Homework radiative transfer and spectropolarimetry

February 11, 2019

1. Assuming a simple slab model for the spectral line formation (the line forms in a slab of a finite optical thickness, with the source function that is generaly different than the incident radiation), and wavelength-independent incident radiation, derive expression for emergent radiation under the assumption that the slab is optically thin (optical thickness is small but not zero) at all the wavelengths. What shape will the spectral lines have in this approximation?

2. Using expressions for opacity and emissivity for the line radiation, and relying on Boltzmann statistics, derive relationships between Einstein coeefficients. (Hint: the source function should be equal to the Planck function under LTE).

   Note: Even though we assumed LTE, relationships between the Einstein coefficients are always valid.

3. From a model of the solar atmosphere (FALC model is posted on the website, but if you want, feel free to use another one), calculate and plot the total particle number density. Now, this involves *all* the possible particles in the solar atmosphere (electrons, atoms, ions, molecules). Assume that the atmosphere consists only of hydrogen and calculate from that the electron density in the atmosphere. At which regions is hydrogen predominantly ionized?

   Columns meaning: optical depth in the continuum in log scale, height, temperature, total gas pressure. CGS system.