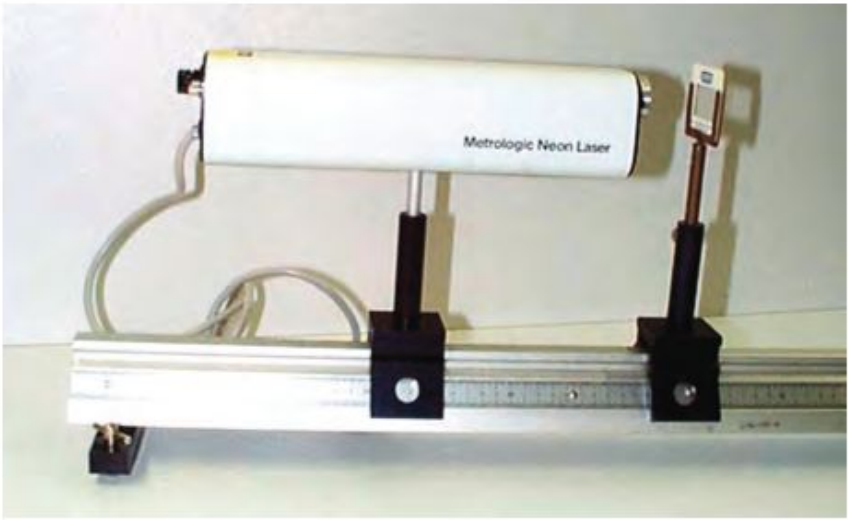
DEPARTMENT OF PHYSICS AND NANOTECHNOLOGY
SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

18PYB101J - Electromagnetic Theory, Quantum Mechanics, Waves and Optics
Module-IV (Waves and Optics) Lecture-8

Applications of Diffraction Grating-Determination of Wavelength

Applications of diffraction grating-determination of wavelength

In the laboratory, the grating spectrum of a given source of light is obtained by using a spectrometer. Initially all the adjustments of the spectrometer are made and it is adjusted for parallel rays by Schuster's method. The slit of the collimator is illuminated by monochromatic light (say light from sodium lamp) and the position of the telescope is adjusted such that the image of the slit is obtained at the position of the vertical cross-wire in the field of view of the telescope. Now the axes of the collimator and the telescope are in the



Determination of wavelength of a spectral line using the transmission grating.

Applications of diffraction grating-determination of wavelength

same line. The position of the telescope is noted on the circular scale and 90° is added to this reading. The telescope is turned to this position. In this position the axis of the telescope is perpendicular to the axis of collimator. The position of the telescope is fixed. The given transmission grating is mounted at the centre of the prism table such that the grating surface is perpendicular to the prism table. The prism table is suitably rotated such that the image of the slit reflected from the grating surface is obtained in the centre of field of view of the telescope. This means that the parallel rays of light from the collimator are incident at an angle 45° on the grating surface because the axis of the collimator and the telescope are perpendicular to each other. The reading of the prism table is noted and adding 45° to this reading, the prism table is suitably rotated to the new position so that the grating surface is normal to the incident light.

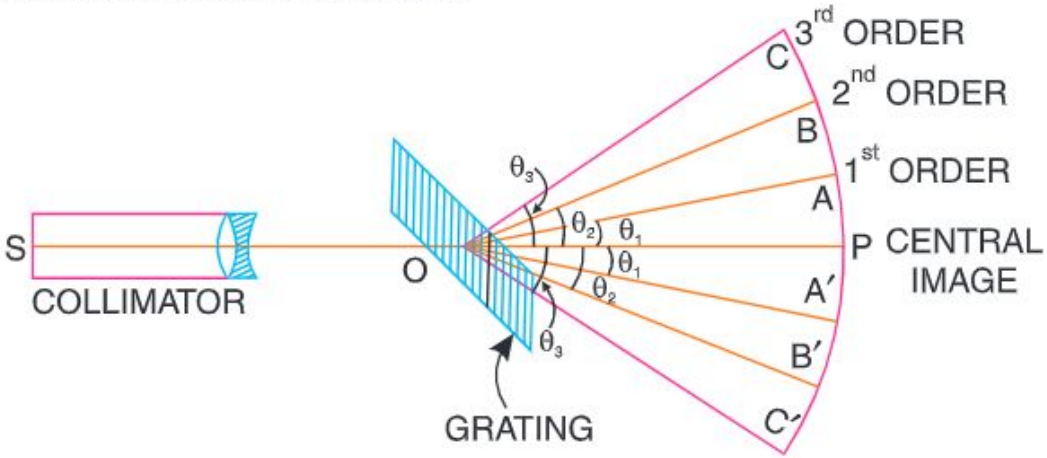


Fig. 18.18

Applications of diffraction grating-determination of wavelength

If the wavelength of the sodium light is to be determined, then the angles of diffraction θ_1 and θ_2 corresponding to the first and second order principal maxima are determined (Fig. 18.18). OA, OB etc., give the directions of the telescope corresponding to the first and second order images. A′, B′ etc refer to the positions of these images towards the left of the central maximum. The angles AOA′ and BOB′ are measured and half of these angles measure θ_1 and θ_2. Then

$$(a + b) \sin \theta_1 = 1\lambda \quad (18.54)$$

and

$$(a + b) \sin \theta_2 = 2\lambda \quad (18.55)$$

Then the value of λ is calculated from equations (18.54) and (18.55) and the mean value is taken. $(a + b)$ is the grating element and it is equal to the reciprocal of the number of lines per cm. If the number of lines on the grating surface is 15,000 per inch then

$$(a + b) = \frac{2.54}{15000} \text{cm}$$