

## Phys 2053: Homework IX

due April 1, 2016

### PhET Simulation of a Laser

#### 1. (4 pts) Laser: Pumping a two state system

1. This simulation uses an optical pump as an energy source for a laser. Turn the light source on a medium level with the preset wavelength. What do you observe about the emitted photons? (Are they spontaneous emissions, stimulated emissions or both and how can you identify this?)
2. When you change the intensity of the light source to a very low level, what do you notice about the emitted photons?
3. When you change the intensity of the light source to a very high level, what do you notice about the emitted photons?
4. When you have the intensity at a medium level but decrease the lifetime, what do you notice about emissions?
5. When you have the intensity at a medium level but increase the lifetime, what do you notice about emissions?
6. When you tune the light to a color that has a lower energy than the preset color, what do you observe?
7. When you tune the light to a color that has a higher energy than the preset color, what do you observe?

Summarize your findings, and interpret them using your knowledge about two state system.

#### 1. (4 pts) Laser: Pumping a three state system

1. When you change to a three state system, can you still only pump electrons to a higher energy level with the red light or is there another light energy that works now? Explain.

2. What characteristics do you observe about the emission events when you pump with the additional color? (Are all emissions the same color, are they stimulated, spontaneous, etc.?)
3. Click on display photons emitted from upper state.) What transition do these photons represent, and what region of the spectrum are these photons in?
4. When you increase the lifetime of the upper state what happens to the emission events?
5. When you in increase the lifetime of the lower state what happens to the emission events?

Summarize your findings, and interpret them using your knowledge about three state system.

**3. (3 pts) Making a laser with a three state system** You studied a two and three state laser. What about a four state laser? Put all your learning together and find conditions that make a good laser. Describe them below. (Good equals continually running with decent output in the green lasing power.)