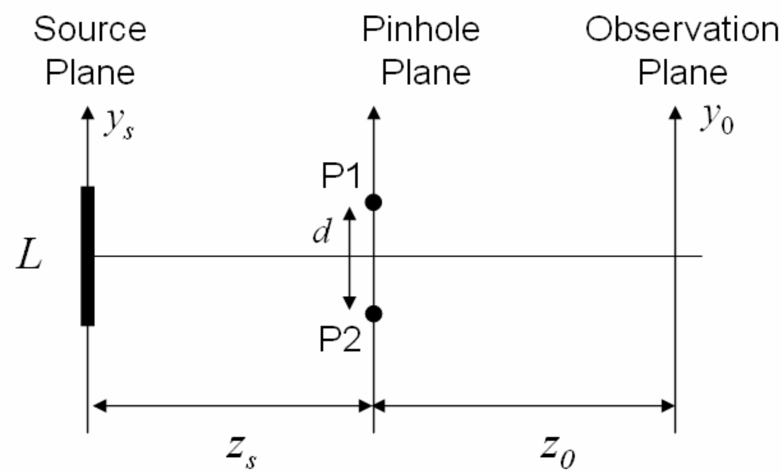
C-B1) A 1 mm diameter pinhole is placed immediately in front of a spatially incoherent source of average wavelength 650 nm. The light passed by the pinhole is to be used in a diffraction experiment, for which it is desired to illuminate a distant 4 mm hole coherently. Calculate the minimum distance between the pinhole source and the diffracting aperture. State any assumptions being made. (For example, you may simplify the problem by assuming a one dimensional source and describing it with a rect function.)

C-B2) An interferometer is used in space outside the Earth's atmosphere. It is desired to use a distant star as the light source. The star can be considered as an extended incoherent source. A filter is used to limit the wavelengths to a narrow band around $\lambda = 0.5\ \mu m$. The diameter of the star is 10^9 m. What is the distance of the closest star that will meet the requirement of obtaining a 1 m diameter coherent area illuminating the interferometer? State any assumptions being made. (Hint: You may assume a one dimensional source and describe it with a rect function.)

C-B3) A small telescope objective is fitted with a two slit mask having a slit separation of 2.0 cm and a narrow band spectral filter passing the wavelength of 500 nm. Consider an automobile moving toward the telescope. The headlights of the auto are 120 cm apart. At a certain distance the interference fringes due to the light from the headlights vanish for the first time. Assume the ideal conditions that the road is smooth and the auto is traveling with uniform velocity toward the telescope. The contrast of the fringes due to the headlights is monitored and it is found that the second time the fringe contrast goes to zero is one hour later. What is the speed of the automobile?

C-B4) Taking the angular diameter of the sun viewed from the earth to be about ½ degree, determine the diameter of the corresponding coherence area (areaoverwhichvisibility$\geq$0.88), neglecting any variations in brightness across the surface.(Let λ = 550nm.) What does this coherence diameter tell you about the fringe visibility you would obtain using the sun as a light source for a YDPI experiment? State any assumptions that you make.

C-B5) A quasi- monochromatic spatially incoherent source is used for a YDPI experiment. State any assumptions you make in answering parts (a) and (b)

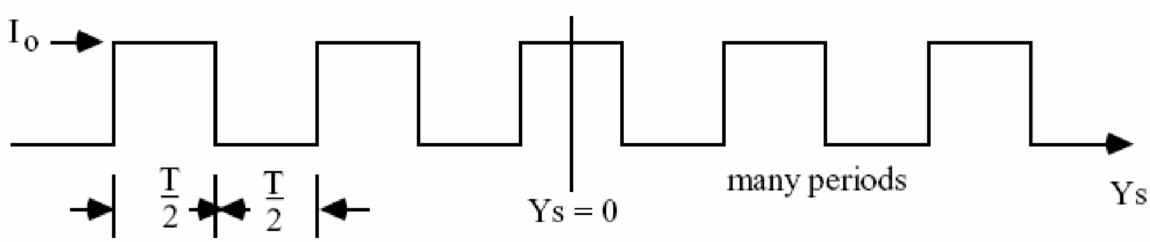


a.) Let the radiant excitance of the source be given by the function

$$M_R(x_s, y_s) = I_0\left[1+\cos\left(2\pi y_s / T\right)\right] \ ,$$

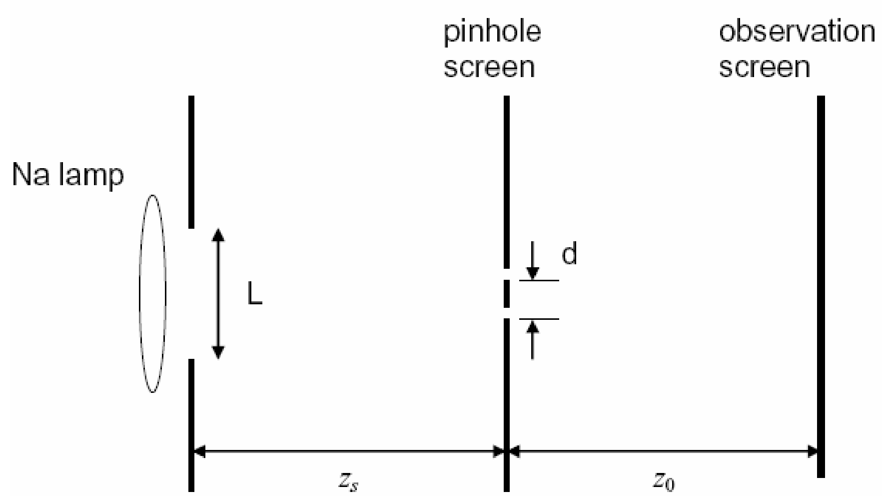
where I_0 and T are constants. Let the width of the source in the y_s direction be L, where $L >> T$. How does the fringe visibility depend upon T, z_s, z_0, d, and λ?

b.) Repeat (a) for the radiant excitance function below.



C-B6) A sodium vapor lamp is placed behind a square aperture of side L. The radiant exitance from this aperture can be modeled as uniform. The power spectrum of the source can be modeled as consisting of two spectral lines at frequencies ν_1 and ν_2. The width of these lines can be neglected, and it can be assumed that the spacing between them, $\Delta\nu$, is small compared to ν_1 or ν_2. The objective of this problem is to discuss the coherence properties of the field produced by this source in a plane a distance z_s from the aperture. The tool to investigate these properties is a pair of pinholes of spacing d as shown. Fringes are observed in a plane a distance z_0 from the pinholes. Assume that z_s and z_0 are much larger than L or d.

a) Give an expression for the fringe spacing for fringes near the axis.
b) Discuss the fringe pattern for points off the axis for fixed d, z_s, and z_0. Illustrate with appropriate sketches.
c) Discuss the effect of pinhole spacing d on the fringe pattern. Again, illustrate the discussion with appropriate sketches.
d) Explain how you can deduce the aperture size L from the fringe pattern.
e) Explain how you can deduce $\Delta\nu$ from the fringe pattern.



C-B7) In the Young's two pinhole experiment shown below the source is displaced off axis 1 cm. Assume the pinhole diameter is comparable to the wavelength. Let the source have a spectral distribution shown below. Where is the fringe visibility a maximum? Give the two values of y closest to the maximum fringe visibility where the fringe visibility goes to zero.