Name: ____ Name: ____

AST358: Stellar Populations

In this activity you will use models of stellar spectra to explore what the composite stellar population of a group of stars appears like. Part 1 should be done in pairs, the rest can be done as a table.

Part 1:

a) Assume that one billion masses of gas is instantaneously converted into stars, with stellar masses distributed according to a Salpeter initial mass function (α=-2.35). What is your educated guess for the number of M-stars formed compared to the number of O-stars formed? Discuss in your group, and write your answer here:

b) Using the mass ranges per spectral type defined in the table below, calculate the number of stars formed in each spectral type, and put in the final column.

$$\phi(m) \propto m^{\alpha}$$

$$N = \int_{m_l}^{m_u} \phi(m)\ dm$$

$$M_{total} = \int_{m_l}^{m_u} \phi(m)\ m\ dm$$

Spectral Type	Mass ($M_\odot$)	Number (millions)
O	20 - 100	
B	3 - 20	
A	1.7 - 3	
F	1.1 - 1.7	
G	0.8 - 1.1	
K	0.6 - 0.8	
M	0.08 - 0.6	

c) How does your calculated number of M-stars versus O-stars compare to your initial guess? Discuss as a group, and write a few sentences of explanation here.

Part 2:

a) Now you will use the set of transparencies I have handed out to explore what the integrated stellar populations. Before you inspect these, discuss with your partner and write down your guess here for what the *combined* spectrum of all of the stars in this population will look like. Will it look more like an O-star? An M-star? Or something in between? Explain your reasoning.

b) You should have seven transparencies, one per spectral type (note that the "O" spectrum is an O5, "B" is B5, etc; this is an imperfect approximation). Using the numbers you calculated in Part 1, align these spectra on your table to explore what the combined spectrum of the entire stellar population would look like. You can do this any way you wish, but one suggestion would be to create a set of master axes on your table, and place each transparency at its appropriate y-axis position. Raise your hand if, after discussing amongst your table, you do not know how to begin.

Once you have these aligned properly, use your marker to draw on the table what the *combined* spectrum would be from all of these stars; this will just be adding each wavelength up vertically (but note the log scale!!). Draw your combined spectrum below, labeling the axes appropriately.

c) Recall that the color is defined as $X-Y=(-2.5)*\log(f_X/f_Y)$. By reading off the values from your combined spectrum, estimate the U-B, and U-R colors of your population, and record here (U~3500 Å, B~4500 Å, R~6500 Å).

Part 3:

a) The population above was captured at time=0. However, you know that stars "die" at different times. Lets shift 500 Myr into the future. First, guess how the integrated spectrum will look different, and record here.

b) Using the definition of main-sequence timescale below, at what stellar mass does a star have a main-sequence lifetime of 500 Myr?

$$\tau_{MS} \approx 10^{10} \left(\frac{M}{M_\odot}\right) \left(\frac{L}{L_\odot}\right)^{-1} yr \qquad \frac{L}{L_\odot} \propto \left(\frac{M}{M_\odot}\right)^{3.5}$$

c) Now go back to your composite stellar population, and remove any stars which need removing. Re"compute" your composite, now 500 Myr old population, and draw, in a different color or linestyle, on the plot on the previous page. Be sure to label which curve corresponds to the t=500 Myr population. Qualitatively, how does this spectrum differr from the t=0 spectrum? Which spectral type does it most resemble?

d) Calculate the U-B and U-R colors of this new population, and list here.

e) Explain in your own words how you can use the observed colors of a stellar population to infer the age (assuming all stars form at the same time). Comment specifically on whether U-B or U-R is a better indication of age.