Solution

Angular splitting of the Sodium doublet:

Consider the two closely spaced spectral (yellow) lines of sodium (Na), λ_1 = 589 nm and λ_2 = 589.6 nm. If light from a sodium lamp fully illuminates a diffraction grating with 4000 slits/cm, what is the angular separation of these two lines in the second-order (m=2) spectrum?

Hint: First find the slit spacing d from the number of slits per centimeter.

$$d = \frac{1\,cm}{4000} = 2.5 \times 10^{-4}\,cm = 2.5\,\mu m$$

$$\theta_1 = \sin^{-1}\left(m\frac{\lambda_1}{d}\right) = 28.112°$$

Small angle approximation is not valid.

$$\Delta\theta = \sin^{-1}\left(m\frac{\lambda_2}{d}\right) - \sin^{-1}\left(m\frac{\lambda_1}{d}\right) = \boxed{0.031}°$$