# AST 300B – Spring 2018

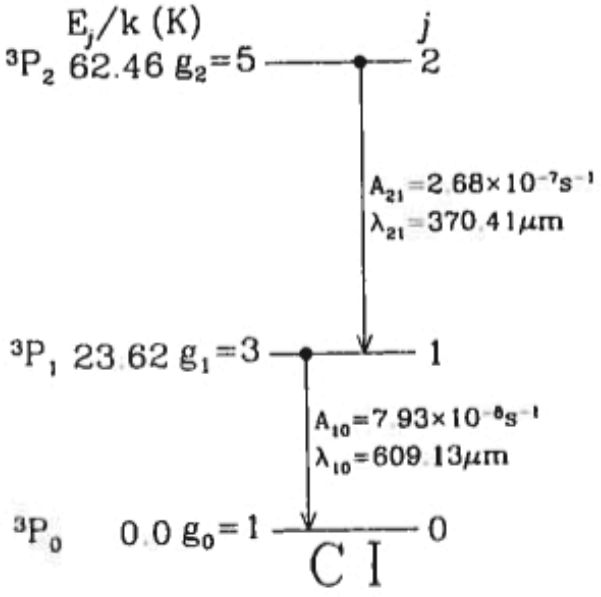
## In-class/take-home Problems Due: Monday April 9

38. The Carbon problem continued… Up to this point, we've assumed that the emission was optically thin. Let's check that assumption. Calculate the column density for which the optical depth at the peak of the spectral line (v = 0 km/s) is equal to 1 for the 492 GHz (609 ) CI line with a velocity dispersion $\sigma_v$ = 1 km/s and $T_{ex}$ = 25 K (assumed constant along line of sight). What abundance of Carbon does this correspond to if the cloud has $A_V \sim 1$ mag?

Hint: the equations you used for problem 37 ASSUMED optically thin – so you need a different starting point. Assume the line profile function is given by a Gaussian:

$$\phi_\nu = 1/\mathrm{sqrt}(2\pi) * c/\nu * 1/\sigma_v * \exp( - v^2/2\sigma_v^2)$$

More hints: (1) convert all Einstein Bs to As. (2) you should have 2 terms. Pull out a factor of $N_u$, the column density in the upper state, and use the Boltzmann equation to simplify.




| EINSTEINA(s^-1) | FREQ(GHz) | E_u(K) |
|---|---|---|
| 7.880E-08 | 492.160651 | 23.620 |
| 2.650E-07 | 809.34197 | 62.462 |