Data analysis in Astronomy {-}

Homework 1 {-}

Due Oct 11 11:59 pm

- Please submit your homework through NTU cool
- Please write your answers in English

Note: for this homework, please do not discuss it with your friends and classmates. Consider that you are the only person who has the dataset and wants to explore it. We will discuss it next week.

Answer these questions in the jupyter notebook and output as a pdf file which includes the code you wrote.

1. (Data exploration) Use the tools (SDSS navigate tools / topcats / Python) discussed in the lecture to explore this dataset (https://www.dropbox.com/s/xakm1krrpqrll8w/a_catalog_with_50_objects.fits?dl=0) and answer the following questions. Please describe what you observe and find and offer plots and evidence when needed: {-}

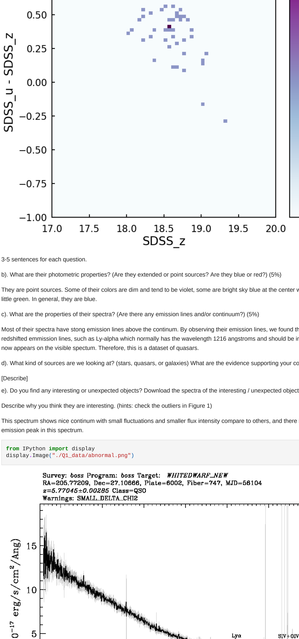
(45%)

a). Make a color-magnitude plot with y-axis (SDSS_u-SDSS_z) and x-axis (SDSS_z). (10%)

In [ ]:
```
### Write your code here
import numpy as np
import matplotlib.pyplot as plt
import astropy.io.fits as pf

def my_plot_style():

    params = {'legend.fontsize': 20,
              'axes.labelsize': 20,
              'axes.titlesize':20,
              'xtick.labelsize':16,
              'ytick.labelsize':16,
              'xtick.major.size':5,
              'xtick.minor.size':2.5,
              'ytick.major.size':5,
              'ytick.minor.size':2.5,
              'figure.facecolor':'w',
              #'lines.linewidth' : 1.5,
               'xtick.major.width':1.5,
               'ytick.major.width':1.5,
               'xtick.minor.width':1.5,
               'ytick.minor.width':1.5,
               'xtick.major.pad': 12,
               'ytick.major.pad': 8,
               'axes.linewidth':1.5,
               'xtick.direction':'in',
               'ytick.direction':'in',
               'ytick.labelleft':True,
               'text.usetex' : False,
               'font.family' : 'sans-serif'}

    plt.rcParams.update(params)

data = pf.open('a_catalog_with_50_objects.fits')
catalog = data[1].data
SDSS_u = catalog['SDSS_u']
SDSS_z = catalog['SDSS_z']
UmZ = np.subtract(SDSS_u, SDSS_z)

my_plot_style()

plt.figure(figsize = (8, 8))
plt.hist2d(SDSS_z, UmZ, bins=[60, 80], range=[[17, 20], [-1, 1]], cmap=plt.cm.BuPu)
plt.colorbar()
plt.xlabel('SDSS_z')
plt.ylabel('SDSS_u - SDSS_z')
plt.subplots_adjust(bottom = 0.1, top = 0.9, left = 0.15, right = 0.98)
plt.show()
```

In [2]:
```
from IPython import display
display.Image("./Q1_data/figure_1.png")
```

Out[2]:



3-5 sentences for each question.

b). What are their photometric properties? (Are they extended or point sources? Are they blue or red?) (5%)

They are point sources. Some of their colors are dim and tend to be violet, some are bright sky blue at the center with their outer part a little green. In general, they are blue.

c). What are the properties of their spectra? (Are there any emission lines and/or continuum?) (5%)

Most of their spectra have stong emission lines above the continum. By observing their emission lines, we found that some stars have redshifted emission lines, such as Ly-alpha which normally has the wavelength 1216 angstroms and should be in ultraviolet region, but now appears on the visible spectrum. Therefore, this is a dataset of guasars.

d). What kind of sources are we looking at? (stars, quasars, or galaxies) What are the evidence supporting your conclusion? (10%)

[Describe]

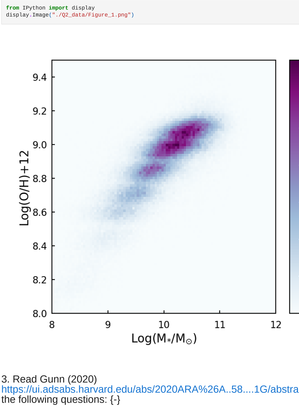
e). Do you find any interesting or unexpected objects? Download the spectra of the interesting / unexpected objects and plot it. (15%)

Describe why you think they are interesting. (hints: check the outliers in Figure 1)

This spectrum shows nice continum with small fluctuations and smaller flux intensity compare to others, and there is no significant emission peak in this spectrum.

In [3]:
```
from IPython import display
display.Image("./Q1_data/abnormal.png")
```

Out[3]:



In [ ]:
```
### Write your code here
```

2. (Visualization) Use Python to plot (this dataset https://www.dropbox.com/s/ev10vdr6tjb955s/Simple_mass_metallicity_210927.fits?dl=0) mass (mass) in x-axis and metallicity (OH) in y-axis. The xscale should be [8.12] and the yscale should be around [8, 9.5]. Do your best to make it clean and informative. {-}

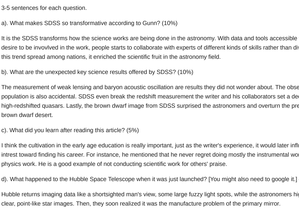
Add your plot here.

(25%)

In [ ]:
```
### Write your code here
import numpy as np
import matplotlib.pyplot as plt
import astropy.io.fits as pf

def my_plot_style():

    params = {'legend.fontsize': 20,
              'axes.labelsize': 20,
              'axes.titlesize':20,
              'xtick.labelsize':16,
              'ytick.labelsize':16,
              'xtick.major.size':5,
              'xtick.minor.size':2.5,
              'ytick.major.size':5,
              'ytick.minor.size':2.5,
              'figure.facecolor':'w',
              #'lines.linewidth' : 1.5,
               'xtick.major.width':1.5,
               'ytick.major.width':1.5,
               'xtick.minor.width':1.5,
               'ytick.minor.width':1.5,
               'xtick.major.pad': 12,
               'ytick.major.pad': 8,
               'axes.linewidth':1.5,
               'xtick.direction':'in',
               'ytick.direction':'in',
               'ytick.labelleft':True,
               'text.usetex' : False,
               'font.family' : 'sans-serif'}

    plt.rcParams.update(params)

data = pf.open('Simple_mass_metallicity_210927.fits')
catalog = data[1].data

my_plot_style()

plt.figure(figsize = (8, 8))
plt.hist2d(catalog['mass'], catalog['OH'], bins = [100, 100], range = [[8, 12], [8, 9.5]], cmap = plt.cm.BuPu)
#plt.colorbar()
cbar = plt.colorbar()
cbar.ax.get_yaxis().labelpad = 18
cbar.ax.tick_params(labelsize=15)
cbar.ax.set_ylabel('counts', rotation=270)
plt.xlabel(r'$\log(M_{\*}/M_{\odot})$')
plt.ylabel('log(O/H)+12')
plt.subplots_adjust(bottom = 0.15, top = 0.9, left = 0.15, right = 0.98)
plt.show()
```

In [11]:
```
from IPython import display
display.Image("./Q2_data/Figure_1.png")
```

Out[11]:



3. Read Gunn (2020) https://ui.adsabs.harvard.edu/abs/2020ARA%26A..58....1G/abstract and answer the following questions: {-}

Please describe with your own words. (Note that direct copy and paste from the article is plagiarism.) {-}

(30%)

3-5 sentences for each question.

a). What makes SDSS so transformative according to Gunn? (10%)

It is the SDSS transforms how the science works are being done in the astronomy. With data and tools accessible to more people who desire to be involved in the work, people starts to collaborate with experts of different kinds of skills rather than diving hard individually. As this trend spread among nations, it enriched the scientific fruit in the astronomy field.

b). What are the unexpected key science results offered by SDSS? (10%)

The measurement of weak lensing and baryon acoustic oscillation are results they did not wonder about. The observation of asteroids population is accidental. SDSS even break the redshift measurement the writer and his collaborators set a decade ago, finding the high-redshifted quasars. Lastly, the brown dwarf image from SDSS surprised the astronomers and overturn the previous saying about brown dwarf desert.

c). What did you learn after reading this article? (5%)

I think the cultivation in the early age education is really important, just as the writer's experience, it would later influence his attitude and intrest toward finding his career. For instance, he mentioned that he never regret doing mostly the instrumental work of SDSS rather than physics work. He is a good example of not conducting scientific work for others' praise.

d). What happened to the Hubble Space Telescope when it was just launched? (You might also need to google it.) (5%)

Hubble returns imaging data like a shortsighted man's view, some large fuzzy light spots, while the astronomers highly expected some clear, point-like star images. Then, they soon realized it was the manufacture problem of the primary mirror.

In [ ]:
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