

PHYS 622**Problem set # 8** (due April 8)

Each problem is 10 points.

Sakurai and Napolitano problems: 7.6, 7.8

A1 Consider the Fock state $|n\rangle$ with n excitations of the photon field with known momentum and polarization in a volume V . Compute the following quantities:

- Average electric field $\langle \vec{E} \rangle$.
- Variance of the electric field $\langle \Delta E^2 \rangle = \langle E^2 \rangle - \langle \vec{E} \rangle^2$.
- Average photon number $\langle N \rangle$
- Photon number variance $\langle \Delta N^2 \rangle$.

A2 Prove that the coherent state $|\alpha\rangle = e^{-|\alpha|^2/2} \sum_{n=0}^{\infty} \frac{\alpha^n}{\sqrt{n!}} |n\rangle$ is an eigenvector of the annihilation operator.

A3 Repeat calculations from problem A1 for the coherent state $|\alpha\rangle$.

Q1 Consider a particle with mass m in an asymmetric potential well shown below of width a and $U_1 < U_2$.

(a) Write down a transcendental equation that defines energy levels for bound state of the particle inside potential well.

(b) Analyze this equation and show that for small enough a no bound states can exist inside the well. Write down the equation that relates heights of potential walls U_1 and U_2 and the smallest width a_0 that allows for at least one bound state.

(c) Find an approximate solution for a_0 if $U_1 \ll U_2$.

