Diffraction (i.e. Spreading) of (Light &) Sound Waves Through Constricting Apertures:

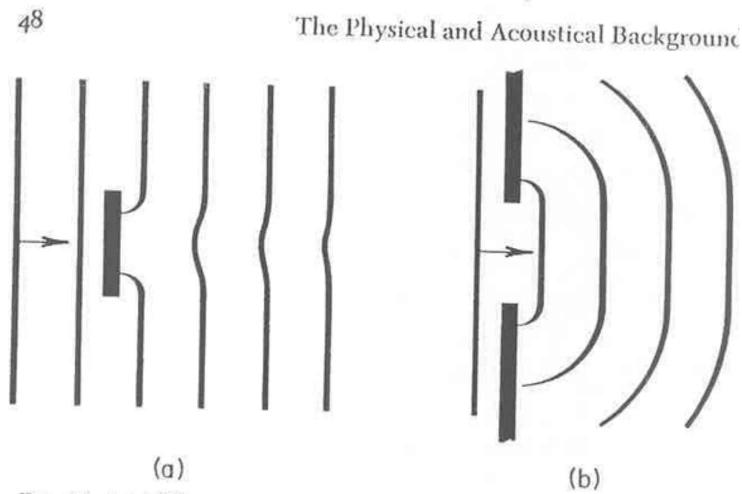

FIG. 18. (a) Diffraction of waves around an obstacle. (b) Diffraction of waves through an aperture.

For sound (or light) incident as plane waves on a single, narrow slit/aperture of lateral width, a, the intensity $I(\theta)$, far from the aperture (the so-called Fraunhofer limit), making an angle θ with the initial direction of propagation of the sound (or light) waves, is given by:

$$I(\theta) = I_o \left\{ \frac{\sin^2\left(\frac{\pi a \sin\theta}{\lambda}\right)}{\left(\frac{\pi a \sin\theta}{\lambda}\right)^2} \right\} = I_o Sinc^2\left(\frac{\pi a \sin\theta}{\lambda}\right)$$

where $I_o = I(\theta = 0)$ and $\mathrm{Sinc}(x) \equiv \sin x / x$. This formula results from considering the interference arising from a succession of contiguous, infinitesimally small slits of lateral width, δa adding up to the total lateral width, a of the physical aperture. The phasor diagram for this situation is an arc – *i.e.* a segment of a circle of radius R, as shown in the figure below. Note that the arc length formula, $S = R\theta$ and the formula for the chord of a circle are used in deriving the above relation.