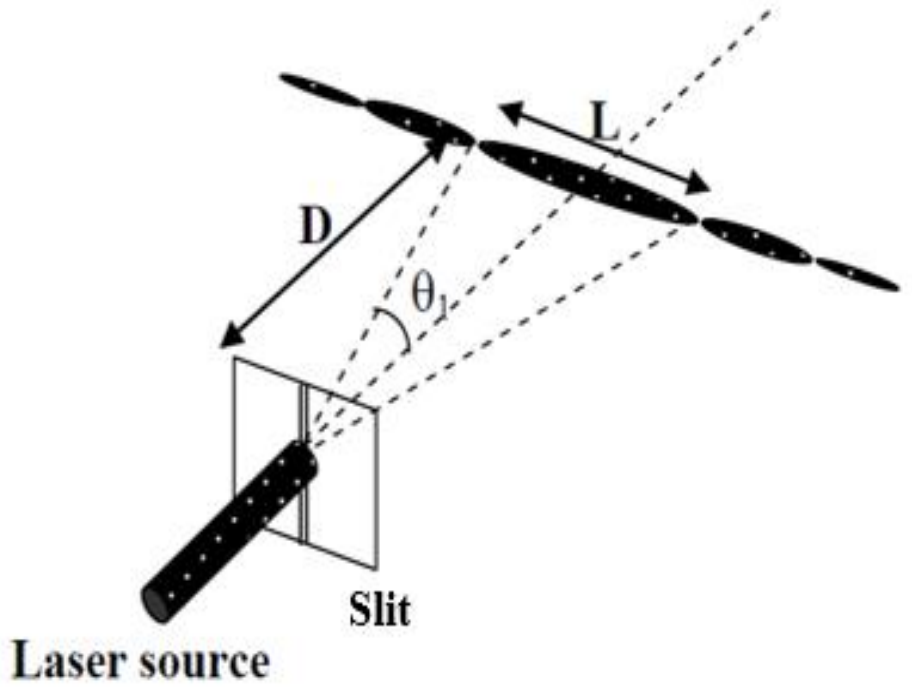
Chapter 13

Diffraction of light

Light undergoes diffraction when it passes through a **very narrow slit** or when it falls on a sharp edge.

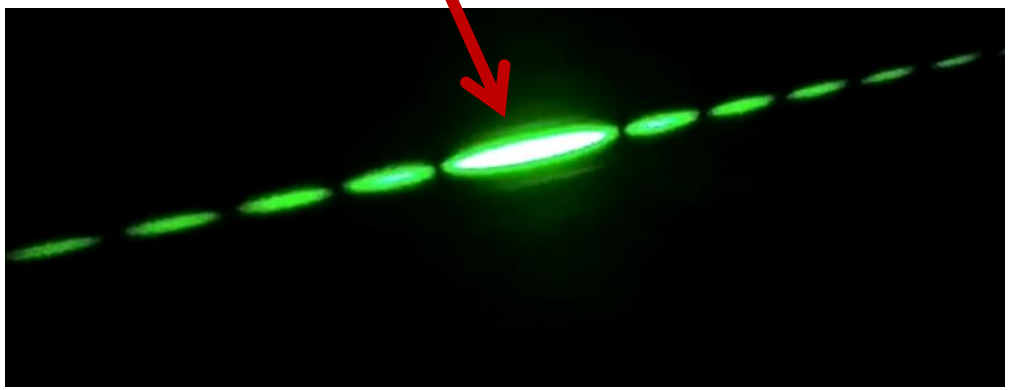
Narrow Slit



a) Characteristics of the diffraction pattern

The system of fringes observed on the screen are:

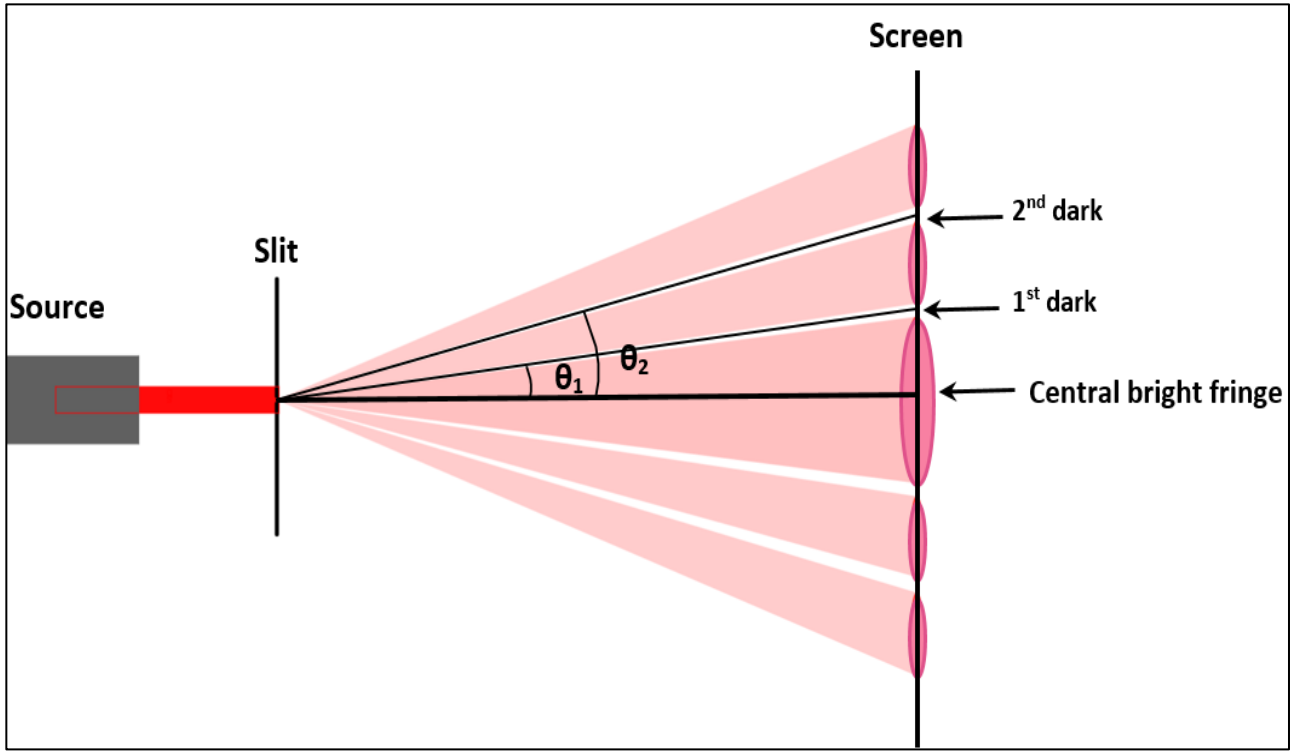
- Alternating bright and dark fringes;
- the width of the **central fringe** is double that of any other bright fringe
- The direction of the pattern of fringes is perpendicular to that of the slit.



b) Positions of dark fringes:

The position of dark fringes is determined by the angle θ such that:

$$\sin\theta = \frac{n\lambda}{a}$$



Where:

λ is the wavelength of the used source of light in (m)

a is the width of the slit

$n = \pm 1, \pm 2, \pm 3, \ldots\ldots$ *is the order of the dark fringe*

θ is very small angle (<10 º)

$$\Rightarrow \sin\theta = \theta_{rd} = \frac{n\lambda}{a}$$

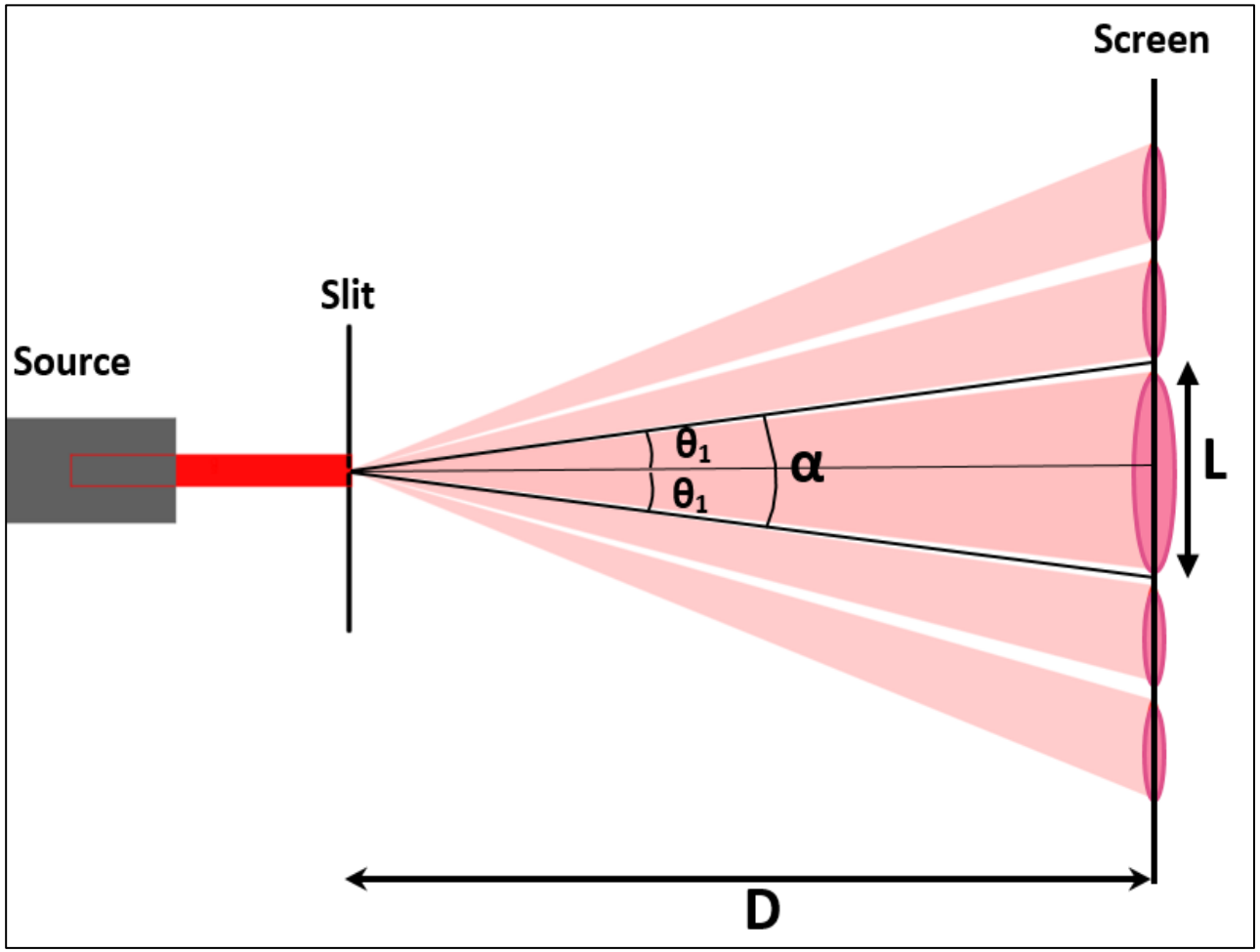
$$First dark fringe \Rightarrow \sin\theta_1 = \theta_1 = \pm\frac{\lambda}{a}$$

$$Second dark fringe \Rightarrow \sin\theta_2 = \theta_2 = \pm\frac{2\lambda}{a}$$

c) Angular width α of the central fringe

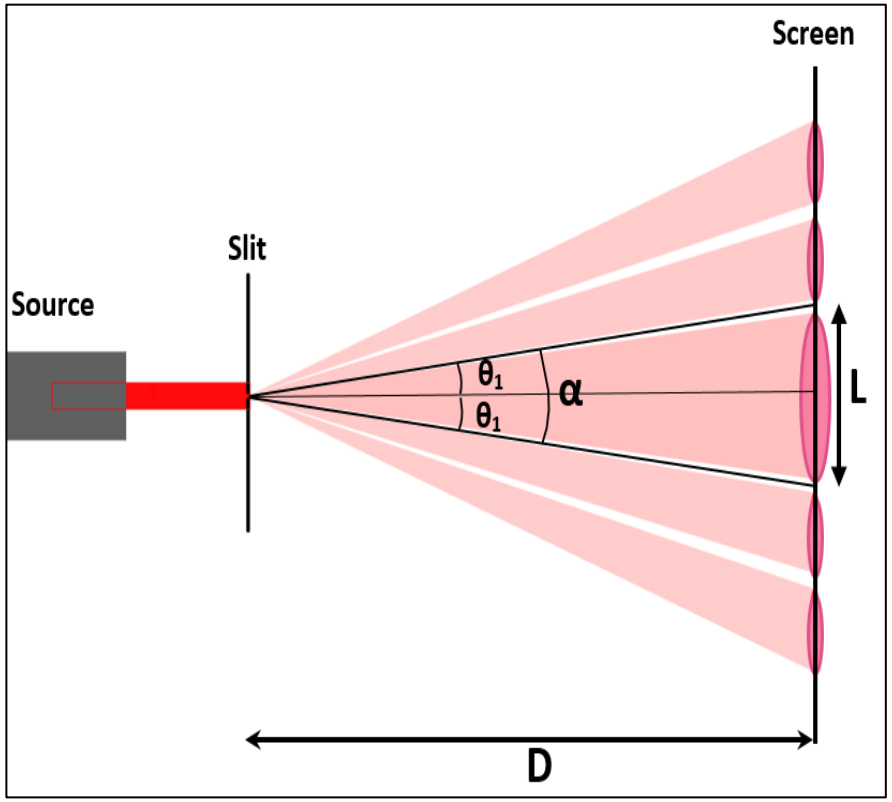
Is the angle through which the Central fringe is seen from the center of the slit.

$$\alpha = 2\theta_1 = \frac{2\lambda}{a}$$



d) Linear width L of the central fringe:

In the adjacent figure:



$$\left.\begin{aligned}\tan\theta_1 = \theta_1 = \frac{opp}{adj} = \frac{L/2}{D} = \frac{L}{2D}\\ \sin\theta_1 = \theta_1 = \frac{\lambda}{a}\end{aligned}\right\} \Rightarrow \frac{L}{2D} = \frac{\lambda}{a}$$

$$\boxed{\Rightarrow L = \frac{2\lambda D}{a}}$$

D: is the distance between the slit and the screen in (m)

e) Curve of intensity of light