# RESOLVING TWO SINGLE SLIT LIGHT SOURCES: GRAPHICAL EXAMPLE

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Reference: Carroll, Bradley W. & Ostlie, Dale A. (2007), *An Introduction to Modern Astrophysics*, 2nd Edition; Pearson Education - Chapter 6, Problem 6.17.

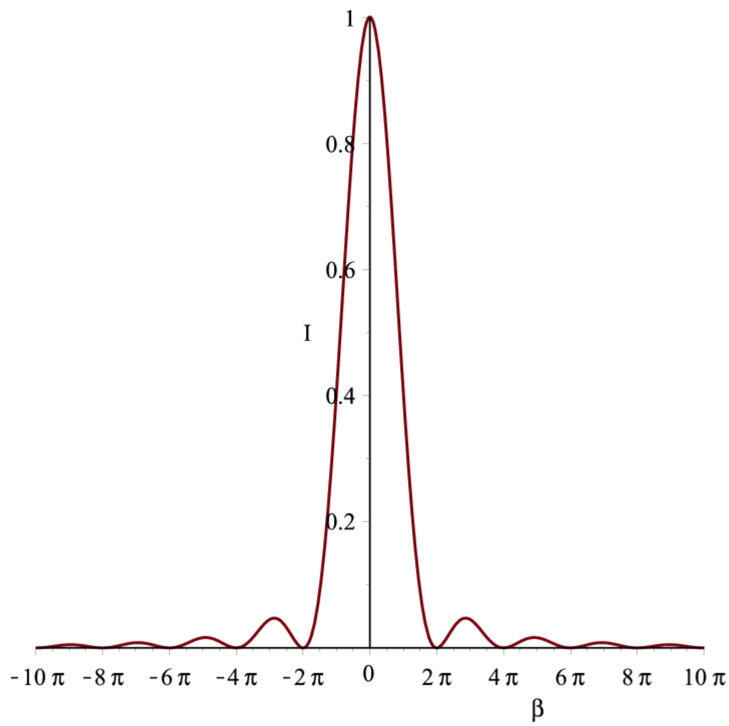
We can get a feel for the effects of single slit diffraction by drawing a few plots of an idealized situation. Suppose we have two parallel vertical slits and we place a separate light source (to avoid any double-slit interference patterns) behind each slit. The diffraction pattern produced by slit 1 (which we'll assume is aligned so that its central peak appears at an angle $\theta = 0$ relative to the normal to the slit) is given by

$$\frac{I(\theta)}{I_0} = \frac{\sin^2(\beta/2)}{(\beta/2)^2} \tag{0.1}$$

where

$$\beta \equiv \frac{2\pi D}{\lambda} \sin\theta \tag{0.2}$$

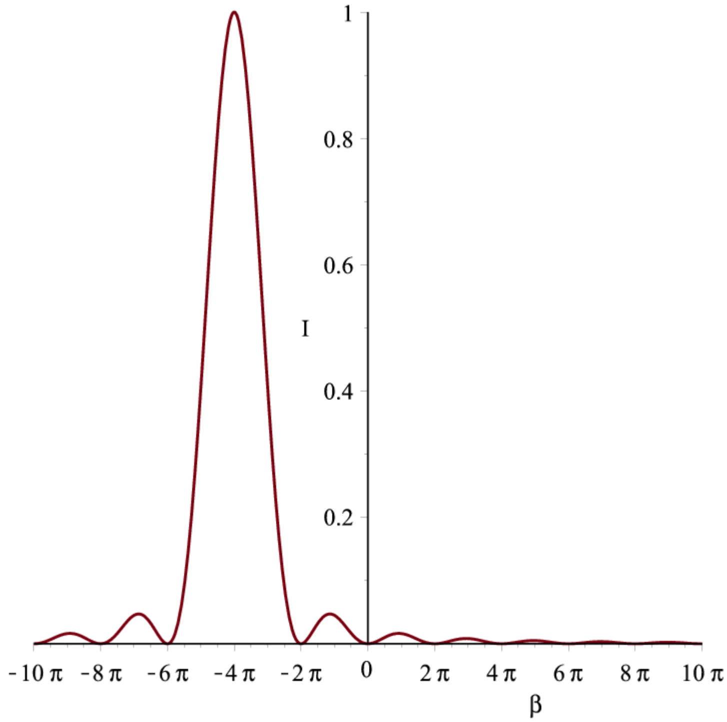
and $D$ is the width of the slit, with $\lambda$ being the wavelength of the light (which we'll take to be the same for both light sources). A plot of the diffraction pattern for slit 1 is (with $I_0 = 1$):



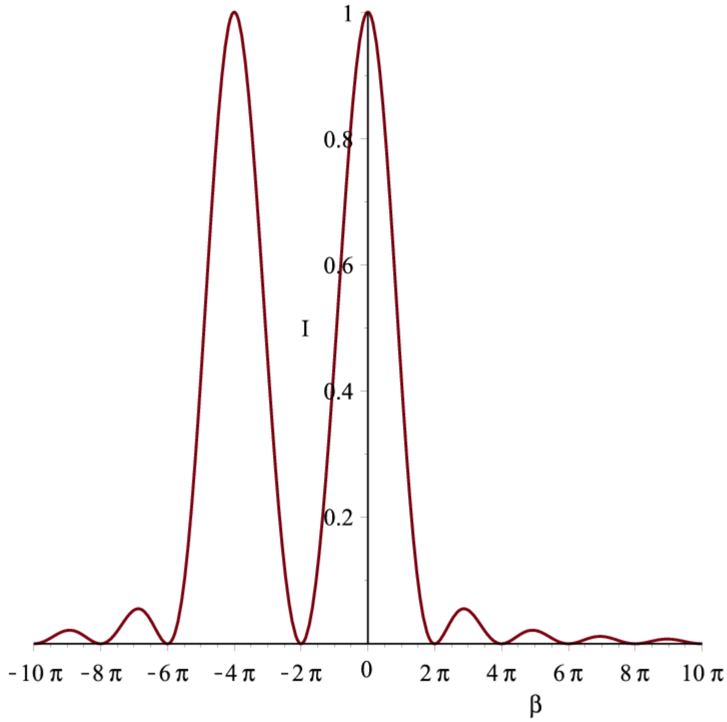

Now suppose we position slit 2 so that its central maximum falls at the second minimum on the left of slit 1, that is, at $\beta = -4\pi$. Its diffraction pattern is given by

$$\frac{I(\theta)}{I_0} = \frac{\sin^2([\beta + 4\pi]/2)}{([\beta + 4\pi]/2)^2} \tag{0.3}$$

and looks like this:




With both lights on at the same time, the combined diffraction pattern is the sum of the two:

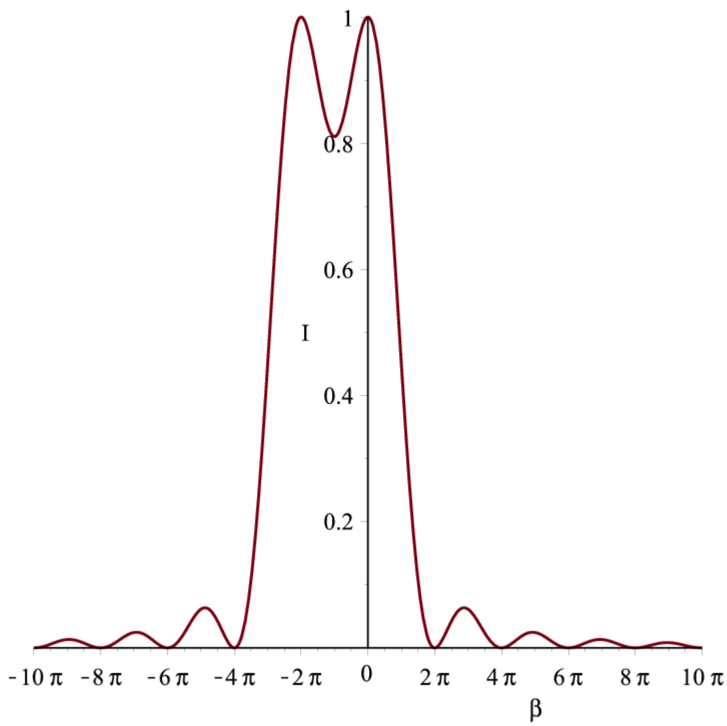



There's a clear separation of the two light sources with a minimum of $I=0$ at $\beta=-2\pi$.

For circular apertures, the Rayleigh criterion requires the second light source's central maximum to be no closer than the *first* minimum of the first light source. In our single slit experiment, we would place the second slit so that the central maximum occurs at $\beta=-2\pi$:

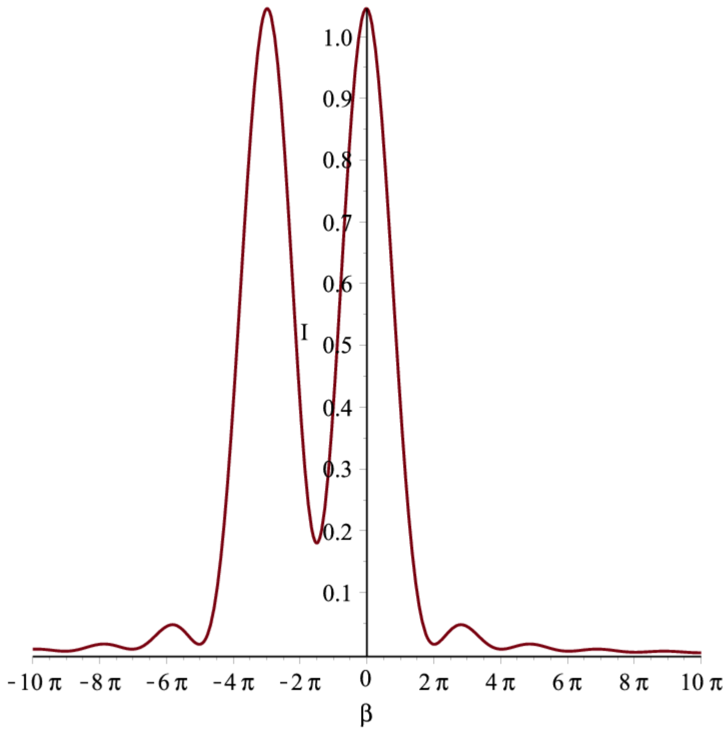
$$\frac{I(\theta)}{I_0}=\frac{\sin^2([\beta+2\pi]/2)}{([\beta+2\pi]/2)^2} \tag{0.4}$$

Adding this to the first light source gives:




In this case, the two lights would be separated by only a slight dimming in intensity.

Incidentally, the fact that the two maxima both have an intensity of 1.0 occurs because we've chosen the separation of the slits such that the maximum of one slit falls at a minimum of the other. If we choose some other separation such as setting the second slit's maximum at $\beta = -3\pi$, we get a curve like this:




The two maxima are now slightly greater than 1.0, and there are no absolute minima, where the intensity drops to zero.