OPTICS, 114210 - Homework Exercises
I. Coherence

1. Estimate the coherence time for emission from a cloud of Na atoms at λ=0.6μm at temperature 800K.

2. Two very distant incoherent point sources (stars) with wavelength λ are separated by angle α in the (x, z) plane. They illuminate a pair of pinholes at x=±b/2 in the plane z=0. On a screen at distance z_0 after the pinholes, fringes are observed.
   (a) What is the coherence function $\gamma(x)$ in the plane z=0?
   (b) What is the separation of the fringes in the plane $z=z_0$?
   (c) What is the visibility of the fringes when b= $\lambda/2\alpha$, λ/α, $2\lambda/\alpha$?
   (d) Is the centre fringe bright or dark, in each of the above cases where the visibility is not zero.

3. The sun subtends an angle of about 32 arc-min (0.0093 rad) at the earth. For λ=550nm, what is the size r_c of the coherence region of sunlight on the earth?

4. In a laser resonator cavity several longitudinal modes can be excited, satisfying $m\lambda=2L$, where L is the length of the cavity.
(a) Assuming these modes have random phases, what is the coherence length of the laser light?
(b) If the modes have the same phase, what does the laser output look like (this is called a mode-locked laser)?

5. The photograph below shows night-time urban scene containing many street lamps at different distances, photographed with a pair of horizontal slits separated by 1.5mm in front of the camera lens. The Na lamps emit at wavelength 600nm and have dimension about 10cm. By estimating the visibility of the Young's interference fringes around each lamp (NOT the sinc envelope resulting from the widths of the individual slits) estimate the distances of the various lamps. (Analogy to astronomical interferometry using a Michelson Stellar Interferometer)