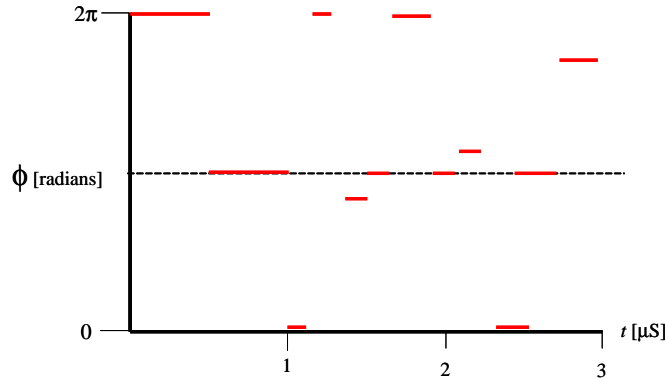


1. A narrow band of light of width  $\Delta\lambda$  centered about  $\lambda_0 = 520 \text{ nm}$  is chopped by a shutter whose on-off cycle is 40 MHz (pretty fast!). Determine the bandwidth  $\Delta\lambda$  of the resulting light.
2. A short sample of the optical phase  $\phi [t]$  of light emitted by a source is shown in the graph; the phase behaves similarly over time. This light interferes with light from a perfectly coherent source, as in a Young's two-aperture experiment.



- (a) The irradiance from the interference is observed on a screen by eye. Will interference be seen? Explain.
  - (b) The irradiance is observed with a sensor whose response time is 1 ns; will interference be observed?
  - (c) Use the results from (a) and (b) to make a statement about the coherence of the two sources.
3. Consider Young's two-aperture experiment with separation  $d_0 = 100 \mu\text{m}$  and the distance from the aperture plane to the observation screen is  $z_2 = 500 \text{ mm}$ . Compute the distances between adjacent irradiance maxima for  $\lambda_1 = 400 \text{ nm}$  and  $\lambda_2 = 700 \text{ nm}$  and sketch the resulting patterns.
  4. Calculate the irradiance pattern that would be observed at the output plane in problem #3 if a third aperture is added to one side so that the separations of adjacent slits are identically  $d_0 = 100 \mu\text{m}$ .
  5. A two-slit experiment is modified so that the light through one slit passes through a half-wave plate with the fast axis parallel to the slit and the light through the other passes through an identical half-wave plate with the fast axis perpendicular to the slit. The incident light is unpolarized. Determine the positions of the maxima and minima in the irradiance fringe pattern.

MORE → → → →

6. Consider two examples of division-of-wavefront interference created by light from a monochromatic point source with wavelength  $\lambda_0$  located at a distance  $z_1$  from the aperture plane that is sufficiently large for the Fraunhofer approximation to apply. The aperture is a pair of slits of width  $d_0$  and separation  $\ell_0$  that are sufficiently long that you may assume that their y-dimensions are infinite. The light then propagates a distance  $z_2$  from the apertures to the observation plane that is also in the Fraunhofer diffraction region.

In the first example, the monochromatic point source located on axis and one slit (the “lower one” whose coordinate of its center satisfies  $x_0 < 0$ ) is covered by a thin piece of glass whose thickness  $t_0$  is such that it delays the phase of the light through that slit by  $\frac{\pi}{4}$  radians.

The second system is composed of the same source and the same slits, but the piece of glass has been removed and the point source of light is translated above the optical axis by the distance  $x_0$ .

- (a) Derive the amplitude distributions  $g[x; z_1, z_2]$  of the interference patterns in both cases.
- (b) Derive AND GRAPH the irradiances  $I[x; z_1, z_2] \propto |g[x; z_1, z_2]|^2$  of the patterns.
7. A Michelson interferometer is aligned to show white light fringes. A source of sodium light is substituted that emits equal amplitudes at two wavelengths:  $\lambda_1 = 589.0$  nm and  $\lambda_2 = 589.6$  nm. One mirror is moved farther from the beamsplitter by the distance  $\ell$  until the fringe visibility decreases to a minimum. Determine the value of  $\ell$ .