XUVI

Mid-Term Progress Report

ABOUT THE PROJECT

Spectroscopy

Absorption and emission of light and other radiation by matter

Exoplanets Detection

Computational methods for detection of exoplanets and their characteristic parameters.

Solar Flare Analysis

Detection of solar flares and classification

Project Timeline

01 Solar Flare introduction, Python basics, Jupyter and Git setup

02 EM Waves and Python libraries - Numpy, Pandas and Matplotlib

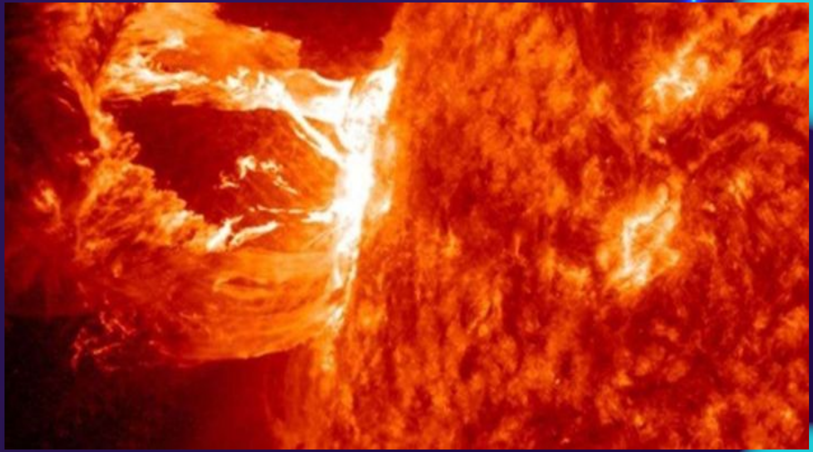
03 Spectroscopy and advance libraries of python like Scipy and Astropy

04 Methods of detecting Exoplanets like Astrometry and Transit Photometry

WEEK 1

PYTHON AND ITS LIBRARIES:

1. Pre-defined Data types
2. Arithmetic operations
3. User defined functions
4. Classes in Python

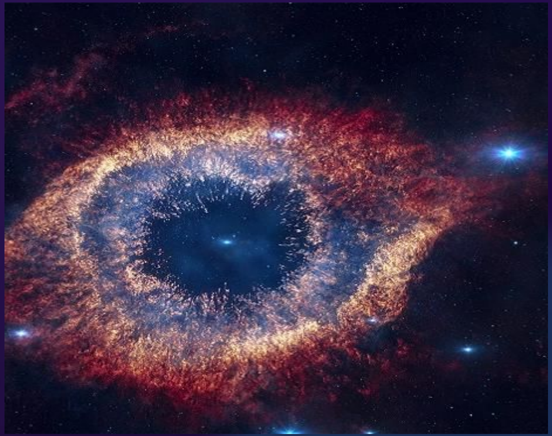


As a part of assignment,
We solved basic questions to practice python.

SOLAR FLARES

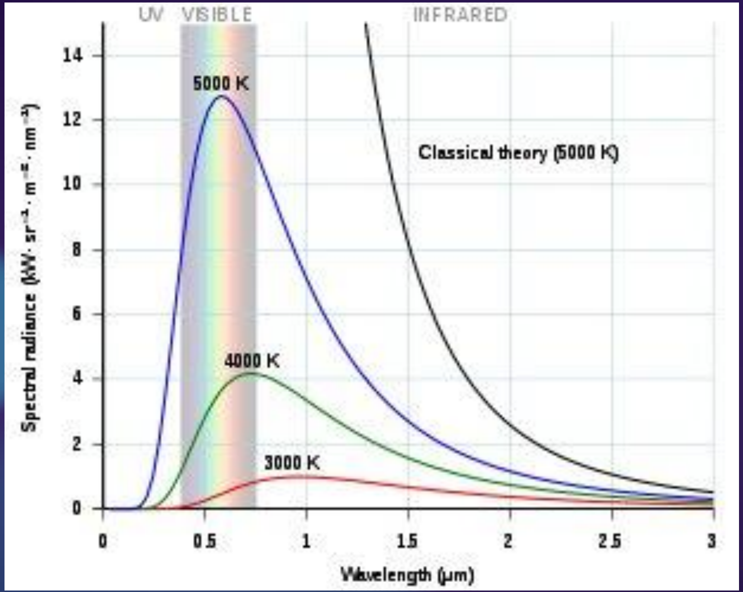
WEEK 2

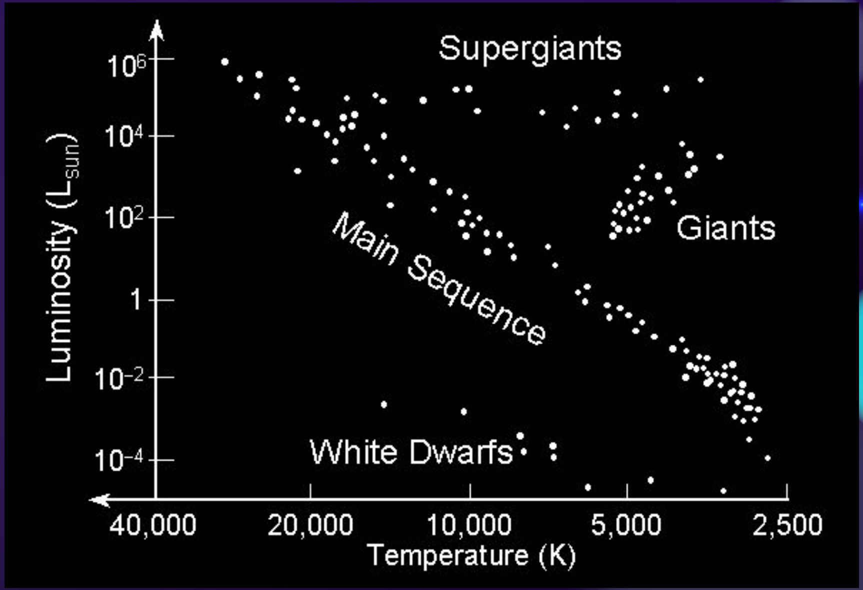
1. Astronomical spectroscopy
2. Nebulae
3. Galaxies
4. Python libraries
   - Numpy
   - Pandas
   - Matplotlib



SPECTROSCOPY

It turns out that just by observing the star, by virtue of physics, we can determine its mass, radius and its constituent elements.





WEEK 3

Exoplanets

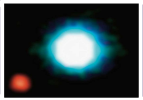
We applied our knowledge in a real-life scientific discernment....

Detection Techniques For Exoplanets

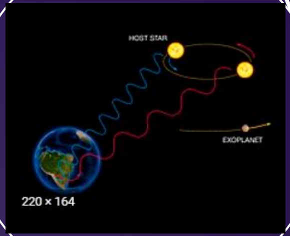
Exoplanets are of recent interest to astronomers and astrophysicists to understand the formation of solar system and possibly find signs of extraterrestrial life. Astronomers, aided by computational methods, have numerous techniques to detect and determine their measurable properties

Techniques To Detect Exoplanets

1. Direct Imaging

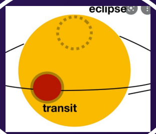


2. Radial Velocity



3. Astrometry

4. Transit Photometry



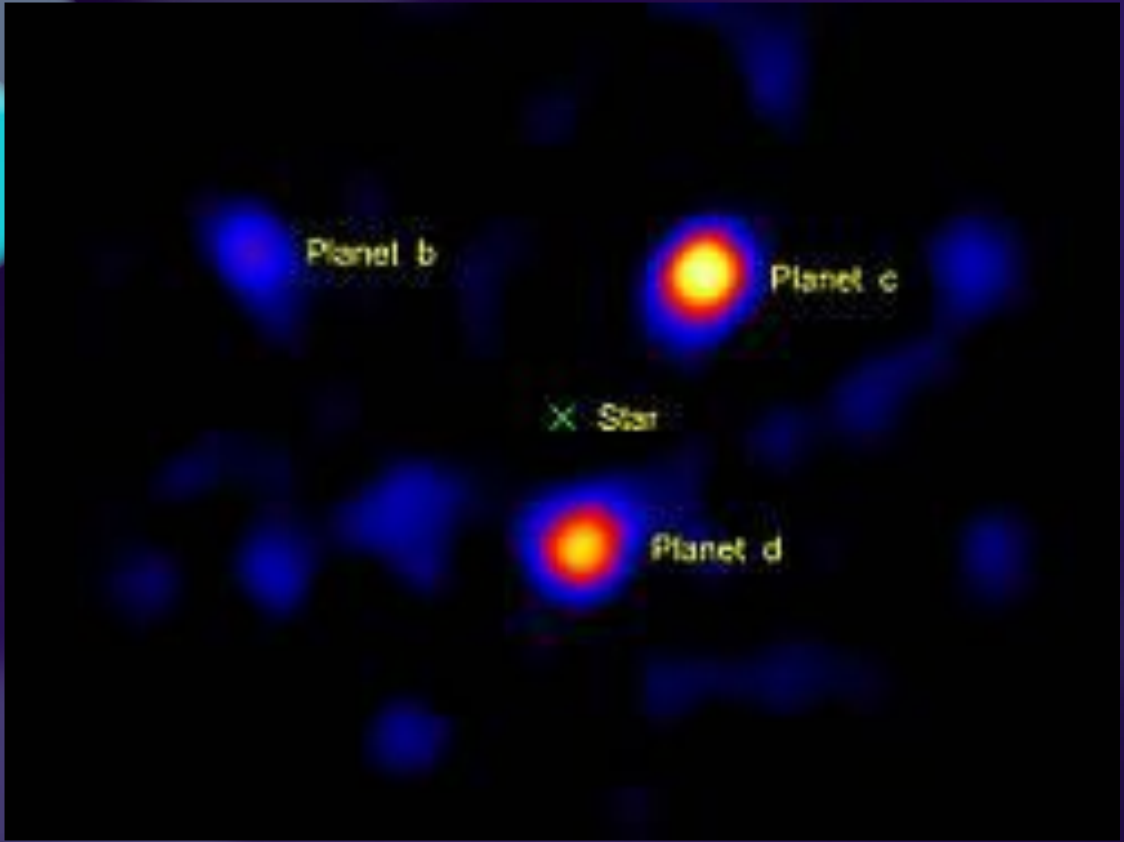
1. DIRECT IMAGING

Best for □

A. Actually seeing an exoplanet
B. Finding exoplanets with large orbits
C. Finding exoplanets that do not transit stars

Not ideal for ✗

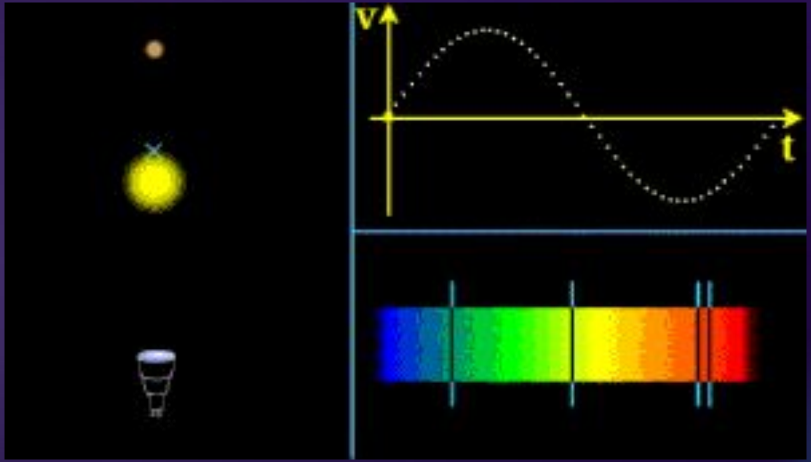
A. Finding faraway exoplanets
B. Finding many exoplanets at once
C. Finding exoplanets around bright stars



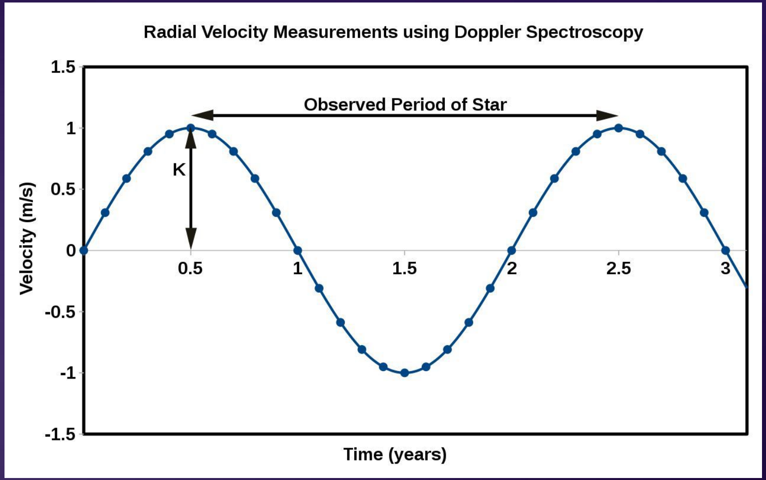
Direct image of exoplanets around the star **HR8799**

2. RADIAL VELOCITY

Planets revolve around the Center of Mass of the star-planet system. If the orbital plane is not normal to us, we can perceive the star's back and forth movement via doppler shift. The shift in the star's light can be measured via advanced spectroscopes, which can then be processed to calculate the effect of the planet's mass on the star.



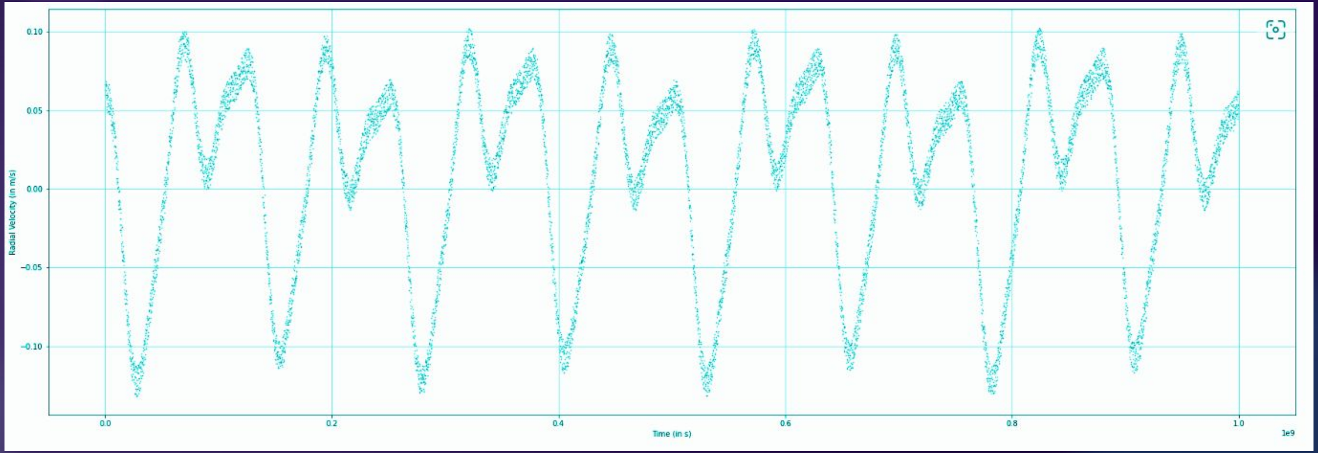
Mass of the planet can be determined from the changes in the star's radial velocity. A graph of measured radial velocity versus time will give a characteristic curve (sine curve in the case of a circular orbit), and the amplitude of the curve will allow the mass of the planet.

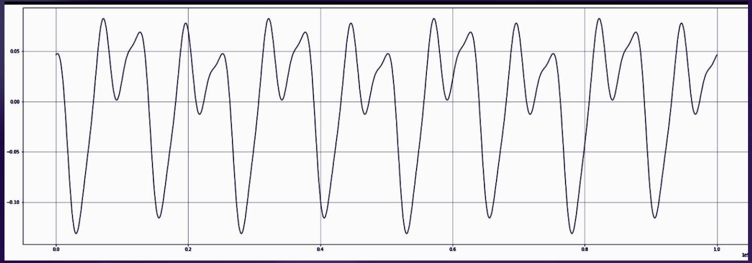


3. ASTROMETRY

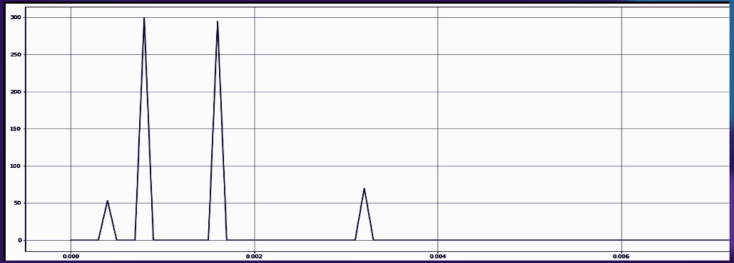
-Only Planets revolve, and Star is stationary. (Wrong)

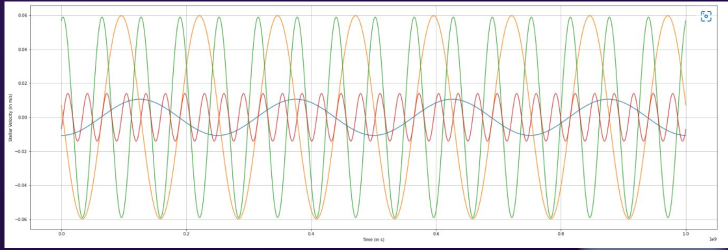
- Both Star and planet revolve around common centre of mass.





Fourier Transform



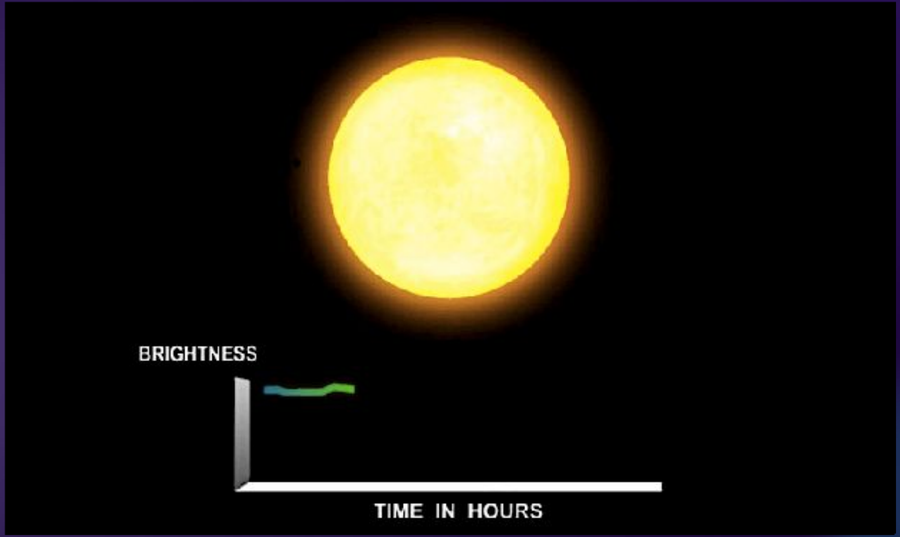


$$\frac{GMm}{(R+r)^2} = m\omega^2 r$$

$$\frac{GM}{R^3\omega^2} = \frac{r}{R}\left(1+\frac{r}{R}\right)^2$$

4. TRANSIT PHOTOMETRY

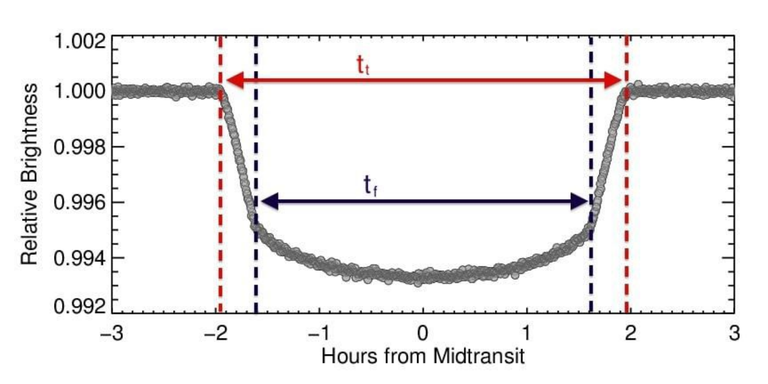
We can detect exoplanets using the dip in the star's relative brightness as perceived to us, when the exoplanet passes in front of the star. For this to happen, the planet must be orbiting within the Field of View of the telescope.



Calculating the Dip

The dip in the graph is a function of ratio of radius of planet to the ratio of radius of star (since luminosity is a function of area).

$$\text{Depth} = \left(\frac{R_p}{R_\star}\right)^2$$



Each planet is unique
Every one hundred billion+
of them
-NASA

THANKS!

"COSMOS IS WITHIN US!"