PH451 Review

Harmonic Oscillator

- New in this course
- 1-d (with generalizations to 2-d now we have learned 2-particle systems)
- Energy spectrum & states
- Time development
- Raising and lowering operators, commutation relations
- operator/ket; matrix/vector; {x, d/dx}/wave function notation
- Physics: molecular vibrations

Hydrogen Atom

- Continued in this course
- Energy spectrum & states
- Time development
- Coulomb, relativistic KE, spin-orbit, hyperfine, Zeeman
- operator/ket; matrix/vector; {x, d/dx}/wave function notation

Understand the sizes of energies and lengths

How does the spectrum change with added interactions?

What is the physics?

Perturbation Theory

- Non-degenerate, degenerate
- 1st & 2nd order energy; 1st order state
- Use: Operator/ket; matrix/vector; {x, d/dx}/ wave function notation

Apply to

- 1-particle and 2-particle systems
- Harmonic oscillator, H atom, Particle in a box, Spin-1/2, Spin-1, , free particle

Angular momentum addition

- E.g. $\mathbf{J} = \mathbf{L} + \mathbf{S}$ (vector)
- AM quantum numbers j, mj; s, ms; l, ml (and j(j+1) etc
- J^2, J_z, J_x, J_y; L^2, L_z, L_x, L_y; S^2, S_z, S_x, S_y;
- Raising and lowering operators, commutation relations
- Clebsch-Gordan coefficients
- Situations:

Spin-orbit coupling

Hyperfine interaction

Non-interacting two-particle systems

Identical particles

- Fermions, bosons; distinguishable particles
- Symmetric and antisymmetric states/vectors/ wave functions
- Product states, esp ground and 1st excited
- Non-interacting systems (but PT)
- Use: Operator/ket; matrix/vector; {x, d/dx}/wave function notation

Apply to

- Harmonic oscillator, H atom, Particle in a box, Spin-1/2, Spin-1, free particle

Time-dep PT

- Coefficient of a state c_k after perturbation of $H'(t)$ → transition rate

- Shape (in time) of perturbation is important (Fourier coefficients)

- Light wave – stimulated emission and stimulated absorption

- Some transitions are forbidden by selection rules (spatial integral vanishes).

Advice

- Review midterms (**work** problems again)
- Review homework sets (**work** problems again)
- Reread text with problems by your side
- **Write** summaries, **work** problems
- Reread posted notes with the problems by your side
- **Write** summaries, **work** problems
- Reread your notes with problems by your side
- **Write** summaries, **work** problems

Advice - II

- Looking at your solution or a posted solution does not constitute "working through a problem" unless it was is a really routine one that you don't have to review anyway.

- You must put your notes away and redo the problem.

- Reading these slides will not help you with the exam. It might help you study, though.