AST 300B – Spring 2019

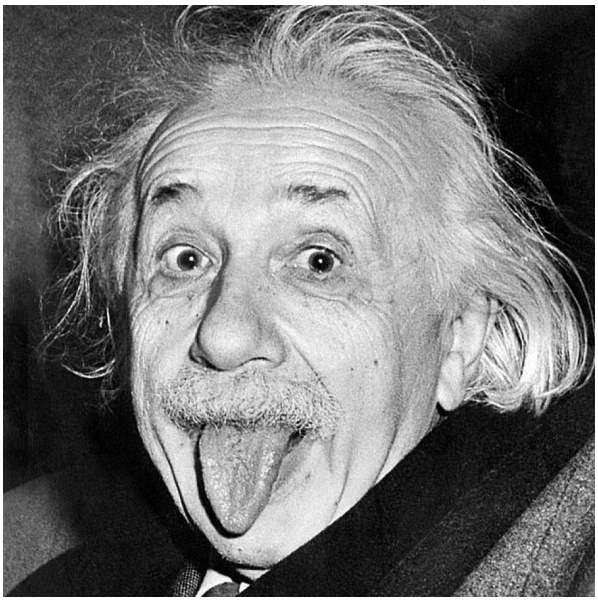
In-class Problems Due: Friday Mar. 22

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 λ = 21.1 cm $A_{ul} = 2.9 \times 10^{-15}$ s^{-1}

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

c. CII fine structure transition λ = 157.7 μm $A_{ul} = 2.4 \times 10^{-6}$ 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):

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

Calculate the oscillator strength for the Lyα 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.