ESA614: Computational Astrophysics
Assignment # 2

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Program: MS Astronomy and Astrophysics

Attached file *blazar_S0716.dat* contains the photometric observations of a blazar S50716+714.‡

Choose finely sampled block of data in timescale of a few hours around 5th Jan 2016 and 29th Jan 2016. Interpolate the magnitude vs time data ~~with both Lagrange and~~§ Cubic Spline (use *scipy.interpolate* for spline) interpolation.

~~Choose the more appropriate interpolation method out of these two,~~ interpolate V, R, and I light curves. Obtain *V*-R and *R*-*I* colors.

(i) Separately plot *V*-*R* and *R*-*I* colors vs R magnitude and see (visually) if there is correlation between color variation and flaring.
(ii) Plot a color-color diagram (*V*-*R* vs *R*-*I*) of the blazar.

Python Code:

```
from astropy.io import ascii
from astropy.table import Table
import matplotlib.pyplot as plt
from scipy import interpolate
import numpy as np


#plt.style.use('seaborn-bright')
plt.style.use('default')
fig = plt.figure(figsize = (20,10))

data =
ascii.read("https://raw.githubusercontent.com/abrahammathews2000/Dataset_for_Gcolab/main/LabMockTest1/blazar_S0716.dat",delimiter=' ')
data_order = data[data.argsort('date')] # To order in Ascending order
mask_date_index = (data_order['yr'] == 2016) & (data_order['month'] == 1) & (data_order['day']>=5) &
(data_order['day']<=6)
#mask_date_index = (data_order['yr'] >= 2011) & (data_order['yr'] <= 2018)

data_selected = data_order[mask_date_index]

mask_Rband = (data_selected['band'] == 'R')
mask_Iband = (data_selected['band'] == 'I')
mask_Vband = (data_selected['band'] == 'V')
data_selected_Rband = data_selected[mask_Rband]
data_selected_Iband = data_selected[mask_Iband]
data_selected_Vband = data_selected[mask_Vband]


#Spline Interpolate
```

```
x_min =
min(data_selected_Rband['date'][0],data_selected_Iband['date'][0],data_selected_Vband['date'][0])
x_max =
max(data_selected_Rband['date'][len(data_selected_Rband['date'])-1],data_selected_Iband['date'][len(data
_selected_Iband['date'])-1],data_selected_Vband['date'][len(data_selected_Vband['date'])-1])
x=np.linspace(x_min,x_max,5000)
#Rband
xRband =
np.linspace(data_selected_Rband['date'][0],data_selected_Rband['date'][len(data_selected_Rband['date'])-
1],5000)
rBandSpline = interpolate.CubicSpline(data_selected_Rband['date'],data_selected_Rband['mag'])
plt.plot(xRband,rBandSpline(xRband),label = 'Spline for R Band')
#Iband
xIband =
np.linspace(data_selected_Iband['date'][0],data_selected_Iband['date'][len(data_selected_Iband['date'])-1],
5000)
iBandSpline = interpolate.CubicSpline(data_selected_Iband['date'],data_selected_Iband['mag'])
plt.plot(xIband,iBandSpline(xIband),label = 'Spline for I Band')
#Vband
xVband =
np.linspace(data_selected_Vband['date'][0],data_selected_Vband['date'][len(data_selected_Vband['date'])-
1],5000)
vBandSpline = interpolate.CubicSpline(data_selected_Vband['date'],data_selected_Vband['mag'])
plt.plot(xVband,vBandSpline(xVband),label = 'Spline for V Band')

plt.scatter(data_selected_Rband['date'],data_selected_Rband['mag'],color='black',edgecolors =
'blue',label="R band (Data Points)",marker = 'o')
plt.scatter(data_selected_Iband['date'],data_selected_Iband['mag'],color='black',edgecolors =
'orange',label="I band (Data Points)",marker = 's')
plt.scatter(data_selected_Vband['date'],data_selected_Vband['mag'],color='black',edgecolors =
'green',label="V band (Data Points)",marker = 'v')


plt.legend(bbox_to_anchor = (1.05, 0.6))
plt.xlabel("Julian Date")
plt.ylabel("Magnitude (mag)")
plt.grid()


plt.show()

# i)
# To plot V-R vs R magnitude
fig = plt.figure(figsize = (20,10))
plt.scatter((vBandSpline(data_selected_Rband['date'])-data_selected_Rband['mag']),data_selected_Rband['
mag'],label = 'V-R vs R',marker ='o',edgecolors = 'black')
plt.title('V-R vs R')
plt.legend()
plt.xlabel("R (mag)")
plt.ylabel("V-R (mag)")
plt.grid()
plt.show()

# i)
# To plot R-I vs R magnitude
fig = plt.figure(figsize = (20,10))
```

```
plt.scatter((data_selected_Rband['mag']-iBandSpline(data_selected_Rband['date'])),data_selected_Rband['
mag'],label = 'R-I vs R',marker ='o',edgecolors = 'black')
plt.title('R-I vs R')
plt.legend()
plt.xlabel("R (mag)")
plt.ylabel("R-I (mag)")
plt.grid()
plt.show()

# ii)
# To plot V-R vs R-I magnitude
fig = plt.figure(figsize = (20,10))
plt.scatter((vBandSpline(data_selected_Rband['date'])-data_selected_Rband['mag']),(data_selected_Rband['
mag']-iBandSpline(data_selected_Rband['date'])),label = 'V-R vs R-I',marker ='o',edgecolors = 'black')
plt.legend()
plt.title('V-R vs R-I')
plt.xlabel("R-I (mag)")
plt.ylabel("V-R (mag)")
plt.grid()
plt.show()
```

Outputs:

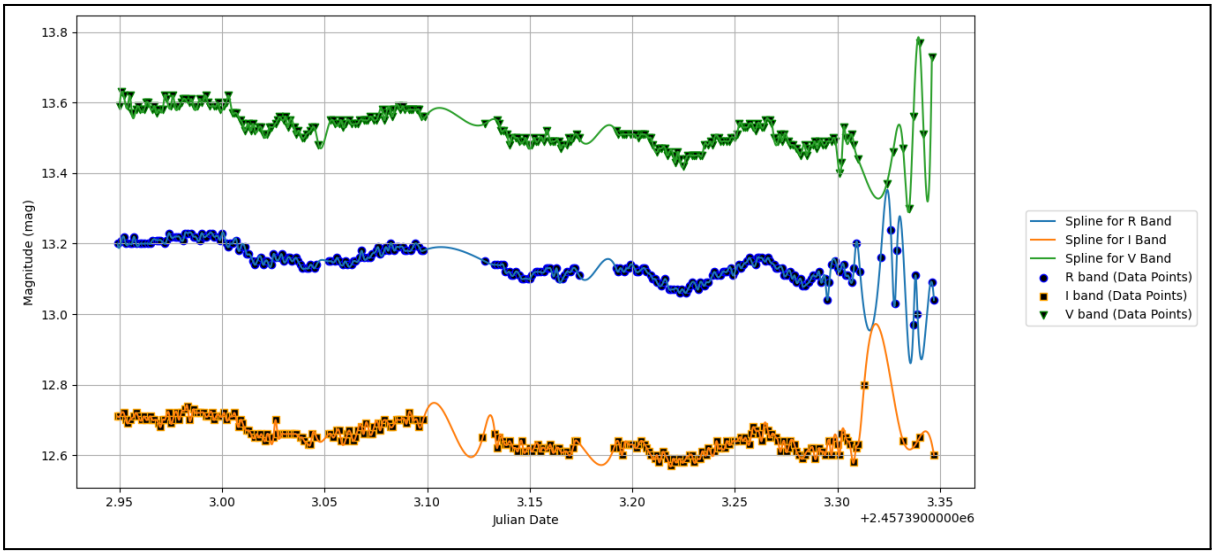

Fig 1: Spline interpolation for each of the band

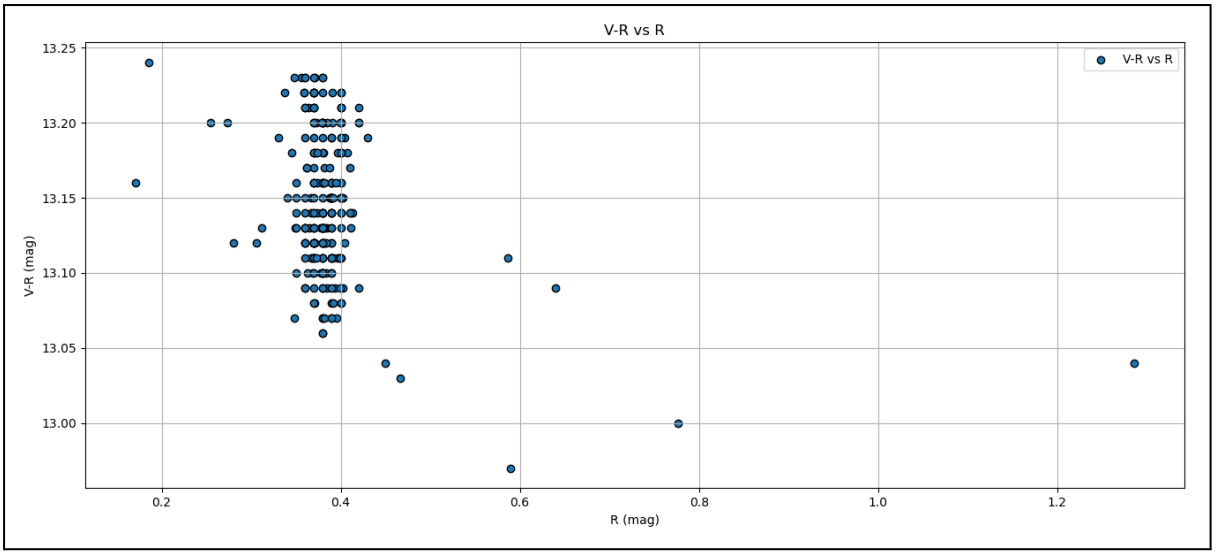

Fig 2: V-R vs R magnitude Plot

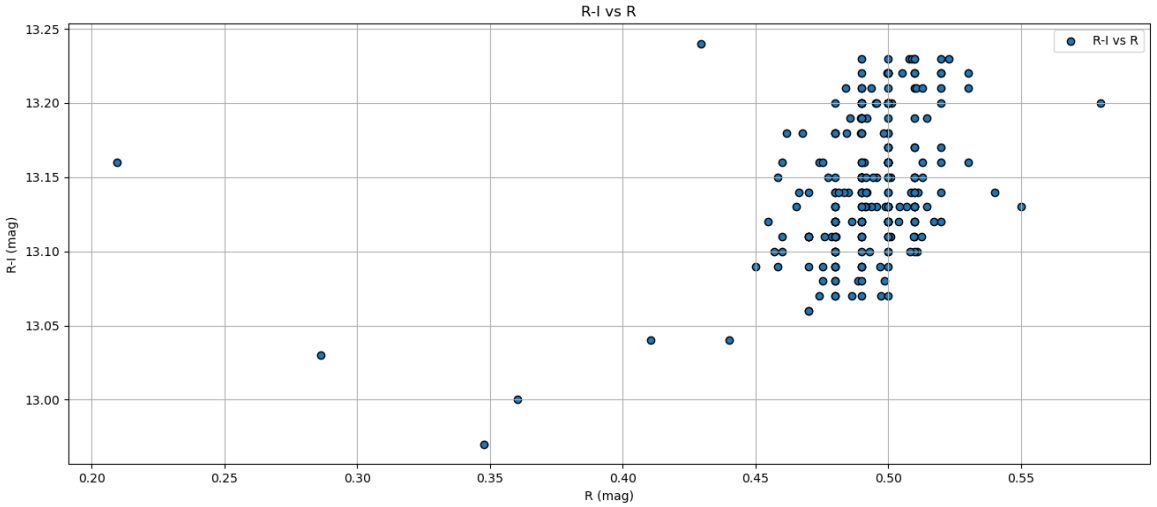

Fig 3: R-I vs R magnitude Plot

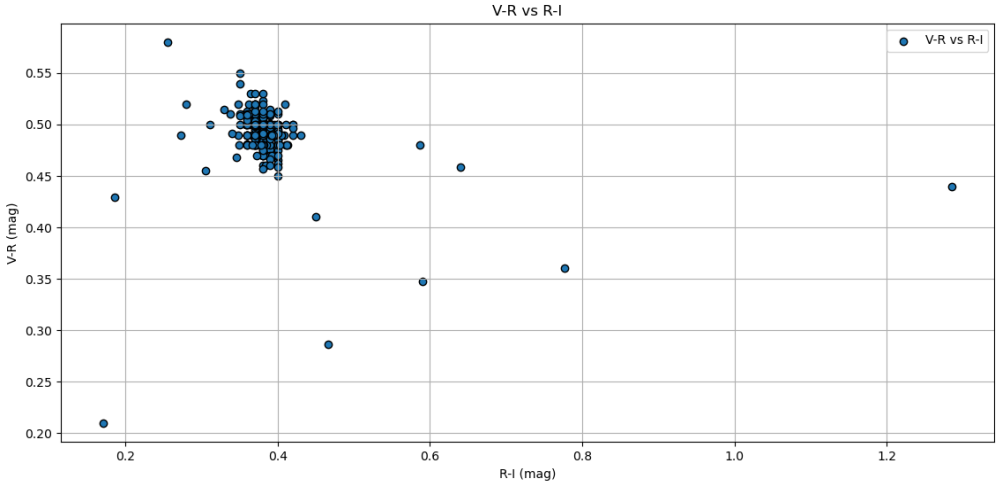

Fig 4: V-R vs R-I magnitude Plot