Lecture 16

The SHO all over again
The Pieces of the Course

- Wave particle duality
- Bound states of quantum mechanical potentials
- Quantum mechanical states of optical radiation field
- Interaction of quantized light and matter
Topics from Last Time

• The SHO potential
• Why SHO’s
• Solving inhomogeneous differential equations
• The SHO solutions
• Wigner distributions
Topics for Next Time Next Monday

- Multi particle wave functions, classical and quantum (chapter 15)
- Quantum postulate 4
- Entangled qubits
- Bell states for teleportation and dense coding
- Bell’s inequality
Topics for Today

- Solving inhomogeneous differential equations
- The SHO solutions $\langle x|n\rangle$ and $|n\rangle$
- Matrix elements of $x$ and $p$, then $a$ and $H$
- SHO modes in phase space
- Wigner distributions for the SHO modes
Solving Inhomogeneous Differential equations

- Counting constants
- Dimensionless variables
- An exponential factor
- Polynomials and boundary conditions
The SHO Modes

- Energy levels
- The Gauss Hermite modes $<x|n>$
- The nodes and the energy levels
- $|n>$ and equally spaced energy ladders
- Derivatives of GH modes
Matrix Elements

• $<m|x|n>$
• $<m|p|n>$
• $<n|a|n+1>$
• $<n|H|n>$
• $|n>$ without the $<x|$
Classical SHO’s

- Newton’s solutions for $x(t)$ and $p(t)$ and their phase space representation
- Designing lens systems
- The classical probability
- Modes in phase space and their quantization
The Wigner Distribution

• Quantizing modes in phase space
• Comparing the quantized classical probability densities with the higher GH modes
• Quantizing the ray paths in phase space
• The density operator