
Python Decal
Final Project
By Xinze Guo, Angela Beatty, David Pham, Alexey Krivega

Objective:

Utilize data from Berkeley SETI's Automated Planet Finder to plot a 2D spectrum of Tabby's Star/extract 1D spectrum to find H-alpha line and radial velocity

Utilize data from ESO’s Library of Stellar Spectra to plot 1D spectrum from OBAFGKM stars and compare results

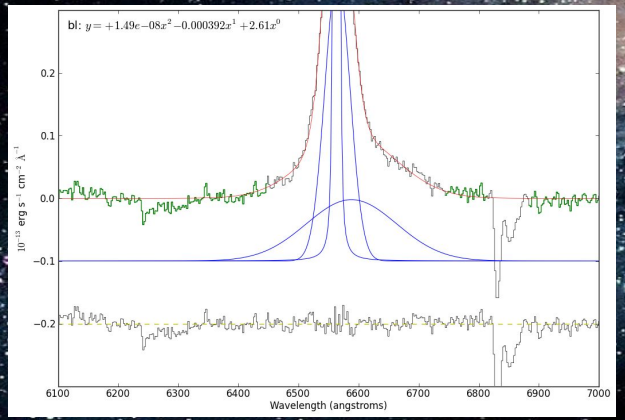
Background Information

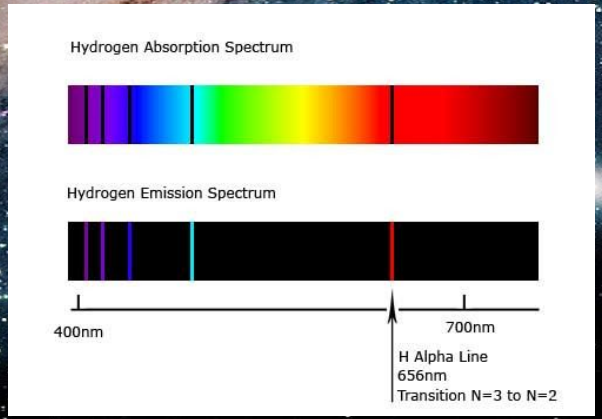
Tabby's Star

- Also known as Boyajian's star and/or KIC 8462852
- F-type main sequence star (yellow-white dwarf star) located 1,280 light years away
- Kepler telescope revealed randomized dimming patterns (up to 22 percent)
- Theories range from alien megastructures to decaying exomoon

H-alpha Diagram

- H-alpha spectral line is light emitted from hydrogen atoms (visible as red in electromagnetic spectrum)
- On a 1D spectrum, the H-alpha line has a theoretical wavelength of 6563 Angstroms
- Regions that display H-alpha emission indicate that hydrogen is being ionized there
- Finding the experimental H-alpha wavelength will tell you the star's relative motion via doppler shift

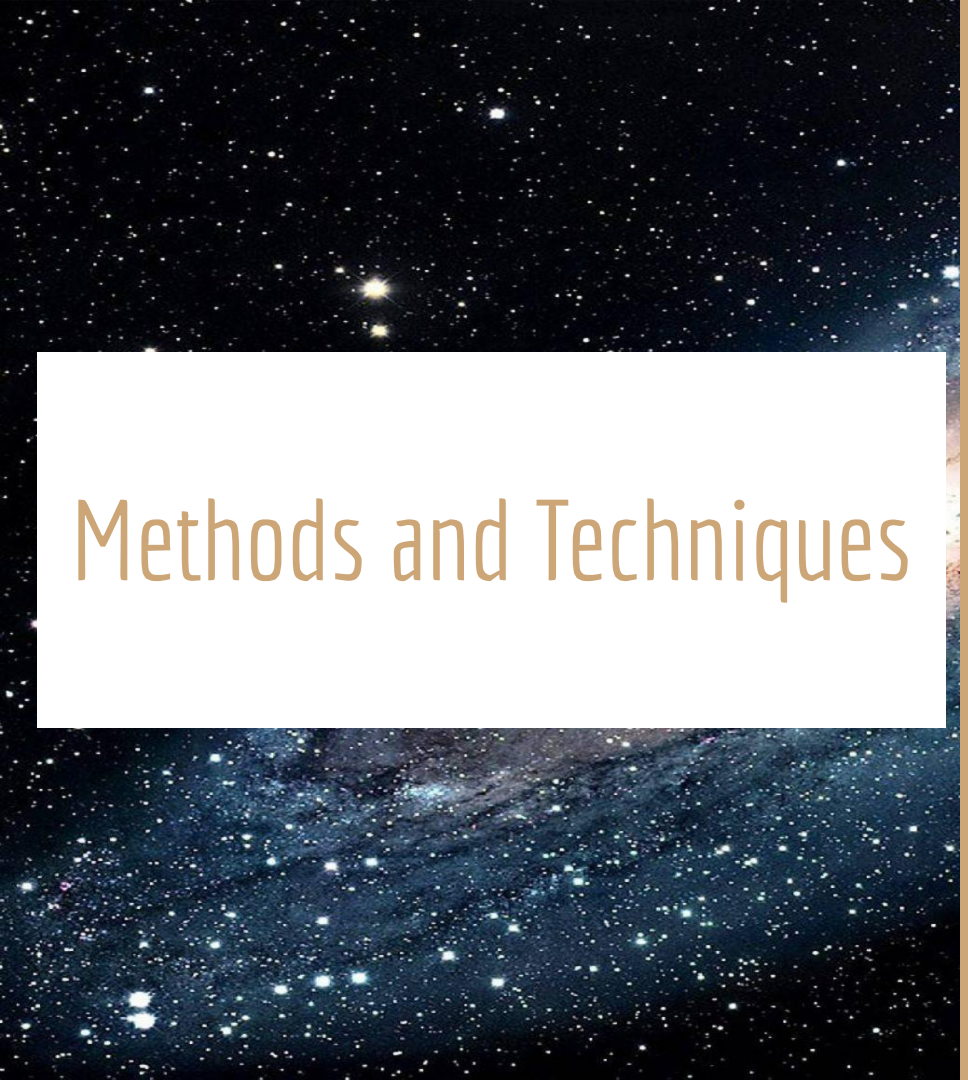




OBAFGKM stars

- The main types of star are divided into a number of classes depending on their spectra and temperature.
- Oh, Be A Fine Girl/Guy, Kiss Me

Class	Spectrum	Colour	Temperature
O	ionized and neutral helium, weakened hydrogen	bluish	above 31,000 K
B	neutral helium, stronger hydrogen	blue-white	9750-31,000 K
A	strong hydrogen, ionized metals	white	7100-9750 K
F	weaker hydrogen, ionized metals	yellowish white	5950-7100 K
G	still weaker hydrogen, ionized and neutral metals	yellowish	5250-5950 K
K	weak hydrogen, neutral metals	orange	3800-5250 K
M	little or no hydrogen, neutral metals, molecules	reddish	2200-3800 K

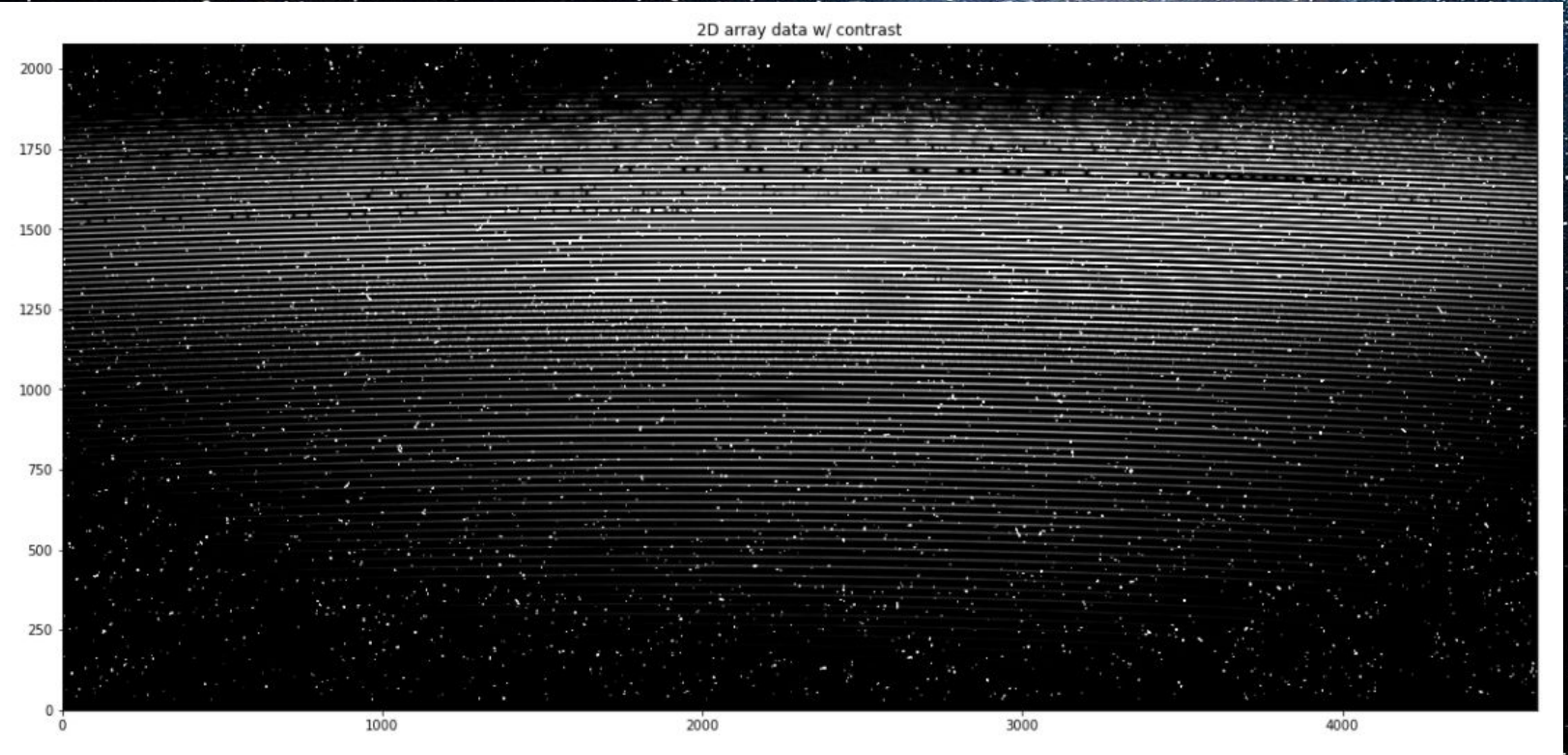


Methods and Techniques

- Used MatPlotLib and NumPy libraries to display visual image of APF sample data/perform Gaussian fit
- Used AstroPy library to extract fits files

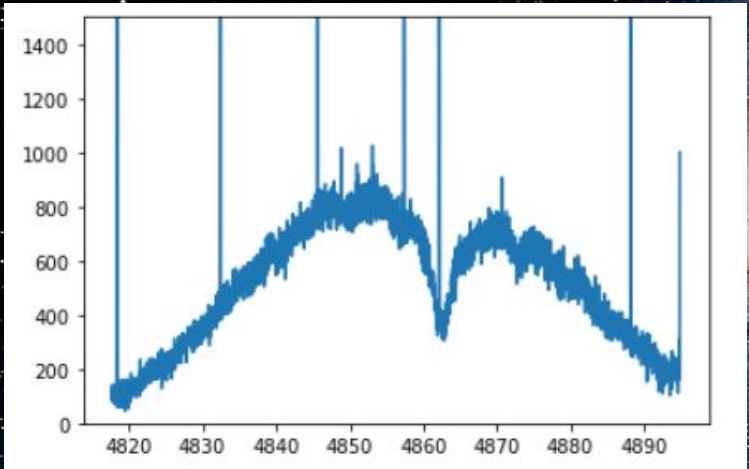
Results and Findings

SETI data results



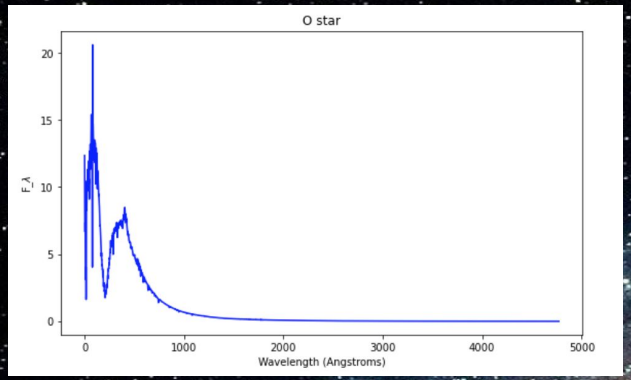
H-Alpha Line and Radial Velocity of Tabby's Star

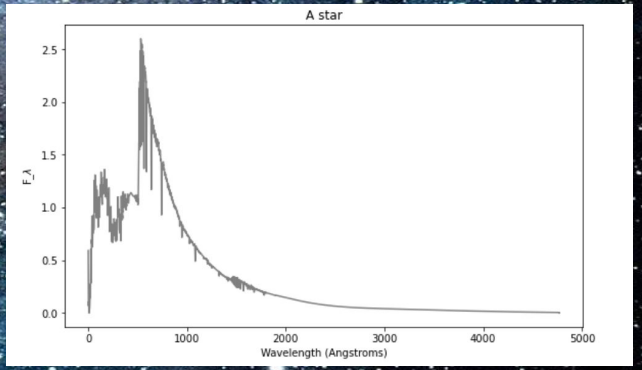
(Speed of light)(Actual H-Alpha Line - Observed H-Alpha Line)/(Actual H-Alpha Line) = Radial Velocity

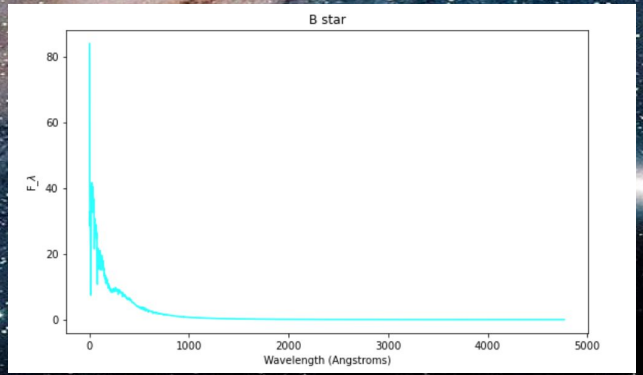


(299,792.458 km/s)(656.3 nm - 486.3 nm)/656.3 nm = 77,708 km/s = Radial Velocity

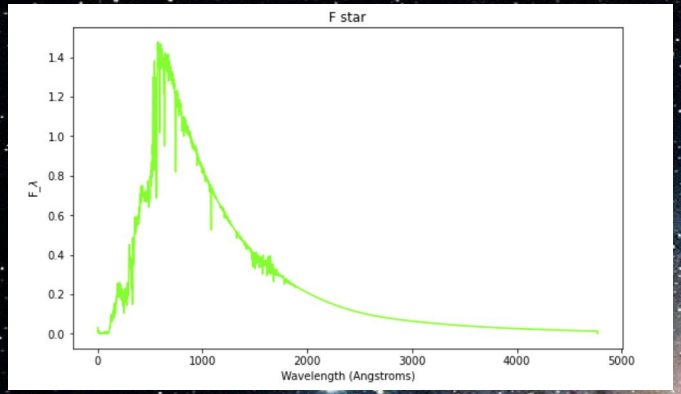
ESO data results

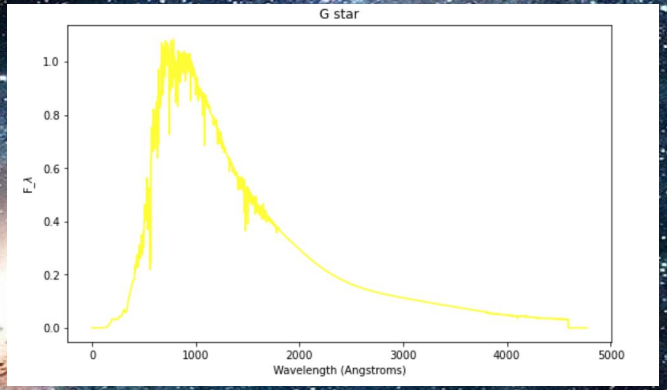


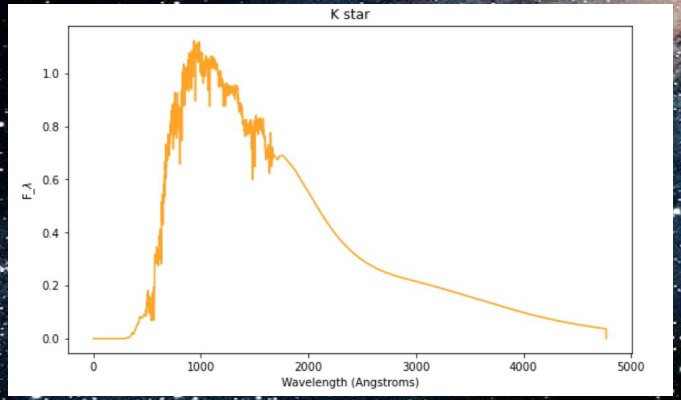


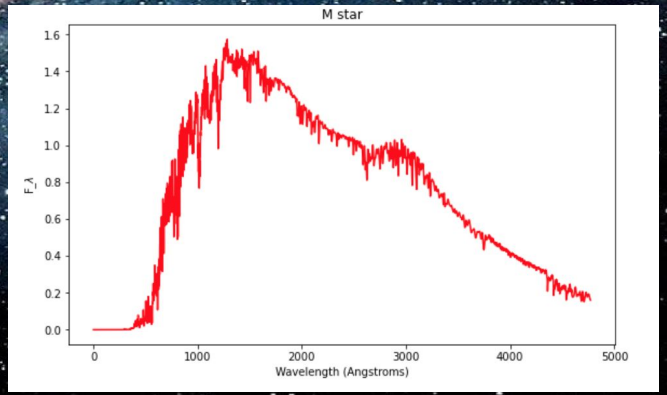


ESO data results (continued)

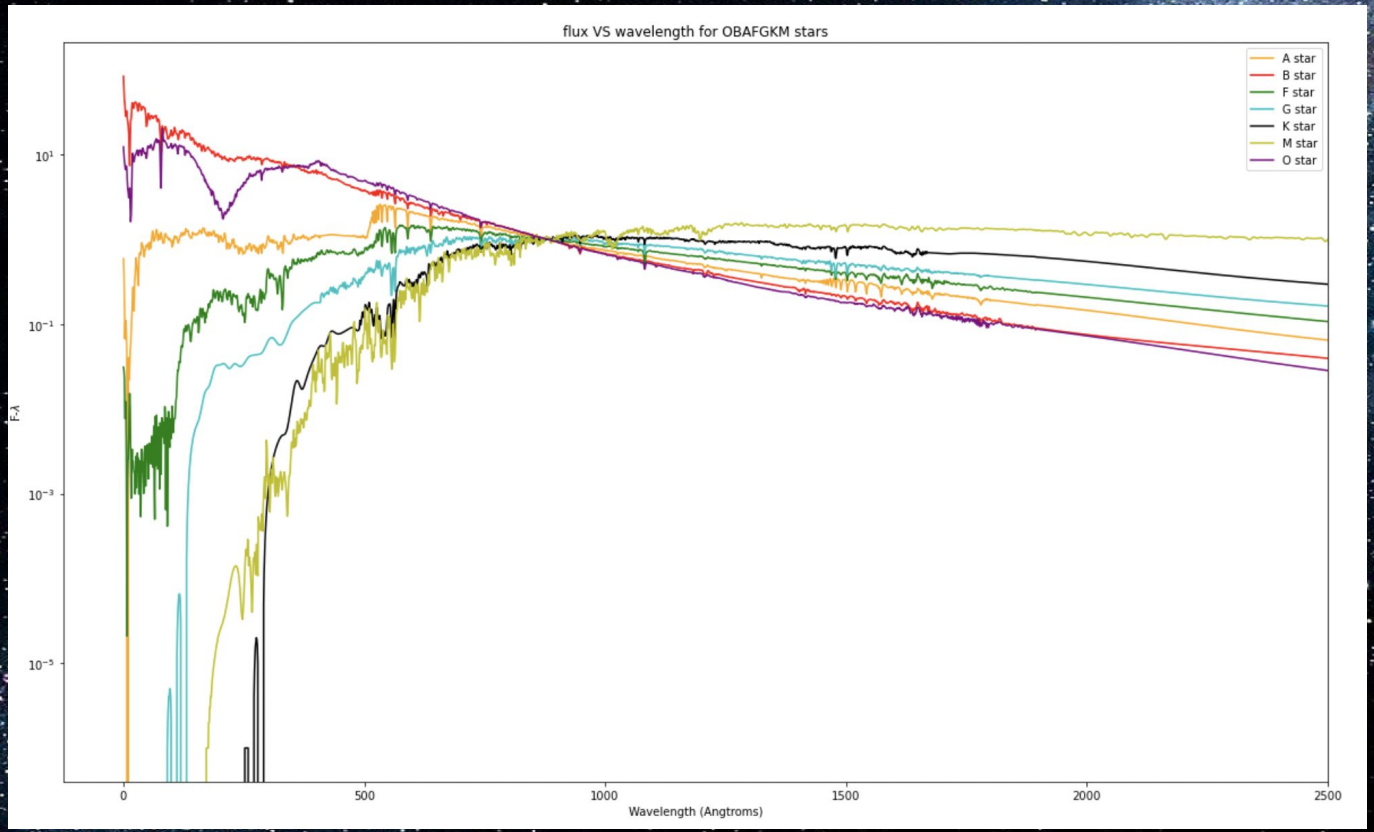








Spectral class comparison



Class	Temperature
O	above 31,000 K
B	9750-31,000 K
A	7100-9750 K
F	5950-7100 K
G	5250-5950 K
K	3800-5250 K
M	2200-3800 K

Conclusion

In summary, we were able to plot the 2D spectrum of Tabby's Star and use this data to extract a 1D plot of the spectrum We also compared Tabby's Star's 1D spectrum to the 1D spectrum of other stars from OBAFGKM classes to compare the temperature and luminosity differences. Also, from the Tabby 1D spectrum, we obtained the experimental h-alpha line, which we used to find the star's radial velocity.
From the 1D spectrum of the ESO data, we can see that brighter stars have peaks at smaller wavelengths. Smaller wavelengths also correspond to hotter stars.

Any Questions?

References

[1] “H-Alpha Emission.” *Landmarks of the ISM*, 8 May 2013, https://ismlandmarks.wordpress.com/h-alpha-emission/.

[2] Mathewson, Samantha. “The Puzzle of 'Tabby's Star': 9 NASA Explanations for Star's Odd Dimming.” *Space.com*, Space, 24 Oct. 2017, https://www.space.com/38536-tabbys-star-mystery-9-nasa-theories.html.

[3] “Open Data.” *Berkeley SETI*, Berkeley SETI, https://seti.berkeley.edu/listen/data.html.

[4] “What Is O B A F G K M?: Classifications, Stand for, Origin & Acroymn.” *The Nine Planets*, 5 Nov. 2019, https://nineplanets.org/questions/what-is-o-b-a-f-g-k-m/.

[5] Venkatesan, Naveen. “Basic Curve Fitting of Scientific Data with Python.” *Towards Data Science*, Medium, 3 Mar. 2021, https://towardsdatascience.com/basic-curve-fitting-of-scientific-data-with-python-9592244a2509.