Answer on Question #81239 Physics / Optics

Question. Sodium light is incident normally on a grating of width $4 \cdot 10^{-3}\ m$. The total number of lines on the grating is 2000. Determine the angular separation between the sodium D −lines in the first order spectrum?

Solution.

This light contains two closely spaced lines (the well-known sodium doublet) of wavelengths $589\ nm$ and $589.59\ nm$. The grating spacing d is given by

$$d = \frac{l}{N} = \frac{4 \cdot 10^{-3}}{2000} = 2 \cdot 10^{-6}\ m.$$

For first line

$$d \cdot \sin\theta_1 = m\lambda_1 \ \rightarrow \ \theta_1 = \arcsin\left(\frac{m\lambda_1}{d}\right) =$$

$$= \arcsin\left(\frac{1 \cdot 589 \cdot 10^{-9}}{2 \cdot 10^{-6}}\right) = 0.298932\ rad = 17.13°.$$

For second line

$$d \cdot \sin\theta_2 = m\lambda_2 \ \rightarrow \ \theta_2 = \arcsin\left(\frac{m\lambda_2}{d}\right) =$$

$$= \arcsin\left(\frac{1 \cdot 589.59 \cdot 10^{-9}}{2 \cdot 10^{-6}}\right) = 0.299241\ rad = 17.15°.$$

The angular separation is

$$\Delta\theta = 0.299241 - 0.298932 = 0.000309\ rad = 1'4''.$$

Answer. $\Delta\theta = 0.000309\ rad = 1'4''$.