PHYS 313: Quantum Mechanics I

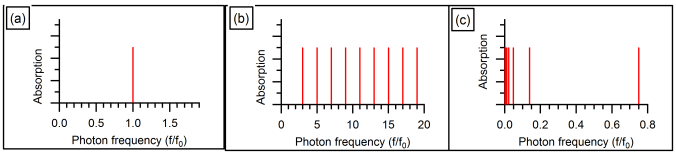
Problem set #9 (due December 6)

All problems are mandatory, unless marked otherwise. Each problem is 10 points.

Townsend, Ch. 10: 10.2, 10.3, 10.5, 10.7, 10.16(a)

Q1: modified problem 9.21 Suppose that the rigid rotator of Problem 9.20 is immersed in a uniform magnetic field $\vec{B} = B_0\vec{k}$ and that the Hamiltonian is given by
$\hat{H} = \frac{\hat{L}^2}{2I} + \omega_0\hat{L}_z$.
Show that $|l, m\rangle$ states are eigenstates of this Hamiltonian and find their corresponding eigen energies.

Q2
The figure below shows (idealized) absorption spectra for three 1D quantum system (that are probably very familiar to you). By analyzing the relative differences between transitions in each system, can you identify them? In the plot each line indicates the possible optical frequency in each system (i.e., the photon energy $\hbar f$ matches the energy difference between two energy levels of the system). All frequencies are normalized to some characteristic value for each system, so your arguments should be based on the relative rather than absolute frequencies of various transitions.



Q3
Since you (almost) finished the course, you are ready to learn the truth about quantum computing. You can use this highly scientific resource or any other of your liking. To receive credit for this problem, formulate in 1-2 sentences why and when we expect quantum computers to outperform classical ones.