PHYS 404 and 690-03
Problem set due Friday, April 29, 2011.

The Quantized Electromagnetic Field

1. Coherent States I

Consider two coherent states $|\alpha\rangle$ and $|\beta\rangle$. Show that they are not orthogonal by proving the relation:

$$\langle\alpha|\beta\rangle = \exp\left[-\frac{1}{2}\left(|\alpha|^2 + |\beta|^2 - 2\alpha^*\beta\right)\right]$$

(Meystre and Sargent, problem 13.2)

3. Coherent States II

For a coherent state $|\alpha\rangle$ with α=10 calculate:

a) the mean photon number.
b) the fluctuations or variance of the photon number.
c) the quantum uncertainty in the optical phase.

2. Vacuum fluctuations

Calculate the variance of the electric field in the vacuum state for a given wavevector and polarization. Write $\left(\hat{a}\hat{a}^+\right)^3$ in normal order.

(Meystre and Sargent, problem 13.6)

4. Casimir Force

Calculate the Casimir force in Newtons between two conducting plates of area 1 cm^2 each separated by a) 1 mm and b) 1 μm. Compare the force to the strength of gravity on Earth.