

UNIVERSITY OF CALIFORNIA, SANTA BARBARA
Department of Physics

Physics 233

Exercise 1 (Due Wed. Jan 13)

Winter 2016

1. The **Milne Relation** describes the general relationship between radiative recombination and photoionization cross sections. Derive it using the *Principle of Detailed Balance* and the *Law of Mass Action*. Please pay careful attention to the details and explicitly state any assumptions you make.

Use the following notation. Let $\sigma_{pi}(h\nu)$ describe the photoionization cross section from level l of atom X to the resulting ion X^+ in energy level u . The rate of photoelectric absorption of photons with frequencies in the range ν to $\nu + d\nu$ is balanced by the rate of radiative recombinations (both spontaneous and stimulated) of electrons within a particular energy range. Make sure you state the relationship between the energy of the ionizing photon, $h\nu$, the kinetic energy of the recombining electron, and the ionization energy $I_{lu} = E(X_u^+) - E(X_l)$.

Show that the recombination cross section from X_u^+ to X_l can be written in terms of the photoelectric absorption cross section from the same level as

$$\sigma_{rr,ul} = \frac{g_{X,l}}{g_{X+1,u}} \frac{h^2 \nu^2}{m_e^2 c^2 v^2} \sigma_{pi,lu} \quad ,$$

where $g_{X,l}$ and $g_{X+1,u}$ are the relevant weighting functions for the atom (or ion).