Physics 8820 **Homework 3** **Sept. 21**

Problems marked with a (*) were taken from an unpublished chapter by Kip Thorne: http://www.pma.caltech.edu/Courses/ph136/yr2004/book03/chap08/0208.1.pdf.
All the formalism needed has been covered in lecture, however.

(1*) An FM radio station has a carrier frequency of 91.3 MHz and transmits heavy metal rock music. Estimate the coherence length of the radiation.

(2*) How closely separated must a pair of Young's slits be to see strong fringes from the sun (angular diameter ~ 0.5^{o}) at visual wavelengths? Suppose this condition is just satisfied and the slits are 10 μm in width. Roughly how many fringes would you expect to see?

(3*) A circularly symmetric source of light has an intensity given by $I(r) = I_o \exp(-r^2/r_o^2)$ where r is measured from the beam axis. What is the lateral coherence length?

(4) Show that the field treated in the notes on p22 (a sum of a large number of randomly phased plane waves) has $g^{(2)}(\tau) = 2$. (Loudon 3.7)

(5) Consider the light beam formed by superposition of two independent stationary beams, labeled a and b, with a total cycle averaged intensity $I(t) = I_a(t) + I_b(t)$. (Think of the two beams following the same path after being combined using a beamsplitter.) Show that the overall degree of second-order coherence is:

$$g^{(2)}(\tau) = \frac{I_a^2 g_a^{(2)}(\tau) + 2I_a I_b + I_b^2 g_b^{(2)}(\tau)}{(I_a + I_b)^2}$$

Here, $g_a^{(2)}$ and $g_b^{(2)}$ are the second order coherences for each beam alone.