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Show code

Plotting Stellar Atmosphere Codes

This notebook serves as an introdution to reading in a ASCII file and plotting the values that have been read in. Specifically this code reads in stellar atmosphere models and plots flux vs. wavelength. The example given is for Kurucz models from ATLAS9.

Here we provide some of the libraries that need to be read in to be able to execute our code. Remember that:
1- **NumPy** is a fundamental package of Python. It allows for a wide range of data types and data manipulation capapbilities. To use it you will call it simply as **np**.
2- **Matplolib** is a Python 2D plotting library. We are only loading the Pyplot capabilties, which provide a collection of command that make matplotlib work like *MATLAB*.
3- `%matplotlib inline` allows for interactive plotting.

```
%matplotlib inline
import numpy as np
import matplotlib.pyplot as plt
```

Reading in a File

Here we are reading in one of the files that contains the out put from the code. The format of the file is such that the first 11 rows are header information and are not needed to be read in. In this particular case you are reading in a model for a star of $T_{eff} = 6000$K and $\log g = 0$.

`np.loadtxt` reads in the columns of your file (in this case `kurucz6000logg0.txt`) into the 2-D array `star1`. You can access the wavelength using `star1[:,0]`, where the `:` means all values in the dimesion, and the 0 is the first element of the second dimension (wavelength in this case). The second element is flux. So every wavelength point has a corresponding value of flux.

- `star1[:,0]` = wavelength array
- `star1[:,1]` = flux array

```
file = 'kurucz6000logg0.txt'
star1 = np.loadtxt(file, skiprows=11) #read in file into star1 array, skip first 11 rows
```

Plotting

Plot the model spectrum over the entire wavelength range

```
fig= plt.figure()
axes=fig.add_subplot(111)
axes.plot(star1[:,0],star1[:,1])
```

Your turn

1. Edit the plotting code above to only plot the spectrum over the visible wavelength range ($\lambda = 3800 - 7000\mathring{A}$)
2. Read in three models with different temperatures into their own arrays.
3. Plot all three models on the same figure. This figure should have:
   - All 3 models, in different colors or line styles.
   - Properly labeled axes and a title
   - A legend labeling each line with its corresponding model (T_{eff} and $\log g$)
4. Provide a brief description of how the spectra change over this temperature range and why, based on what we have been discussing in class in terms of flux, opacity, optical depth, line broadening, etc.
5. Make sure you properly comment your code. This is expected of any future assignment that requires the use of coding. Below is an example of a properly commented IDL code. Note the additional information at the top of the file. Make sure to give creidt to the model source that you used. (e.g. Coelho 2014, $MNRAS$, 440, 1027)
6. Now, repeat steps 1-5 for stars with the same temperature, but different values of gravity.


```
function planck,wave,temp
;+
; NAME:
;       PLANCK()
; PURPOSE:
;       To calculate the Planck function in units of ergs/cm2/s/A
;
; CALLING SEQUENCE:
;       bbflux = PLANCK( wave, temp)
;
; INPUT PARAMETERS:
;       WAVE   Scalar or vector giving the wavelength(s) in **Angstroms**
;               at which the Planck function is to be evaluated.
;       TEMP   Scalar giving the temperature of the planck function in degree K
;
; OUTPUT PARAMETERS:
;       BBFLUX - Scalar or vector giving the blackbody flux (i.e. !pi*Intensity)
;               in erg/cm^2/s/A in at the specified wavelength points.
;
; EXAMPLES:
;       To calculate the blackbody flux at 30,000 K every 100 Angstroms between
;       2000A and 2900 A
;
;       IDL> wave = 2000 + findgen(10)*100
;       IDL> bbflux = planck(wave,30000)
;
;       If a star with a blackbody spectrum has a radius R, and distance,d, then
;       the flux at Earth in erg/cm^2/s/A will be bbflux*R^2/d^2
; PROCEDURE:
;       The wavelength data are converted to cm, and the Planck function
;       is calculated for each wavelength point. See Allen (1973), Astrophysical
;       Quantities, section 44 for more information.
;
; NOTES:
;       See the procedure planck_radiance.pro in
;       ftp://origin.ssec.wisc.edu/pub/paulv/idl/Radiance/planck_radiance.pro
;       for computation of Planck radiance given wavenumber in cm-1 or
;       wavelength in microns
; MODIFICATION HISTORY:
;       Adapted from the IUE RDAF               August, 1989
;       Converted to IDL V5.0   W. Landsman   September 1997
;       Improve precision of constants    W. Landsman  January 2002
;-
 On_error,2

 if ( N_elements(wave) LT 1 ) then begin
     print,'Syntax - bbflux = planck( wave, temp)'
     return,0
  endif

  if ( N_elements( temp ) NE 1 ) then $
      read,'Enter a blackbody temperature', temp

  bbflux = wave*0.

; Gives the blackbody flux (i.e. PI*Intensity) ergs/cm2/s/a

  w = wave / 1.E8                              ; Angstroms to cm
;constants appropriate to cgs units.
  c1 =  3.7417749d-5                ; =2*!DPI*h*c*c
  C2 =  1.4387687d                  ; =h*c/k
  val =  c2/w/temp
```