1. Show that \( \sin(N\gamma)/\sin(\gamma) \to \pm N \) when \( \gamma \to n\pi \) \( (n = 0, \pm 1, \pm 2, ...) \). This is the grating term in the intensity profile for a diffraction grating.

2. A single long slit of width \( d \) is illuminated by monochromatic, plane-parallel light. Just behind the slit is a lens which focuses the slit image on a screen 100 cm from the slit. The wavelength of the light is 6563 Å (H\(\alpha\)). You want the distance between the two dark fringes on either side of the central peak of the diffraction pattern to be 10 mm. How wide \( (d) \) should you make your slit?

3. Take the 14” telescope at the UM Observatory. What is the angular radius, in arcsec, of the first dark ring of the Airy disk at a wavelength of 5000 Å? Suppose you are observing the star Vega. How far is it in parsec (mention your reference)? How far from the star in AU (Astronomical Units) is the first dark ring of the Airy disk? (Recall that at a distance of one parsec, a 1 AU orbit has an angular radius of one arcsec.)

4. A diffraction grating has 600 lines per mm. We wish to observe the yellow D lines of sodium, which form a close doublet of wavelengths 5890Å and 5896Å, in the second order with this grating.

   (a) What is the resolution, \( R \), needed to separate these lines?
   (b) How many lines, \( N \), of the grating must be illuminated to achieve this resolution?
   (c) How wide must our grating be to meet this requirement?

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