FOWLES "MODERN OPTICS"

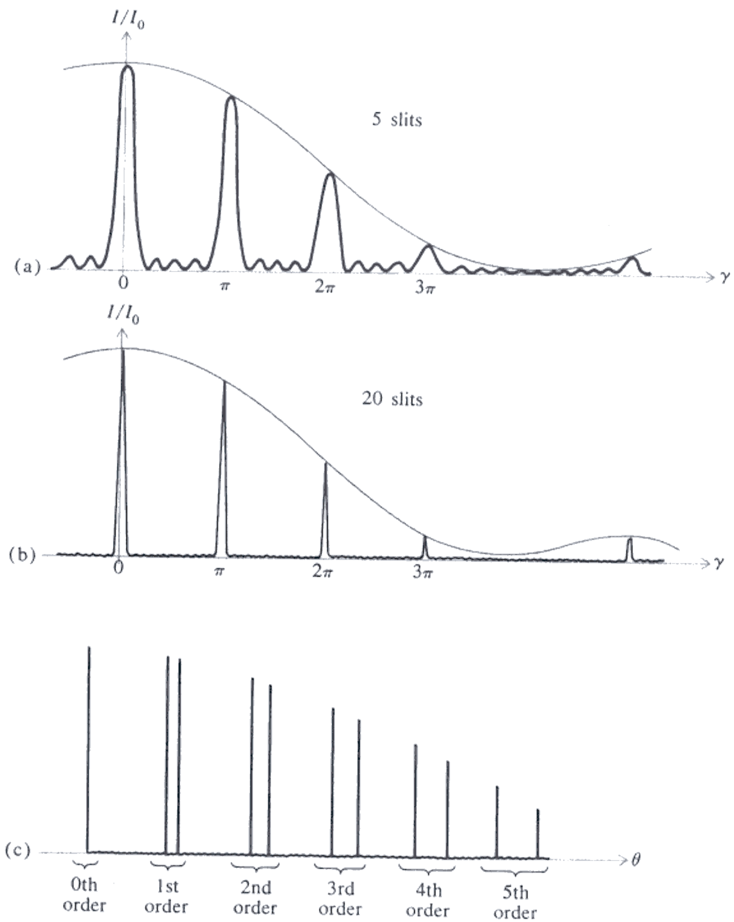

Figure 5.18. Fraunhofer diffraction pattern of a multiple-slit aperture. Graphs (a) and (b) are for monochromatic light. Graph (c) shows the pattern for a many-line grating illuminated with two different wavelengths.

Diffraction gratings used for optical spectroscopy are made by ruling grooves on a transparent surface (transmission type) or on a metal surface (reflection type). A typical grating may have, say, 600 lines/mm ruled over a total width of 10 cm. This would give a total of 60,000 lines and a theoretical resolving power of 60,000 n, where n is the order of diffraction used. In practice, resolving powers up to 90 percent of the theoretical values are obtainable with good gratings.

If the grooves are suitably shaped, usually of a sawtooth profile,

most of the diffracted light can be made to appear in one order, thus increasing the efficiency of the grating. The essential requirement is that the spacing be uniform, within a fraction of a wavelength. This places extreme requirements on the mechanical rigidity of the ruling machine. High-quality replica gratings can be produced by a plastic molding process. These are much less expensive than original gratings.

Most of the gratings used in practical spectroscopy are of the reflection type. Reflection gratings are made with the ruled surface either plane or concave (Figure 5.19). Plane gratings require the use

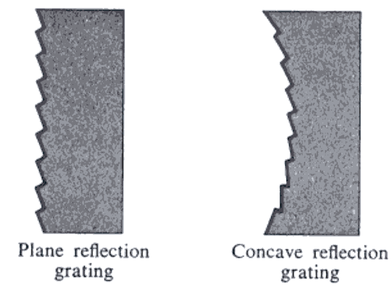

Figure 5.19. Reflection gratings.

of collimating and focusing lenses or mirrors, whereas concave gratings can perform the collimating and focusing functions as well as disperse the light into a spectrum. For more information on the subject of diffraction gratings and their use, the reader should consult References [17] and [35].

5.5 Fresnel Diffraction Patterns

According to the criteria discussed in Section 5.3, diffraction is of the Fresnel type when either the light source or the observing screen, or both, are so close to the diffracting aperture that the curvature of the wave front becomes significant. Since one is no longer dealing with plane waves, Fresnel diffraction is mathematically more difficult to treat than Fraunhofer diffraction but is actually simpler to observe experimentally because all that is needed is a source of light, an observing screen, and the diffracting aperture. The previously mentioned fringe effects seen around shadows are examples of Fresnel diffraction. In this section we shall discuss only a few relatively simple cases of Fresnel diffraction, which can be handled by elementary mathematical methods.