ASTRONOMY 51/151- SPRING 2022
Project Sheet 5
DUE by Friday, April 1, 2022
300 points

A. Rest-frame absolute magnitudes and colors

For all the provided stellar templates (sampling the full range of spectral types and luminosity class; Pickles 1998), calculate, numerically, the absolute magnitude in the U-band (M_U), in the B-band (M_B), and in the V-band (M_V) in the AB magnitude system. Download *Assignment5.zip*; by unzipping it, the directory "Assignment5" will be created. The Pickles' templates are in:
./Assignment5/templates/pickles_stars/ascii_norm/
Within this directory, you will also find the file *README*. As the name of the file encourages, read it carefully. The file *Table.dat* provides the filename of each template, and the corresponding spectral type, luminosity class, and effective temperature at the surface. Complete the file Table.dat by adding 5 new columns, namely M_U, M_B, M_V, $U-B \equiv M_U$-M_B, and $B-V \equiv M_B$-M_V. The filter curves are in ./Assignment5/filters/

B. H-R Diagram

With the information calculated above and the information in *Table.dat*, construct the H-R diagram. Make two versions of the H-R diagram: 1) $y = M_V$ (with bright end, i.e., more negative values, at the top and faint end, i.e., larger values, at the bottom) vs $x = \log(T_{eff})$ (with hot left and cold right); 2) $y = M_V$ (with bright top and faint bottom) vs $B-V$ (with blue, i.e., smaller color, left and red, i.e., larger color, right). In both version, plot with different colors each different luminosity class, and also over-plot the location of the Sun.

C. Color-Color Diagram

Plot $y = U-B$ (with blue, i.e., smaller color, top and red, i.e., larger color, bottom) vs $x = B-V$ (with blue, i.e., smaller color, left and red, i.e., larger color, right); connect the different points belonging to the same luminosity class and color code the individual stars as a function of temperature, preferably as a function of $\log T$. Calculate $U-B$ and $B-V$ colors also for a perfect blackbody with different temperatures from $T_{\rm eff} = 2200$ K to $T_{\rm eff} = 100,000$ K, and over-plot them color coding them as a function of $\log T$ of the blackbody. Do you notice any trend? Describe and discuss your findings.

D. Apparent/Absolute magnitude and distance

The star Vega is a main sequence (luminosity class V) A0 spectral type star, with $M_V = 0.6$. Calculate the apparent magnitude of Vega as a function of distance in parsec (pc) over the range $[4.\times10^{-6}, 10^{6}]$pc. Make a figure showing y=apparent magnitude of Vega

vs x=distance[pc] (using logarithmic scale for the x axis). Highlight (with a filled large circle) on this diagram the values for $d = 4.84 \times 10^{-6}$ pc (i.e., 1 AU, the distance between the Sun and the Earth), $d = 7.68$ pc (i.e., the actual distance of the Vega star), $d = 10$ pc (i.e., used for the definition of absolute magnitude), $d = 8.122 \times 10^3$ pc (i.e., the distance between the Sun and the Milky Way center), and $d = 7.78 \times 10^5$ pc (the distance to the galaxy Andromeda). Overplot the location of the Sun on this diagram ($m_{\rm V} = -26.74$).