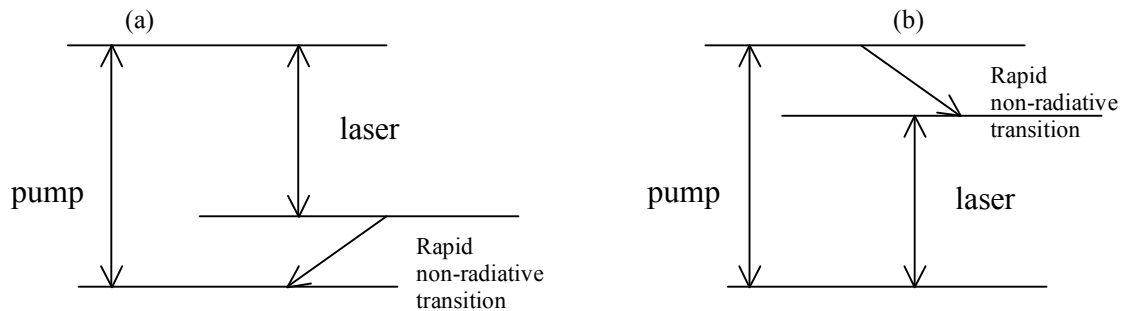


Assignment 3 Time Due: 4PM on October 23, 2009
Please hand to the fourth floor office with cover sheet.

- The experimentally measured lifetime of the 4P to 4S transition in Calcium is about 2.3nS. What is A_{21} for this transition? If the energy difference between the two levels is about 2.9eV then what is the value of B_{12} for the transition as well as its observed wavelength? If the density of the Calcium atoms is 10^{19} cm^{-3} at a temperature of 1240K then what is the value of B_{21} for this transition?
- Shown below are two possible arrangements for a three level laser system. Use the laser rate equations to calculate the efficiency for scheme (a) (i.e. the threshold pump power for inversion). Compare this with the value calculated for scheme (b) in the notes and comment why you think scheme (b) is the preferred model in actual lasers?



- Consider a 4 level laser based on an electrically excited mixture of Helium and Neon gas with the following parameters:
 Laser output wavelength $\sim 633.8 \text{ nm}$, Spontaneous lifetime of the upper laser state $\sim 190\text{ns}$,
 Full width at half maximum (FWHM) of the spontaneous emission $\sim 1.25 \times 10^9 \text{ Hz}$,
 pump frequency $\sim 5 \times 10^{15} \text{ Hz}$, refractive index ~ 1 , resonator length $\sim 12 \text{ cm}$,
 mirror reflectivities ~ 0.97

Assume that all other cavity loss mechanisms are negligible. Both the decay from the excited states to the upper laser level, and the decay from the lower laser level to the ground state is very much shorter than the lifetime of the upper laser level.

- What is the (cold) cavity lifetime (the same as the photon lifetime) ?
- Find the value of the normalized line broadening function $g(\nu)$ at line centre using the usual "top hat" approximation we make in this course.
- What is the threshold population inversion density required to initiate oscillation in this cavity?
- What is threshold pump power necessary to initiate oscillation? How does this compare to the typical level required for a three level laser?
- Is this laser a good candidate for a CW laser?