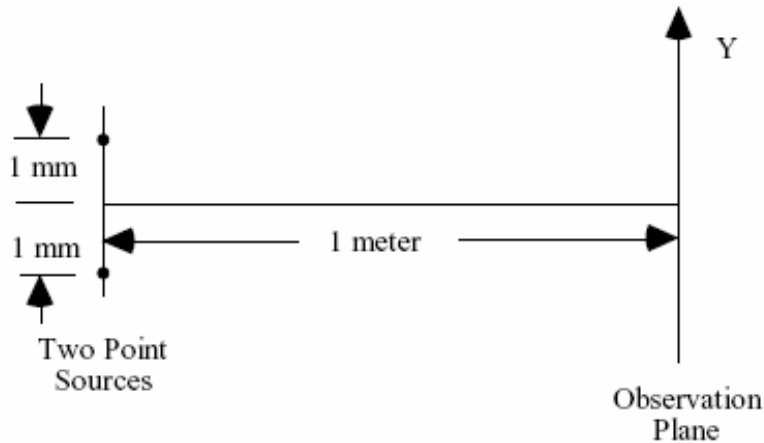


C-A1) Two spherical waves are interfered as shown below.

- What is the fringe spacing (in microns) if the wavelength is 500 nm?
- What is the fringe visibility if the relative intensity of the two spherical waves is 9 to 1? State any assumptions you are making.
- Let the two sources have the same intensity, but now two wavelengths, 500 nm and 510 nm, are present in each source. Give the first value of Y for which the fringe contrast drops to zero.

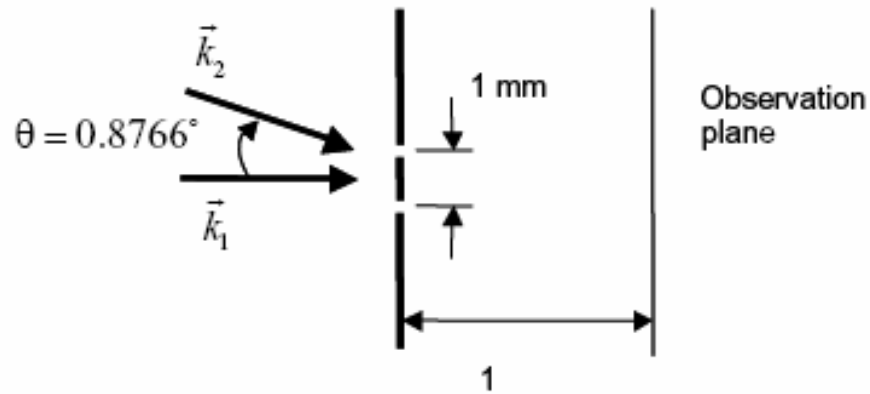


C-A2) Show that

$$\frac{1}{2} \langle |U_{\text{total}}|^2 \rangle \approx A^2 \left[ 2 + 2 \cos\left(\frac{2\pi}{\lambda} \text{OPD}_0\right) \cos\left(\frac{\pi}{\lambda_{eq}} \text{OPD}_0\right) \right]$$

in a two-wavelength YDPI with equal transmission through the pinholes.

C-A3) Two plane waves illuminate a Young's double pinhole interferometer as shown.  $\lambda_1 = 532 \text{ nm}$  and  $\lambda_2 = 541.4 \text{ nm}$ . The angle between the plane waves is 0.8766 degrees.  $\vec{k}_1$  is normally incident onto the aperture plane. The pinhole spacing is 1mm, and the distance from aperture plane to observation plane is 1m. Ignore finite size of the pinholes, and assume that the observation region is limited to a small area around the axis. Sketch the observation-plane irradiance pattern, showing any important features. It may not be possible to show both fine and macroscopic features in the same sketch, so show fine features in one sketch and macroscopic features (features  $> 10$  times larger than the smallest feature) in a second sketch.



C-A4) A certain helium neon laser has three longitudinal modes. That is, the laser output consists of three distinct wavelengths, all of which satisfy the equation  $2nd = m\lambda$ , where  $n$  is the refractive index within the laser cavity, which we will set equal to one,  $d$  is the cavity length, i.e. the distance between the laser mirrors,  $m$  is an integer called the order number ( $m$  between consecutive laser lines is one), and  $\lambda$  is the wavelength of each separate laser line. Let the cavity length be 1 meter and assume for simplicity that intensities of all three wavelengths are equal.

- If the laser is used as a light source for a simple two-beam division-of-amplitude interferometer with a beam splitter, like a Twyman-Green interferometer, derive an equation for the fringe visibility as a function of path difference ( $OPD_0$ ) between the two interfering beams.
- What is the coherence length?
- What path difference gives maximum fringe visibility, and how does this path difference depend upon the laser wavelength?
- How does the path difference for maximum fringe visibility depend upon the number of longitudinal modes present?