Plotting, Normalizing, Fitting Continuum through a Spectrum using SDSS data

R. Virinchi I20PH008
NIT Surat

December 2022

1 Introduction

Astronomical spectra are records of the distribution of light intensity as a function of wavelength or frequency emitted, absorbed, or scattered by celestial objects. Essentially, they break down the light from these objects into its constituent colors, much like a prism dispersing sunlight into a rainbow. The resulting spectra provide a unique fingerprint for each astronomical object, revealing the specific wavelengths at which it emits or absorbs light.

There are two main types of astronomical spectra: emission spectra and absorption spectra. Emission spectra arise when an object emits light, and they appear as bright lines or bands at specific wavelengths. Absorption spectra, on the other hand, occur when an object absorbs certain wavelengths from a continuous spectrum, leaving dark lines or bands in the observed spectrum. These distinctive features, often referred to as spectral lines, are crucial for identifying the chemical elements present in a celestial object.

Astronomers use various instruments, such as spectrographs, to capture and analyze these spectra. By studying the patterns and characteristics of spectral lines, astronomers can determine the composition, temperature, density, velocity, and other physical properties of celestial objects, offering profound insights into the nature and evolution of the universe. In summary, astronomical spectra are a key tool that allows scientists to unravel the secrets of the cosmos by examining the light emitted or absorbed by celestial bodies.

2 Python for analysing astronomical spectra

2.1 Downloading and Reading the data

```
# import required libraries
from astroquery.sdss import SDSS
from astropy.table import Table
import matplotlib.pyplot as plt
```

```
from specutils.fitting import fit_generic_continuum
from specutils import Spectrum1D
from astropy import units as u
from astropy.visualization import quantity_support
quantity_support()

# read the table from disk
table_0=Table.read(f'D:\\pythonenvi\\src\\res_tables\\object_9.fits')

# get the spectra for objects in the table
spec_0=SDSS.get_spectra(matches=table_0)

# extract wavelength and spectra
flux=spec_0[0][1].data['flux']*10**-17*u.Unit('erg cm-2 s-2 AA-1')
wave=10**spec_0[0][1].data['loglam']*u.AA
```

2.2 Plotting the extracted data

```
# convert into spectrum1d object for fitting continuum
spec_obj=Spectrum1D(spectral_axis=wave, flux=flux)

# fit continuum through spectra
s_fit = fit_generic_continuum(spec_obj)
y_fit = s_fit(wave)

# plot spectra and its continuum
plt.figure()
plt.plot(wave,flux)
plt.plot(wave,y_fit, c='r')
plt.show()
```

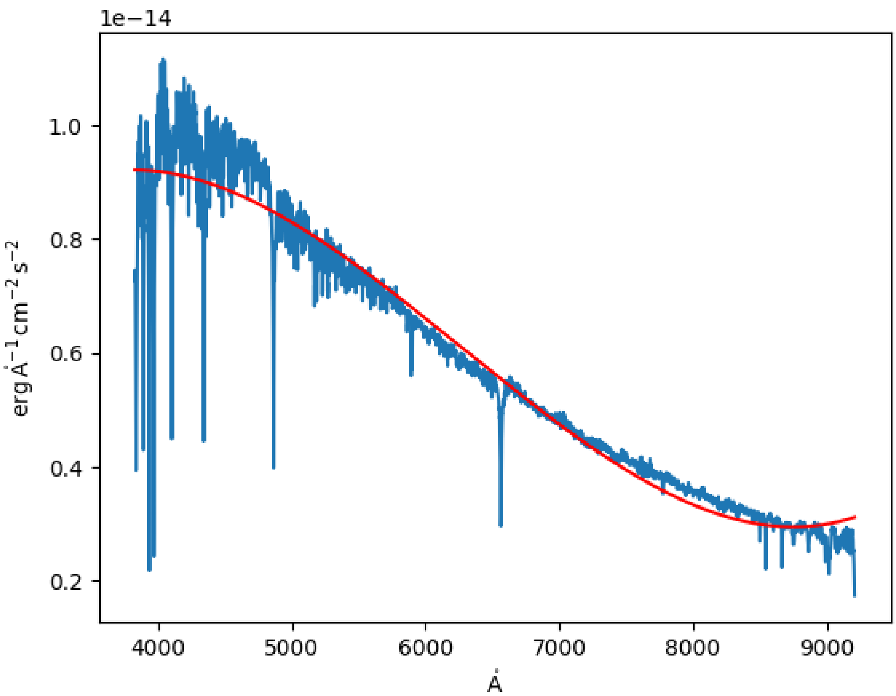

Figure 1: Spectrum and its continuum

2.3 Normalizing spectrum

```
# calculate and plot normalised spectrum
norm=spec_obj/y_fit
plt.plot(norm.spectral_axis,norm.flux*u.Unit('erg cm-
2 s-2 AA-1'))
plt.title('normalised spectrum')
```

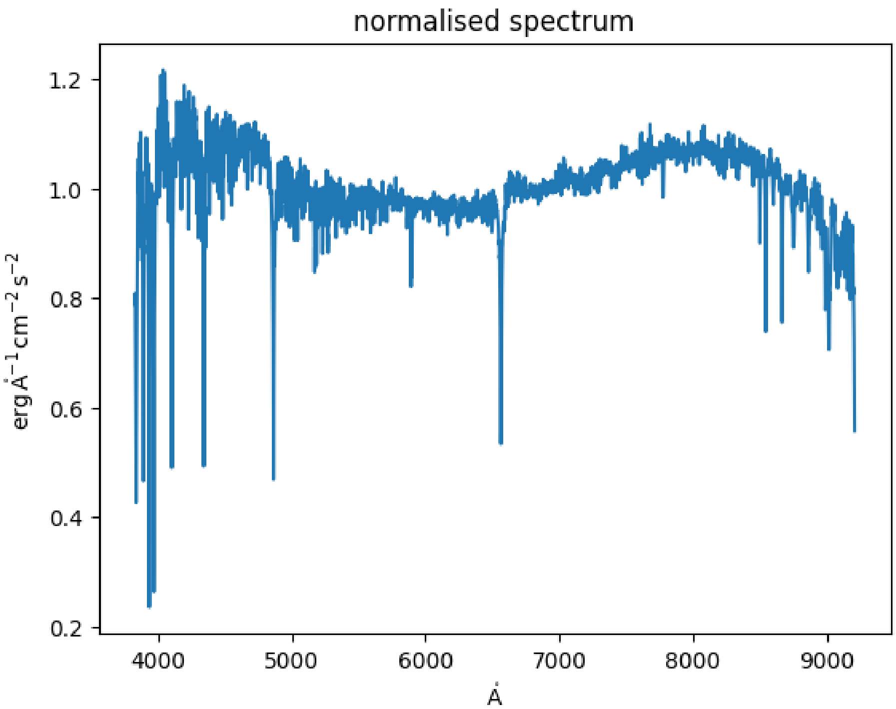

Figure 2: Normalized Spectrum

3 Conclusion

Python has become a prominent programming language in the field of astronomical spectra analysis due to its versatility, extensive libraries, and user-friendly syntax. Astronomers use Python to develop sophisticated data processing and analysis pipelines, making tasks such as spectral calibration, extraction, and manipulation more efficient. Libraries like NumPy and SciPy provide essential tools for mathematical operations and statistical analyses, while Astropy offers a comprehensive framework for handling astronomical data, including spectral data. Additionally, Matplotlib and Seaborn enable the visualization of spectra, aiding researchers in interpreting and presenting their findings. The flexibility of Python allows astronomers to integrate various algorithms and techniques seamlessly, making it a preferred choice for both novices and experts in the field of astronomical spectroscopy. Its open-source nature and active community support further contribute to its widespread adoption, facilitating collaborative efforts and the advancement of spectral analysis techniques in astronomy.