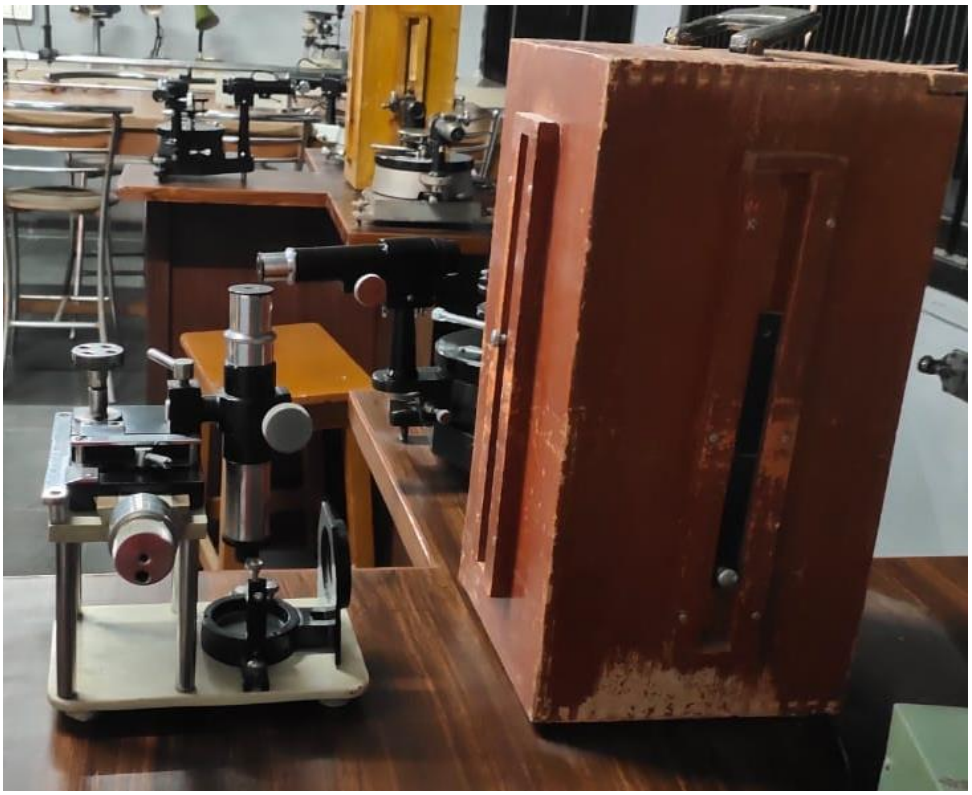
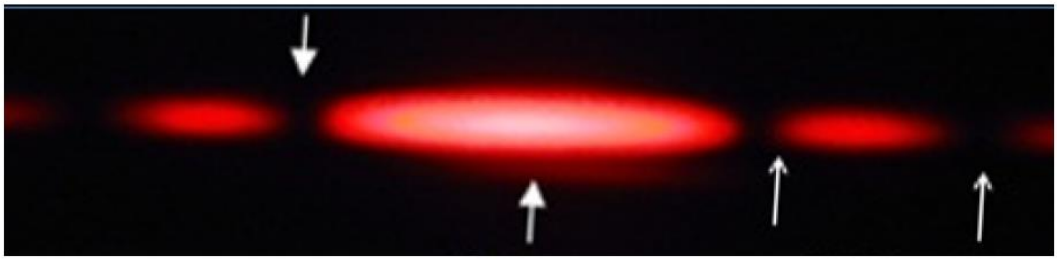
3. **Sodium lamp** is used in the experiments such determination of the angle of prism, refractive index of prism, Cauchy Constants of a material of a prism, resolving power of a prism, where the nearly monochromatic source of light is required.
4. **Mercury lamp** is mainly used to calculate the dispersive power of the material. Here the requirement of splitting of white light into seven colors is required. Moreover, for measuring the wavelength of different colors mercury lamp and grating element are required.
5. **Fresnel Biprism** experiment is used to find out the wavelength of the sodium light on the optical bench. The apparatus required for the experiment is optical bench with uprights, sodium lamp, biprism, convex lens, slit and micrometer eye piece are already fitted on the optical bench.
   Two coherent sources, from a single source, to produce interference pattern are obtained with the help of a Bi-prism. A bi-prism may be regarded as made up of two prisms of very small refracting angles placed base to base. In actual practice a single glass plate is suitably grinded and polished to give a single prism of obtuse angle 170^0 leaving remaining two acute angles of 30` each. This experiment is an example of interference due to division of wavefronts.
6. **Newton's Rings:** When a parallel beam of monochromatic light is incident normally on a combination of a plano-convex lens C and a glass plate P, a part of each incident ray is reflected from the lower surface of the lens, and a part, after refraction through the film between the lens and the plate, is reflected back from the surface of glass plate. These two reflected rays are coherent; hence they will interfere and produce a system of alternate dark and bright rings with the point of contact between the lens and the plate at the center. These rings are known as **Newton's rings.**







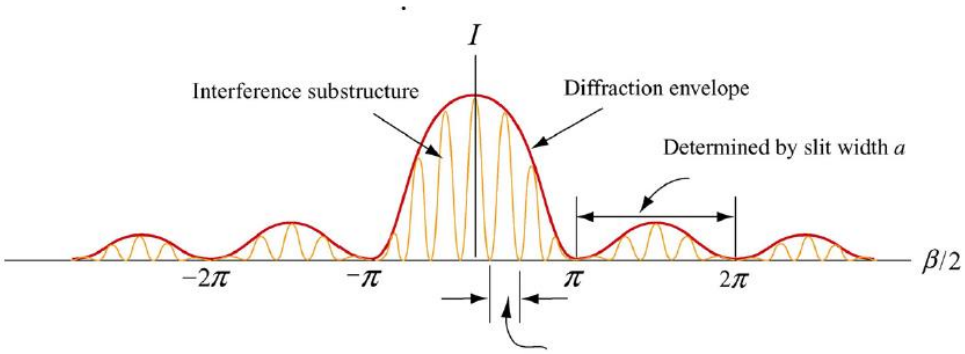
7. Diffraction from the **single slit** has a central maximum and many smaller and dimmer maxima on either side. It is used to calculate the wavelength of the laser light used. The diffraction pattern on the screen is observed as follows:



8. In **Double slit**, the resulting interference pattern for the double-slit will also include a diffraction pattern due to the individual slit. The intensity of the total pattern is simply the product of the two functions:

$$I = I_0 \cos^2\left(\frac{\pi d \sin\theta}{\lambda}\right)\left[\frac{\sin(\pi a \sin\theta/\lambda)}{\pi a \sin\theta/\lambda}\right]^2$$

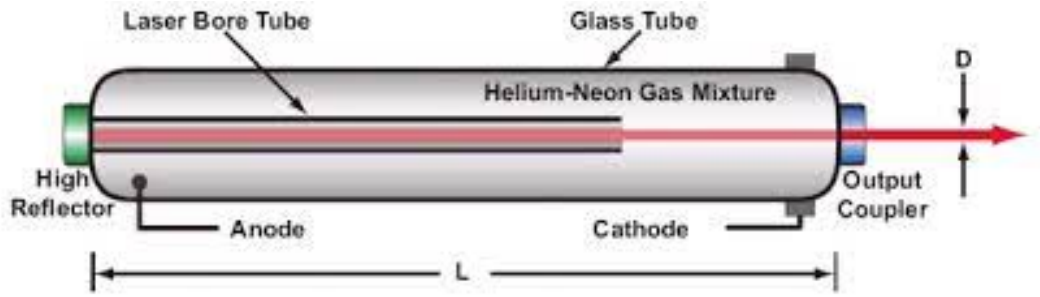
The first and the second terms in the above equation are referred to as the "interference factor" and the "diffraction factor," respectively. While the former yields the interference substructure, the latter acts as an envelope which sets limits on the number of the interference peaks.



9. **Plane diffraction Grating** is a thin film of clear glass or plastic that has many lines per (mm) drawn on it. A typical grating has density of 250 lines/mm. Using more expensive laser techniques, it is possible to create line densities of 3000 lines/mm or higher. When light from a bright and small source passes through a diffraction grating, it generates a large number of sources at the grating. The very thin space between every two adjacent lines of the grating becomes an independent source. These sources are

coherent sources meaning that they emit in phase waves with the same wavelength. These sources act independently such that each source sends out waves in all directions. It is used to calculate the wavelength of Sodium light and different colors observed in the mercury light.

10. **He-Ne Laser** are gas lasers that use a mixture of Helium and Neon as the gain medium excited by an electrical discharge. He-Ne lasers are preferred for many optics lab applications due to their ease of operation and low cost compared to other laser types. This laser is implied to study the diffraction patterns.



11. Some liquids like petrol, alcohol, water etc. flow more freely than honey, glycerin, oil etc. This is due to the property of the liquid called viscosity by virtue of which the liquid opposes the relative motion between its different layers. It is analogous to friction between solid surfaces, except that it comes into play only when the fluid flows. Viscosity is estimated in terms of coefficient of viscosity which is a constant for a liquid and depends on the nature of the liquid, being greater for thick liquids like wax and glycerin than for thin liquids like water. **Poiseuille's method** is used to determine the coefficient of viscosity where liquid flows through the capillary tube at different pressures.

12. Through Melde's experiment kit frequency of electrically maintained tuning fork is determined. Standing waves are formed in the longitudinal and the transverse mode. The frequency is calculated in both modes.