UNIVERSITY OF CALIFORNIA, SANTA BARBARA
Department of Physics

Physics 233 **Exercise 2 (Due Wed. Jan 22)** Winter 2014

Three-Level Atom *(An exercise introduced by Dopita & Sutherland):*

An atom has three fine-structure states: ^3P, $^1S_0$ (excitation energy 0.5 eV), and $^1D_2$ (excitation energy 1.2 eV). From the ground term, the total collision strength to both excited levels is 1.0. Three transition probabilities are $A(^1S_0 \text{ - } ^3P_1) = 5\ \text{s}^{-1}$, $A(^1D_2 \text{ - } ^3P_1) = 20\ \text{s}^{-1}$, and $A(^1D_2 \text{ - } ^1S_0) = 10\ \text{s}^{-1}$. [Hint: You may use the result from quantum mechanics that $A(^1S_0 \text{ - } ^3P_2) \approx A(^1S_0 \text{ - } ^3P_1$ and that $A(^1D_2 \text{ - } ^3P_2) \approx A(^1D_2 \text{ - } ^3P_1)$.

1. Assuming that the ground term splitting is negligible, what are the wavelengths of the forbidden lines produced by the atom?

2. In this case, what is the critical density for each forbidden line?

3. Plot the flux ratio $F(^1D_2 \text{ - } ^3P_{1,2})/F(^1S_0 \text{ - } ^3P_{1,2})$ as a function of temperature for low densities and at the limit of high densities.