PHY362K First Day Review

(1) The time dependent Schrodinger equation (TDSE) is:

$$H\Psi = i\hbar \frac{d\Psi}{dt}$$

What is H? What typically goes into it?

(2) What is the numerical value, including units of h or $\hbar$?

(3) When can the TDSE be separated into a time equation and a space equation?

(4) In the previous case, what is the solution to the time equation?

(5) What is the i doing in the solution?

(6) What exactly solvable problems have you seen?

(7) For those problems, how does the energy depend on the quantum number(s)?

(8) What are the raising and lowering operators, a_+ and a_-?

(9) Given a solution to the time independent Schrodinger equation $\psi_n(x)$, write an expression for the probability that the particle will be found between x_1 and x_2.

(10) Given a set of solutions to the time independent Schrodinger equation $\psi_n(x)$, I can expand a function $f(x)$ according to $f(x) = \sum_n c_n \psi_n(x)$. How are the c_n's found and what do they mean?

(11) What are the solutions to the time independent S.E. in the case where the potential energy is zero?

(12) For these solutions, what is $\psi^* \psi$ as a function of position?

(13) What can you say about the character of of the solutions to the time independent S.E. in regions of space where $E < V$ (i.e., the *classically forbidden region*)? Where $E > V$?

(14) What does the term degenerate mean in the context of quantum mechanics?

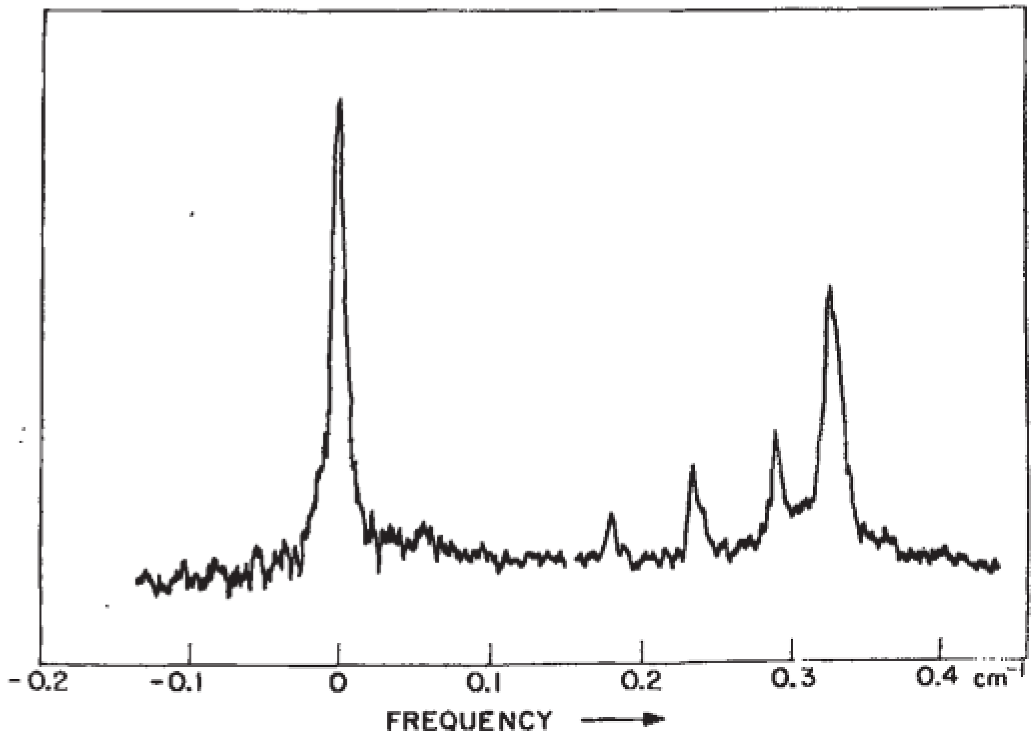
(15) What is an expectation value?

(16) What is $[L_x, L_y]$? What is the significance of this result?

(17) What are the simultaneous observables for angular momentum?

(18) What are the eigenvalue equations for angular momentum?

(19) What are the allowed eigenvalues?



Saturation spectrum of the Hα obtained by Hänsch *et al.*

Figure 1: High resolution of the hydrogen Balmer-α line. The nominal energy of this transition is given by the Rydberg formula $\frac{1}{\lambda} = R\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$ with $R = 1.09737 \times 10^7$ cm^{-1}, n_f=2 and n_i=3. This gives a transition energy of 15,241 cm^{-1} or 565.11 nm.

(20) A spin one-half particle is prepared in a state with $S_z = +\frac{1}{2}$. Can you measure S_x? What value will you get?

(21) How can you prepare a particle with $S_z = +\frac{1}{2}$?

(22) What is the Balmer α line?