

# ASTR HW 5

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## 17.2

**a**

$$j = 0$$

$$j = 1$$

$$\Delta E = E_1 - E_0$$

$$\text{rate coefficient for de-excitation} = k_{10}$$

$$\text{Einstein coefficient for spontaneous decay} = A_{10}$$

By Eq 17.1 in Draine, the excited population of species  $X$  satisfies

$$= n_c n_0 k_{01}$$

$$\frac{dn_1}{dt} = n_c n_0 k_{01} - n_c n_1 k_{10} - n_1 A_{10}$$

In the steady state,  $\frac{dn_0}{dt} = \frac{dn_1}{dt} = 0$

$$n_1(n_c k_{10} + A_{10}) = n_c n_0 k_{01}$$

$$\rightarrow x_{ss} = \frac{n_1}{n_0} = \frac{n_c k_{01}}{n_c k_{10} + A_{10}}$$

**b**

$$y(t) = x(t) - x_{ss}$$

$$\rightarrow \frac{dy(t)}{dt} = \frac{dx(t)}{dt} - \frac{dx_{ss}}{dt}$$

$$\rightarrow \frac{dy(t)}{dt} = \frac{dx(t)}{dt}$$

$$= n_x k_{10} x + A_{10} x = 0$$

$$\rightarrow y(0) = x(0) = 0$$