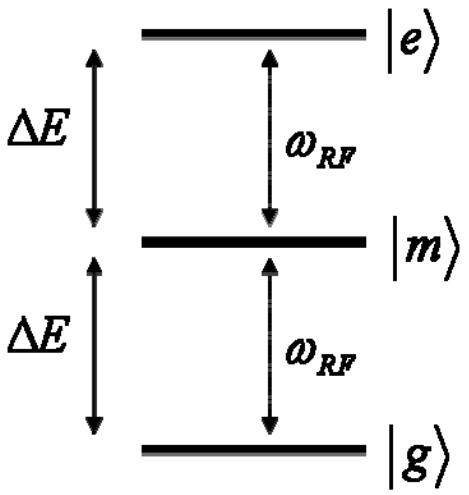
Physics 404 and 690-03: Intro to AMO Physics
Due Date: Friday, March 2, 2012.

# Problem Set #4: 3-level Rabi Flopping

Solve the degenerate 3-level Rabi flopping problem (similar to the 5-level Rabi flopping movie and data that I showed in class, except easier). Consider a 3-level atom with states |g⟩, |m⟩, and |e⟩ with the following energy level structure:




An RF magnetic field with frequency $\omega_{RF}$ is applied to the atom resulting in a (resonant) 2-level Rabi frequency of Ω for both the |g⟩ ↔ |m⟩ and |m⟩ ↔ |e⟩. The |g⟩ ↔ |e⟩ transitions are forbidden.

1) Assuming that you can treat the system as two 2-level atoms with a shared level, show in detail that in the dressed atom picture the Hamiltonian is given by (Ω is real, and $\delta = \omega_{RF} - \Delta E/\hbar$ is the detuning of the driving RF magnetic field)

$$H = \hbar \begin{bmatrix} 2\delta & \Omega/2 & 0 \\ \Omega/2 & \delta & \Omega/2 \\ 0 & \Omega/2 & 0 \end{bmatrix}$$

Also, specify the basis for the Hamiltonian.

2) Find the eigen-energies and eigen-states of the Hamiltonian for δ=0.

3) Consider an initial state of the system where the atom is in the |g⟩ state at t=0. Derive expressions for the probabilities to be in states |g⟩, |m⟩, and |e⟩ as a function of time for δ=0, and plot these probabilities as a function of time.