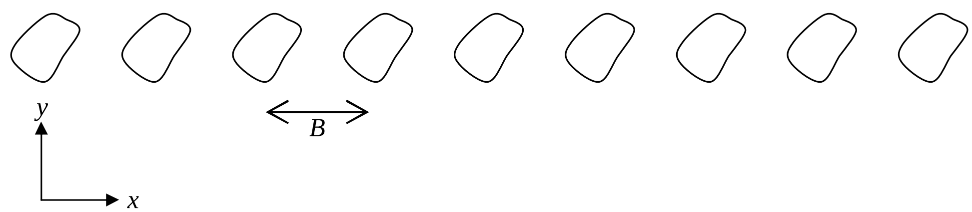
Phys 531 Assignment 8 Due October 24

1. Suppose an opaque screen contains an array of identical small holes. A single hole has a Fourier transform $F_1(\nu_x, \nu_y)$. If N holes are lined up along the x-axis with spacing B as shown, calculate the Fraunhofer diffraction pattern for the array. Sketch the intensity along x, assuming that N is large and that F_1 is a smooth function of ν_x with width $\Delta\nu_x \gg 1/B$.



2. Saleh and Teich, Problem 4.4-2, page 154. Include a sketch of $I_{\rm out}(x)$.
Hints: Remember that the impulse response function $h(x, y)$ is defined so that

$$g(x,y) = \iint f(x',y')h(x-x',y-y')dx'dy'$$

The function $\mathrm{rect}(x)$ is defined to be zero for $|x| \geq 1/2$ and one for $|x| < 1/2$. The delta function $\delta(y)$ has the property

$$\int f(x',y')\delta(y-y')dy' = f(x',y)$$

so the y integration is trivial.

3. Suppose a focussed imaging system, such as that shown in Figure 4.4-8 on page 141, is used to image two point sources. The magnification is such that the two images are a distance B apart. For large B, the points will be resolved and the image shows two distinct peaks. For small B, the points are not resolved and the image shows only one peak. In terms of the wavelength λ, the diameter of the lens D, and the image distance d_2, determine the value of B separating these two regimes. Find an answer accurate to within 2%:
(a) Assuming the two points are mutually coherent. For instance, they might be two tiny holes in a screen illuminated by a plane wave.
(b) Assuming the two points are mutually incoherent. For instance, they might be two distant stars (observed through a filter that transmits only light of wavelength λ). This prevents the two waves from interfering.
A computer program capable of plotting Bessel functions will be useful for this problem.