Diffraction Grating

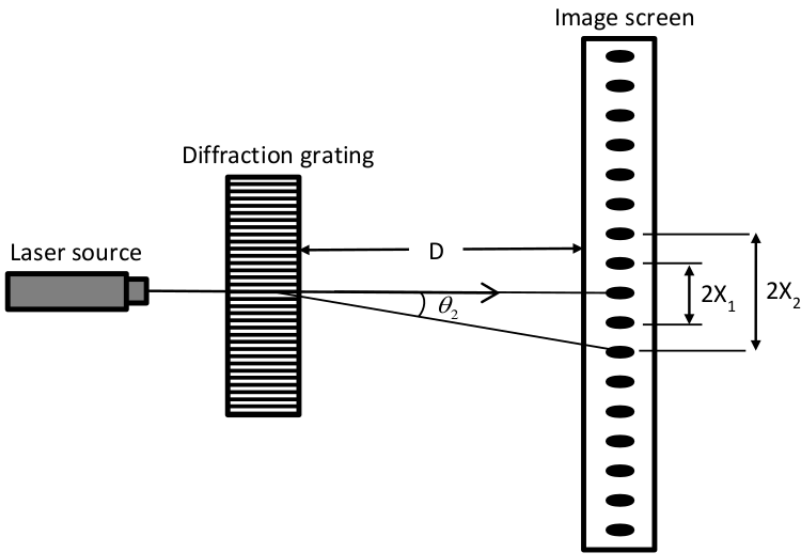


Figure 1: Experimental setup of Diffraction grating experiment.

- **What is the aim of the experiment?**

  The aim is to determine the wavelength of light from the laser source.

- **Explain the experimental setup.**

  Light from the laser source is incident on diffraction grating. The diffracted light is captured on the screen, kept at a distance D from the grating. See figure (1).

- **Define wavelength of light.**

  Light is oscillating electric and magnetic fields (Electromagnetic wave). The distance between consecutive crests (where amplitude is maximum) or consecutive troughs (where amplitude is minimum) is called wavelength.

- **What is Diffraction?**

  Diffraction is defined as the bending of light waves around the corners of an obstacle or through an aperture into the region of geometrical shadow of the obstacle/aperture.

- **What is the condition to observe diffraction?**

  The order of wavelength of incident light should be about size of obstacle/aperture.

- **What is Fresnel diffraction?**

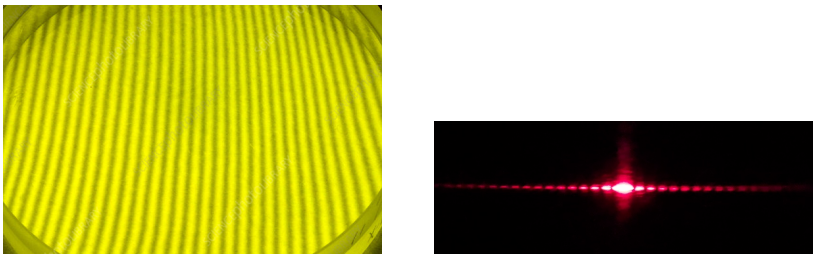
  In this type of diffraction, the source of light and the screen are in general at finite distance from the diffracting aperture.

- **What is Fraunhofer diffraction?**

  In this type of diffraction, the source of light and the screen are at infinite distances from the diffracting aperture.

- **What is the essential difference between interference and diffraction of light?**

  In the case of interference, all the bright fringes have same intensity. It is uniform intensity distribution. In the case of diffraction, the intensity of light decreases with distance from the central maxima. See figure (2).



(a) Interference pattern (b) Diffraction pattern

Figure 2: Difference in light intensity distribution for interference and diffraction.

- **What does the phenomenon of diffraction say about the nature of light?**

  Diffraction of light is explained by wave theory of light. It says that light has wave like properties.

- **What is diffraction grating?**

  It is an arrangement which essentially consists of a large number of equidistant slits.

- **What is grating constant?**

  It is the reciprocal of the number of lines on grating per unit length. Denoted by C.

  For example, if number of lines on grating $N = 500$ per inch $= 19\,685.03\,\mathrm{m}^{-1}$, then Grating constant $C = 1/N = 5.08 \times 10^{-5}\,\mathrm{m}$.

Principle of diffraction grating

The diffraction pattern obtained using grating is known as the grating spectrum.
The position of principal maxima are given by

$$d \sin\theta_m = m\lambda, \quad m = 0, 1, 2, \ldots.$$

d: distance between consecutive slits.
θ_m: angle of diffraction for m^{th} maxima.
The zeroth order ($m = 0$), central maxima occurs at $\theta = 0^o$ irrespective of the wavelength.
For $m \neq 0$, the angles of diffraction are different for different wavelengths and therefore, various spectral components appear at different positions.
Thus, by measuring the angles of diffraction for various colours, one can (knowing the value of m) determine wavelength.
If x_m is the distance to the m^{th} maxima from central maxima, we have

$$\tan\theta_m = \frac{x_m}{D}.$$

$$\therefore \boxed{\theta_m = \tan^{-1}\left(\frac{x_m}{D}\right).}$$