26. Calculate the expression for the ratio of stimulated to spontaneous emission rates. Evaluate this ratio for the following transitions and comment on which transitions you could ignore Einstein B terms in the analysis of the level populations. We will use this result in future statistical equilibrium calculations – it’s always good to check if you can ignore the B terms! Assume that the CMB is the dominant background radiation field.

   a. HI spin flip transition $\lambda = 21.1$ cm $A_{ul} = 2.9 \times 10^{-15}$ s$^{-1}$

   b. CO 1-0 rotational transition $\lambda = 2.7$ mm $A_{ul} = 7.2 \times 10^{-8}$ s$^{-1}$

   c. CII fine structure transition $\lambda = 157.7$ $\mu$m $A_{ul} = 2.4 \times 10^{-6}$ s$^{-1}$

27. Sometimes, instead of an Einstein A, the “oscillator strength” is quoted for a transition. The oscillator strength $f_{lu}$ is given by (cgs units):

   $$f_{lu} = (g_u/g_l) A_{ul} \frac{m_e c}{\lambda_{ul}^2/(8 \pi^2 e^2)}$$

   Calculate the oscillator strength for the Ly$\alpha$ transition (121.567 nm, $A_{ul} = 4.699 \times 10^8$ s$^{-1}$). Note: for the H atom, the statistical weights are $g = 2n^2$. See section D1 of the appendix of Irwin if you are interested in learning more about oscillator strengths.