6.1 THE DIFFRACTION PHENOMENON

Imagine passing a monochromatic light through a narrow hole of width a little larger than the wavelength. You will find that, instead of a simple shadow of the slit on the screen, there appears an interference pattern even though there is only one slit (Fig. 6.1). The pattern of light on the screen will have a bright central circle surrounded by less intense rings, called secondary or side maxima. In between the bright rings lie dark rings.

We have learned in the last chapter that you need two sources of wave for interference to occur. How can there be an interference pattern when we have only one slit? We will see below that the a wavefront can be imagined to be equivalent to an infinitely many point sources of wave, called secondary wavelets. Thus a wave from a slit is not only one wave but infinitely may waves. These waves can interfere with each other resulting in an interference pattern without the presence of the second slit.

To distinguish the interference pattern resulting from an interference of different parts of the same wavefront from the interference between two different wavefronts, we call the former a **diffraction pattern**, and the later the **interference pattern**. The phenomenon of the distortion of a wave and its spread due to a slit or an obstruction in its path is called **diffraction**. Similar to the interference, diffraction is a fundamental property of all waves, whether sound, light or matter waves.

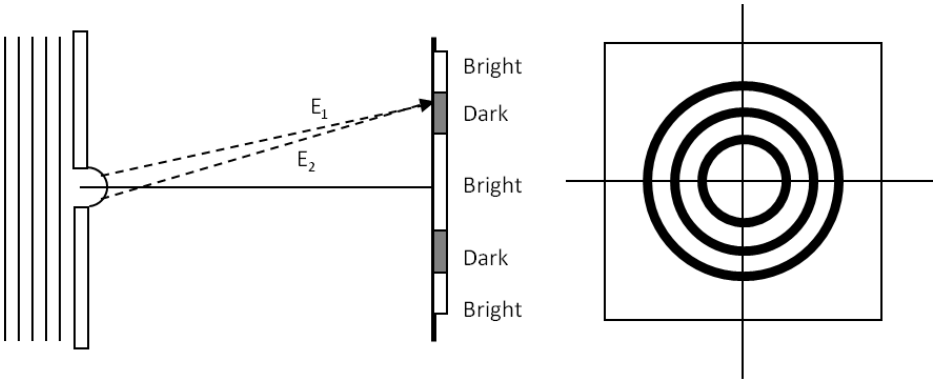

Figure 6.1: Diffraction from a single slit.

The theoretical understanding of diffraction is due to **Augustin Fresnel** (1788-1827), who in 1819 proposed his theory of diffraction in a winning essay to the French academy. Soon S. D. Poisson, a skeptic of the theory, pointed out that Fresnel theory predicted a strange phenomeon that, if you place a disk in the path of the wave,

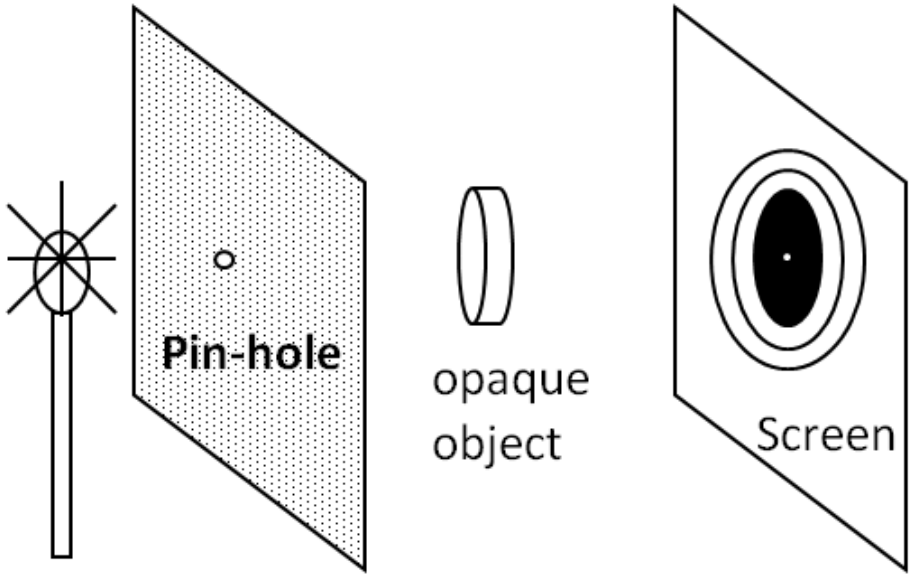

Figure 6.2: Point source of light is produced by a pin-hole which then is incident on an opaque object. The shadow with Poisson spot and diffraction pattern is seen at the screen.

the waves will bend around at the edge and then interfere constructively at the center of the shadow producing a bright spot, called the **Poisson spot**, as displayed in Fig. 6.2. The critics of the wave theory of light charged that a theory that predicted such a strange and unexpected phenomenon must certainly be wrong. The experimental tests however showed that there was indeed a bright spot in the middle of the shadow as predicted, lending invaluable support to the wave theory of light.