# Homework1

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**1. Stellar Spectra(20pts)**

LAMOST is a telescope at Xinglong Observatory that has produced millions of optical spectra. Data is available to everyone and is located at: http://dr5.lamost.org/ Pick a stellar spectrum from LAMOST. You may need to sign up for an account. Select a spectrum with signal-to noise>20 at 5000 angstrom. You may be asked to show your spectrum and describe the star to the class.

a: Plot the spectrum in python. Hand in a printout of the code you used to plot de spectrum.

The spectrum has been plotted and showed below.

b: In your plot, mark at least 5 important spectral features (do this in your plotting program, not by hand).

Five spectral features have been overplotted over the spectrum in a.

c: What kind of star did you choose? Use the features marked in b to provide support for your answer.

We can see the Mg, Na, O, Ha, Ca absorption line on the spectrum, the Ca absorption line is very strong so the spectral type of this star is F star.

**The Code is:**

```
from astropy.io import fits
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
import time
#Load the spectrum data from dr5, including flux, wavelength, error,
    etc.
spec = fits.open('spectrum/spec-55859-F5902_sp02-173.fits.gz')
flux = spec[0].data[0]
wavelength = spec[0].data[2]
err = spec[0].data[1]
#plot the spectrum
plt.figure(figsize=(20,10))
plt.plot(wavelength, flux,c = 'black')
pos = np.where((wavelength>4999) & (wavelength<5001))[0][-1]
print(flux[pos]>20*err[pos])#discuss if the signal to noise > 20 at
    wavelength 5000A.
plt.xlabel('Wavelength [$\AA$]')
plt.ylabel('Flux')
plt.grid();
```

```
#Plot five feature lines over the spectrum.
a_lines = {'Na':5895.6, 'Mg':5176.7, 'O':6302.05, 'Ha':6564.61,
    'Ca':8664.52}
for k in a_lines.keys():
    plt.axvline(a_lines[k],c = 'g',label = 'Ansorption Lines')
    plt.text(a_lines[k], flux.max(),k)
e_lines = {}
plt.show()}
```

**result**:

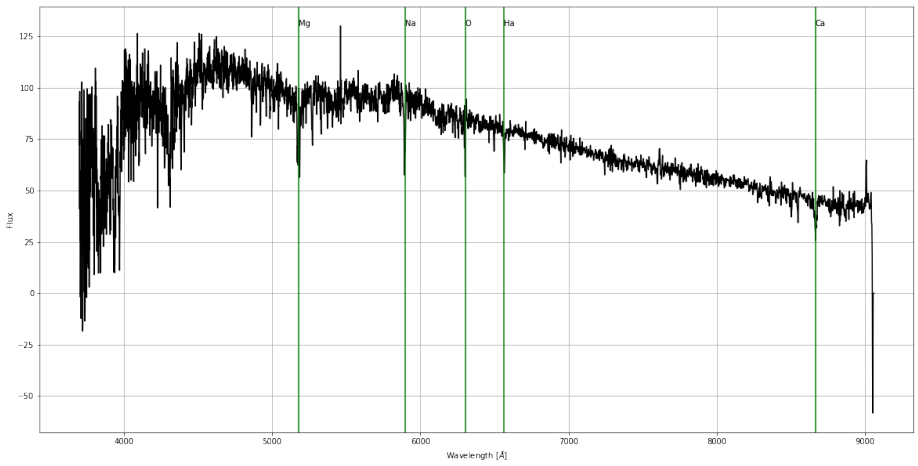


Figure 1: The spectrum of a star whose effective temperature is about 5000 kelvin. We can see feature absorption lines in this figure such as Mg, Na, Ca, etc. The star is a typical G star.

**2. Pollution in Beijing: python and plotting practice (30pts):**

Air quality indices are now easy to access. Until a few years ago, air quality was revorded at the US Embasy in Beijing. The website young-0.com compiles this data.

I have placed historical data of 2.5 micron-sized particles at:http://kiaa.pku.edu.cn/ gherczeg/stellar/api.txt/ This data is current up until today's lecture. Analyse and describe this data. Tell me some interesting things in this dataset. Is pollution getting better or worse? Use python and turn in a copy of any code that you write.

**The PM2.5 level at different years**

```
aqi = pd.read_csv('aqi.txt', sep = '\t') #Load data from file
t = np.array(aqi['Time']) # time
Id = np.array(aqi['Reading'])
PM = np.array(aqi['PM2.5 level']) #air quality
err = np.where(PM == '(no data)') # error data
```

```
t = np.delete(t, err) #delete those error datas
PM = np.delete(PM, err) #delete those error datas
pm = np.array(PM,dtype='float')
year = np.array([2008,2009,2010,2011,2012,2013,
2014,2015,2016,2017,2018,2019,2020], dtype='str')
month = np.array(['-01-01', '-02-01', '-03-01','-04-01',
'-05-01', '-06-01', '-07-01', '-08-01', '-09-01', '-10-01',
'-11-01', '-12-01','-13-01'])
hour = np.array([' 00:00',' 01:00',' 02:00',' 03:00',' 04:00',
' 05:00',' 06:00',' 07:00',' 08:00',' 09:00',' 10:00',' 11:00',
' 12:00',' 13:00',' 14:00',' 15:00',' 16:00',' 17:00',' 18:00',
' 19:00',' 20:00',' 21:00',' 22:00',' 23:00',' 24:00'])
pm_year = []
for i in range(len(year)-1):
    n = np.where((t>year[i])&(t<year[i+1]))
    pm_year.append(np.sum(pm[n])/len(pm[n]))
pm_year = np.array(pm_year)
Y = np.array([2008,2009,2010,2011,2012,2013,
2014,2015,2016,2017,2018,2019])
plt.figure(figsize=(16,9))
plt.plot(Y, pm_year)
plt.xlabel('Time [year]')
plt.ylabel('Average PM Level')
plt.grid()
plt.title('Air Qualities at Different Years',size = 24)
```

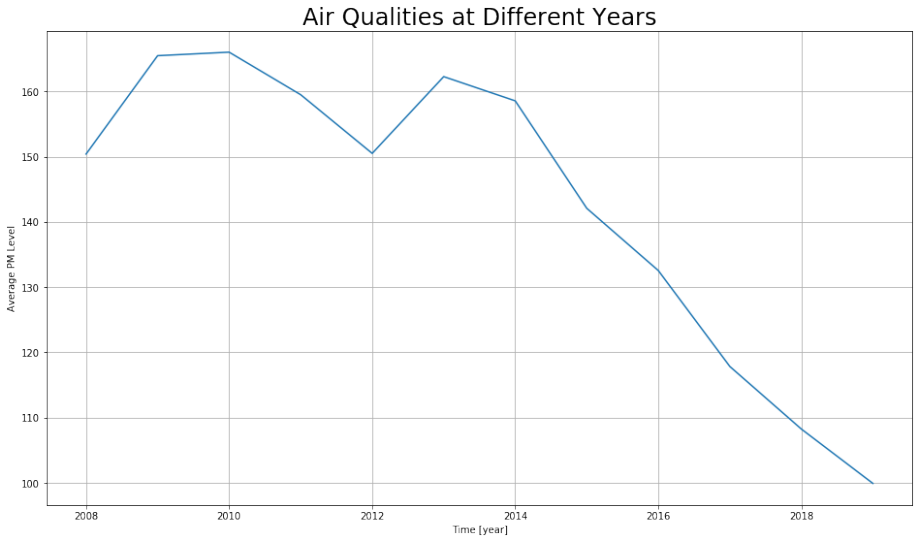


Figure 2: From this figure, we can see that PM2.5 level is getting less in 10 years, although there are some fluctuations in these years.

**The PM2.5 level at different months**

```
month = np.array(['-01-01', '-02-01', '-03-01','-04-01', '-05-01',
    '-06-01', '-07-01', '-08-01', '-09-01', '-10-01', '-11-01',
    '-12-01','-13-01'])
pm_m = []
for i in range(len(month)-1):
    M = []
    for y in year:
        n = np.where((t<y+month[i+1])&(t>y+month[i]))
        M.append(np.sum(pm[n])/len(pm[n]))
    Mon = np.array(M, dtype='str')
    Mon = np.delete(Mon, np.where(Mon == 'nan'))
    Mon = np.array(Mon, dtype='float')
    pm_m.append(np.sum(Mon)/len(Mon))
mon = np.array([1,2,3,4,5,6,7,8,9,10,11,12])
fig = plt.figure(figsize=(16,9))
ax = fig.add_subplot(1,1,1)
ax.set_xticks(mon)
plt.plot(mon, pm_m)
plt.xlabel('Month')
plt.ylabel('PM level')
plt.grid()
plt.title('Air Qualities at Different Months',size=24)
```

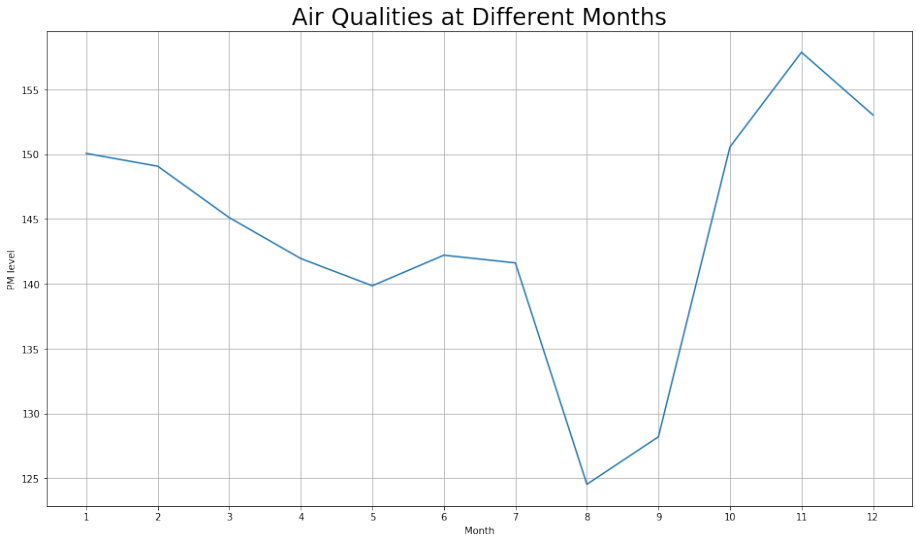


Figure 3: We can see that the air quality is better in spring and summer than that in autumn and winter. In November, average PM2.5 level is highest in one year and the air quality is the worst.

**Air quality trend**

```
time = []
month = np.array(['-01-01', '-02-01', '-03-01','-04-01', '-05-01',
'-06-01', '-07-01', '-08-01', '-09-01', '-10-01', '-11-01', '-12-01'])
for y in year:
    for m in month:
        time.append(y+m)
pm_mon = []
for i in range(len(time)-1):
    n = np.where((t<time[i+1])&(t>time[i]))
    p = np.array(pm[n],dtype='str')
    p = np.delete(p,np.where(p == 'nan'))
    p = np.array(p, dtype='float')
    pm_mon.append(np.sum(p)/len(p))

Y = []
for y in year:
    Y.append(y+month[0])
Y = np.array(Y)
fig = plt.figure(figsize=(16,9))
ax = fig.add_subplot(1,1,1)
plt.plot(time[0:-1], pm_mon)
plt.xlabel('time')
plt.ylabel('PM2.5 level')
plt.grid()
ax.set_xticks(Y)
plt.title('Air Quality Trend of Beijing',size=24)
```

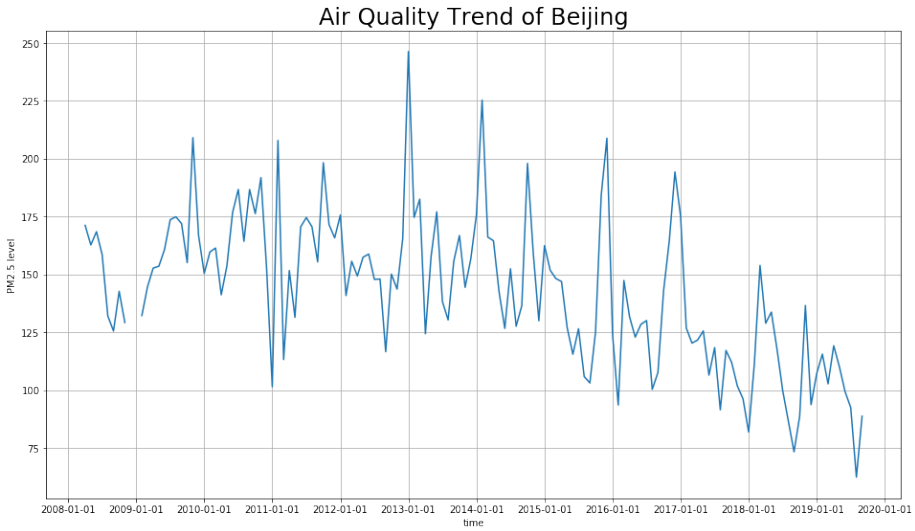


Figure 4: We can see that in 2013, the PM2.5 level is the highest. Since 2013, the air quality is getting better. The autumn and winter is coming so the air quality is getting worse. We should be aware of the dust.