ASTR 545
Homework 2 (50 points; 10 points each)
Due: Thursday September 15

1. *Absorption Lines:* Consider the <u>four</u> macroscopic properties in a stellar atmospheres that predominantly govern the *relative* strengths of absorption features? (a) List them. (b) Succinctly describe each. (c) Briefly qualitatively describe the physical interdependence of these quantities *and* how they affect absorption lines in stellar spectra. [Be brief, not wordy.]

2. *Ionization Edges:* Consider the bound-free absorption cross section for ground-state neutral hydrogen. At $\lambda = 912$ Å, the bound-free cross section is $\alpha_{912} = 6.03 \times 10^{-18}$ cm^2. (a) If the column density of ground-state neutral hydrogen is $\log N(\text{H}\,\textsc{i}) = 17.0$, what is the relative flux (I_λ/I^0_λ) at 912 Å? Show your calculation. (b) If the cloud having this column density is 3 kpc thick, what is the number density of ground-state neutral hydrogen (in cm^{-3})? You can assume a constant density gas structure. Show your calculation.

3. *Excitation and Ionization:* Consider the Balmer hydrogen lines in stellar spectra. (a) Describe how the strength of these spectral lines qualitatively change as one goes from M stars to O stars. Be sure to state in which stars the strengths are a maximum. (b) Qualitatively describe how both the distribution of excitation levels in neutral hydrogen *and* the ionization balance of ionized to neutral hydrogen must behave as a function of temperature in order that the Balmer lines behave as observed.

4. *Luminosity Classes:* (a) For an A star, write the spectral+luminosity class for supergiant, bright giant, giant, subgiant, main sequence star, and white dwarf. (b) From the HR diagram, obtain approximate luminosities for each of these A stars. (c) Given the luminosity and the typical temperature of an A star, compute the radius and surface gravity, $\log g$, of each luminosity class assuming $M = 3M_\odot$. Give your answers in solar units ($R/R_\odot$ and $g/g_\odot$). Show your work for a minimum of one stellar type and tabulate the stars by luminosity classes in order of increasing $\log g$.

5. *Balmer Jump:* (a) What physical process is occurring in stellar atmospheres that gives rise to the Balmer jump? Include which transition it is and for which ion in which excitation state. (b) In which spectral class of stars is the Balmer jump a maximum? (c) For stars with this spectral class, in which luminosity class do you expect that the Balmer jump is strongest? Explain your *physical reasoning.* [3 pts EXTRA CREDIT] For a given spectral+luminosity class, how do you expect the Balmer jump to change with metallicity in the atmosphere? Explain your reasoning.