XUVI

End Term Project Report

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Timeline

01 Python

Panda, Numpy, Scipy, Astropy & Matplotlib

02 Spectroscopy

Astronomical Spectroscopy

03 Exoplanets

Detection Techniques & Analysis

04 Solar Flares

Detection & Curve Fitting

05 Conclusion

Contribution to Pypi

Our Approach

Learning Through Examples & Implementing via Applications.

All the Data used in XUVI are picked Directly from Open Source Datasets provided by International Missions.

01 PYTHON

The Major Tool for Astronomical Data Analysis

Python Libraries

NumPy

- Arrays
- Fourier Transform
- Convolution

Matplotlib

- Plotting
- Gives qualitative idea

Pandas

- Data Reading & Analysis
- Converts files like csv, excel sheets to data frame.

Scipy

- Curve fitting
- Interpolation

Astropy

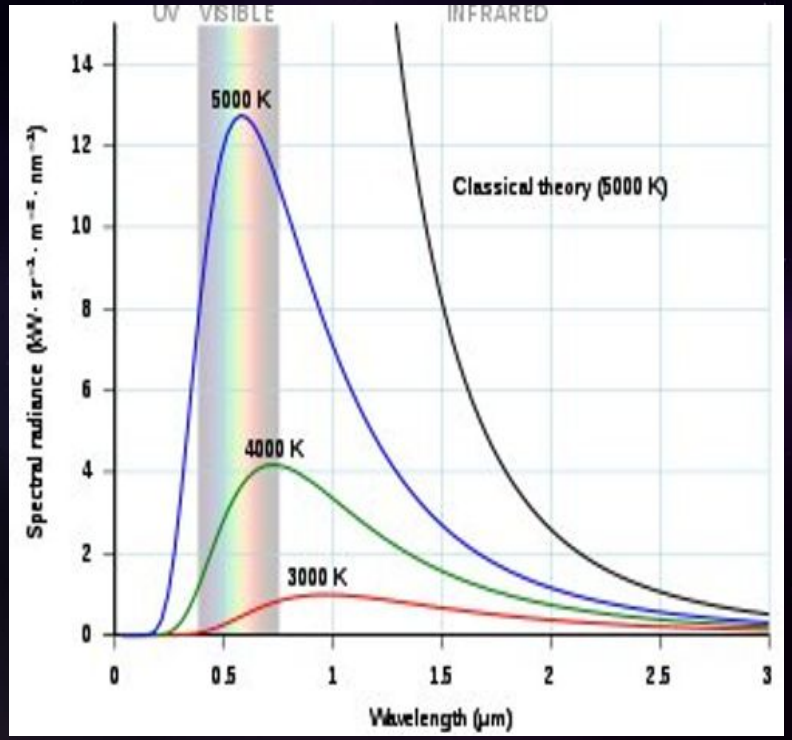
- FITS File Handling
- Linear Regression

02 SPECTROSCOPY

It turns out that just by looking at the star we can determine its mass, radius & its constituent elements.

Spectroscopy

What is Spectroscopy?



V
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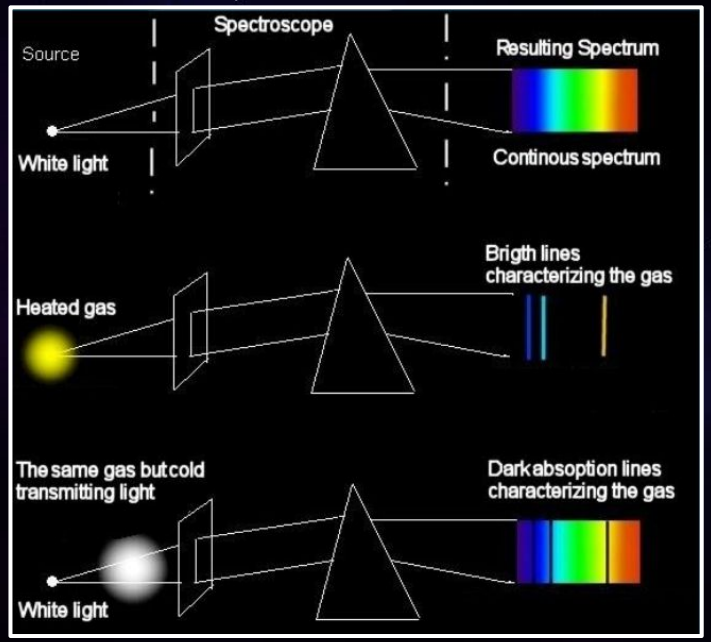
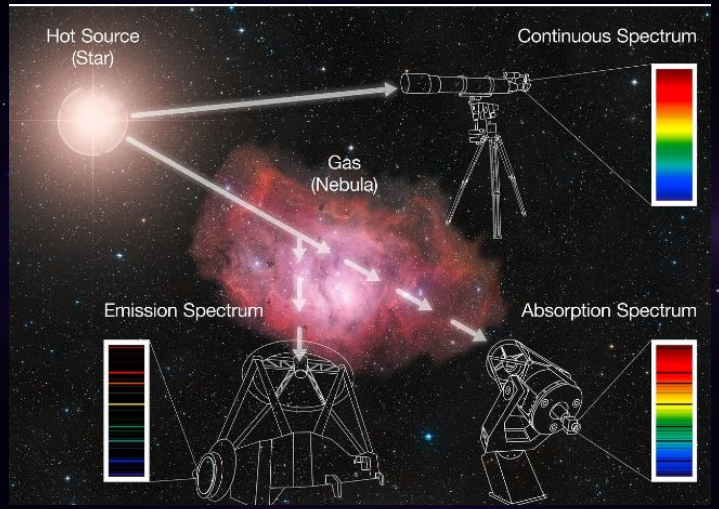
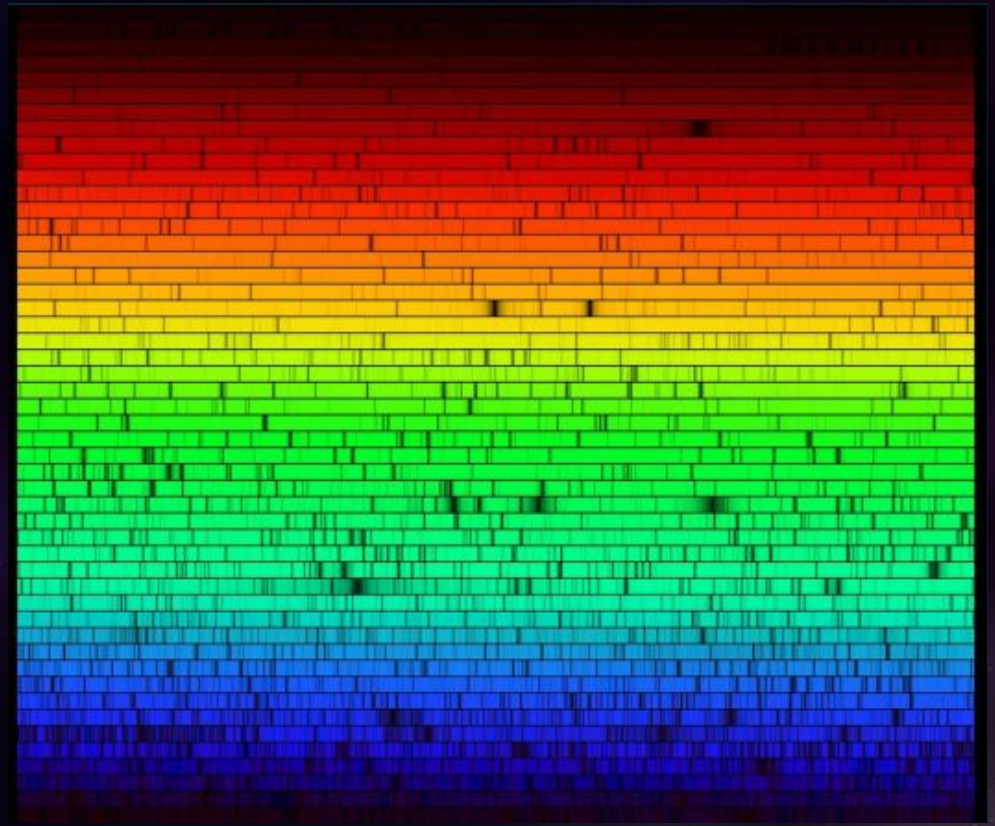
Light emitted by objects is examined to determine
the object's composition,
temperature, motion & density.



Astronomical Spectroscopy

Astronomical spectroscopy is used to measure three major bands of radiation in the electromagnetic spectrum- Radio waves,X-rays, and visible light.



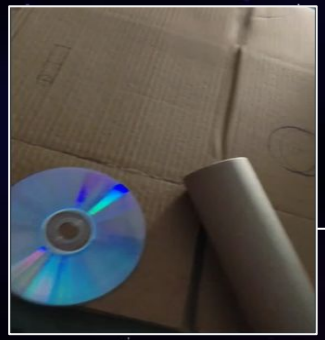


High Resolution Visible Spectrum of the Sun

Our Handcrafted Spectroscope

Assembling The Material

CD, Cardboard box, Cardboard Tube

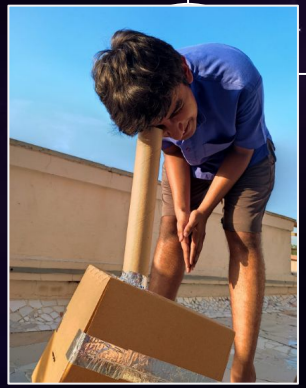


Get To Work

Following the procedure for geometrical construction.

Observations

Detecting the spectrum through the eyepiece



Analysis

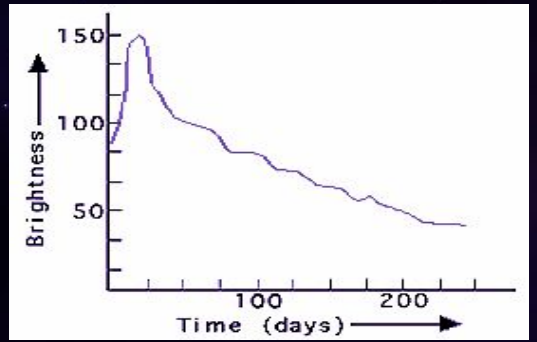
Taking Readings & Inferring The Spectrum

Light Curves

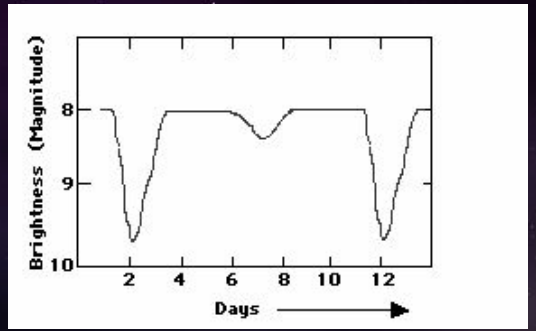
Because light can be curvy.

Light Curves

Supernova Explosion



Binary Eclipsing Star



03 Exoplanets

Each Planet is Unique, Every 100 Billion + of them

Exoplanets Who?

Any planet outside the Solar System is an exoplanet. Aided with computational methods, Astronomers have numerous techniques to determine their measurable properties

Detection Techniques

Direct Imaging

Not With Just
Visible Light

Astrometry

Planets Wobbling
The Star Motion

Radial Velocity

Star & Planet Revolving
Around Each Other.

Transit Photometry

Periodic Rise & Fall in
Star's Brightness

1. DIRECT IMAGING

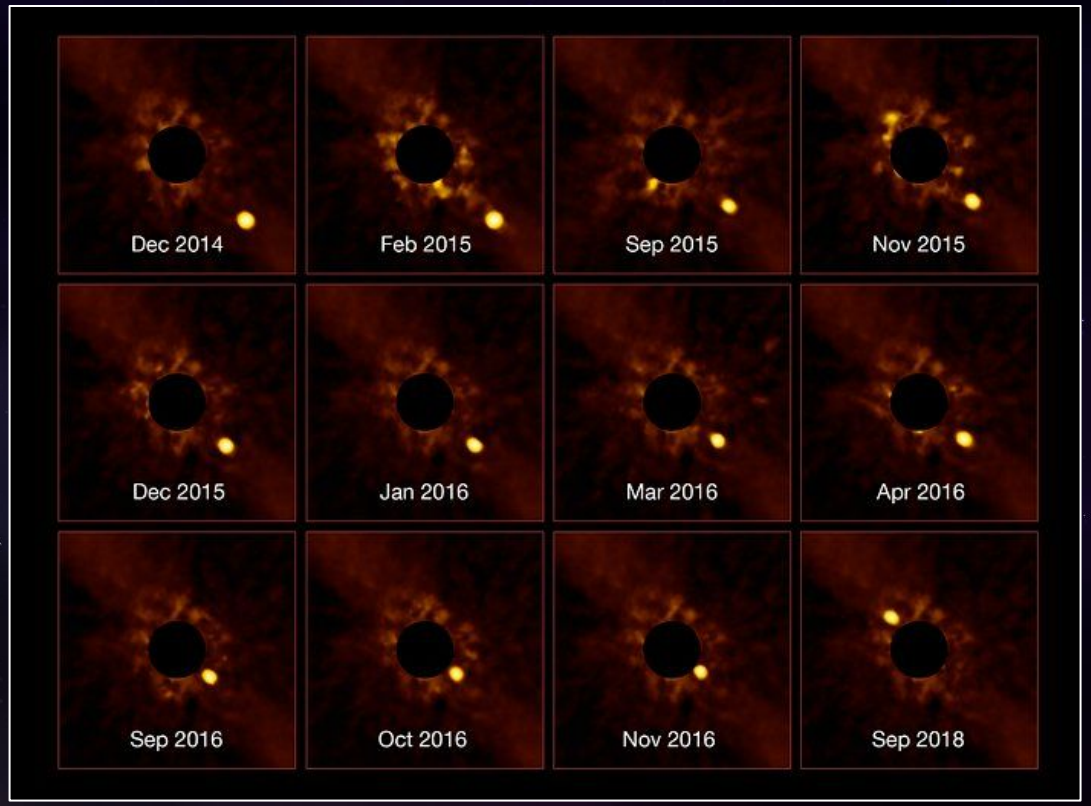
Best for

1. Finding exoplanets with large orbits
2. Finding exoplanets that do not transit stars

Not ideal for

1. Finding many exoplanets at once
2. Finding exoplanets around bright stars

Beta Pictoris b



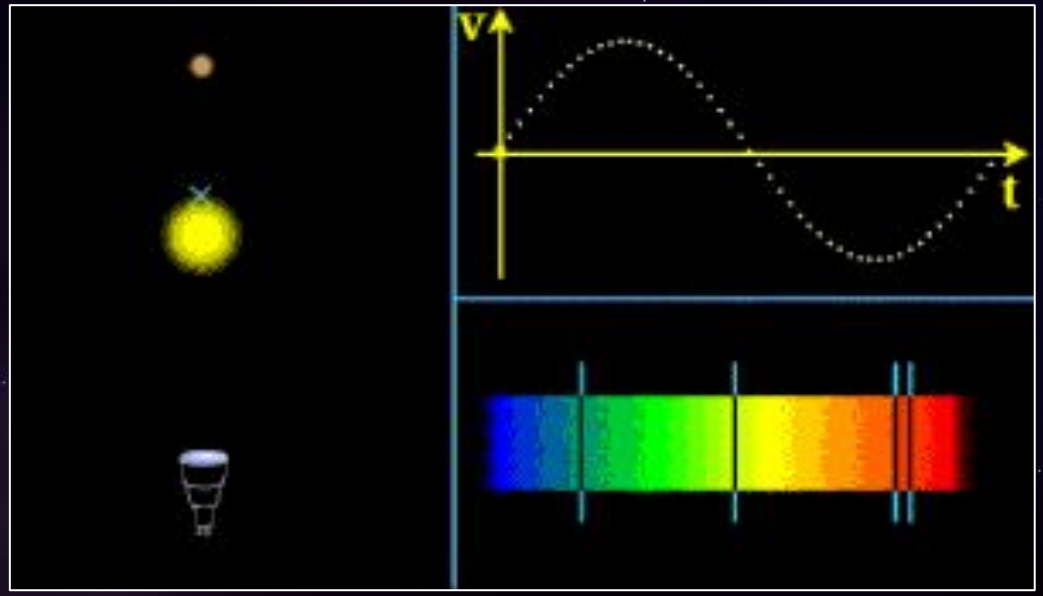
The series of images, with the bright glow of the star Beta Pictoris blocked out, have been compiled to create a unique time-lapse of the long-period orbit of Beta Pictoris b.

(Even the name suggests that this planet was meant to be photographed)

Credits: ESO

2. RADIAL VELOCITY

Planets revolve around the Center of Mass of the star-planet system. We can perceive the star's back & forth movement via doppler shift.



Data Filtering & Analysis

Phase 1

Observations

Telescopes & Spectroscopes help in taking observations.

Phase 2

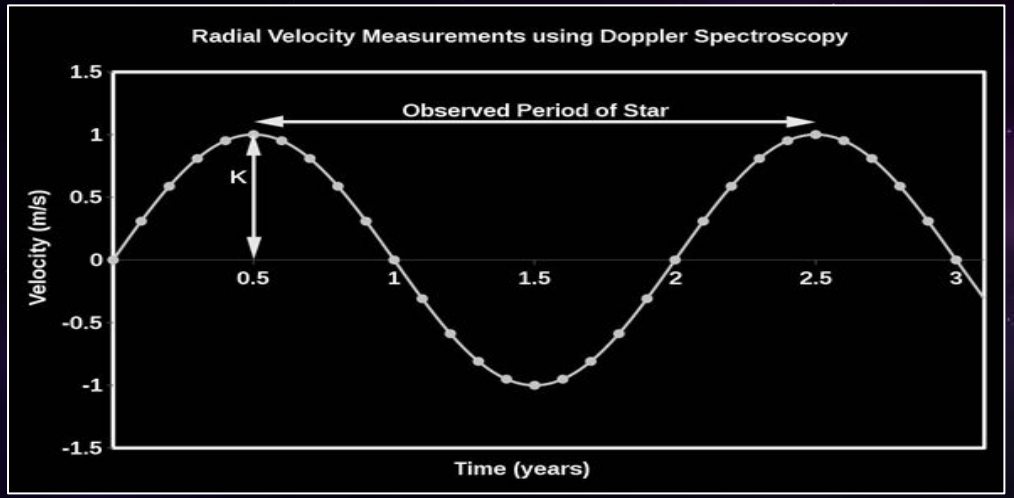
Noise Filtering

Raw data is filtered using certain noise reduction techniques such as interpolation

Phase 3

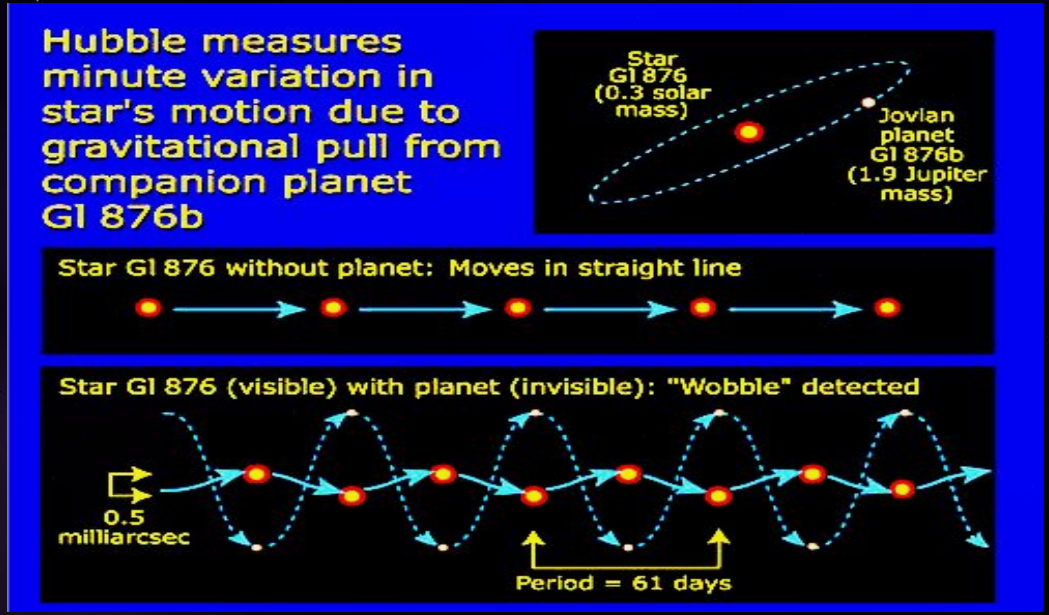
Inferring

Using Newtonian Gravitational equations to solve for mass & radius



3. ASTROMETRY

A Star's revolution around the Galactic centre is affected by motion of exoplanets around it, with unique signature frequency, depending on mass and radius of them individually.



GENERAL ASTROMETRY ALGORITHM

A. Observations

Raw Data is taken

B. Noise Reduction

By Reducing Noise Peaks in Fast Fourier Transform

C. Signature Frequency

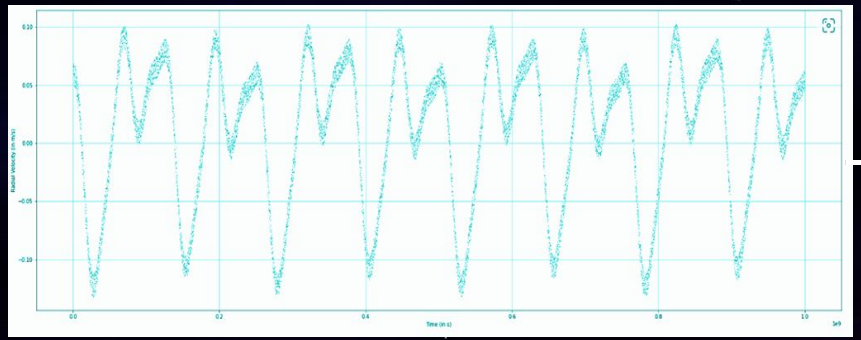
Detecting Individual Frequencies

D. Analysis

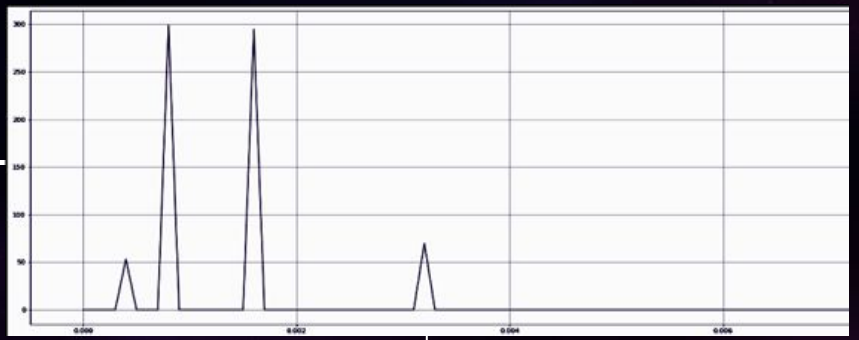
Calculation of Mass & Radius of Exoplanets

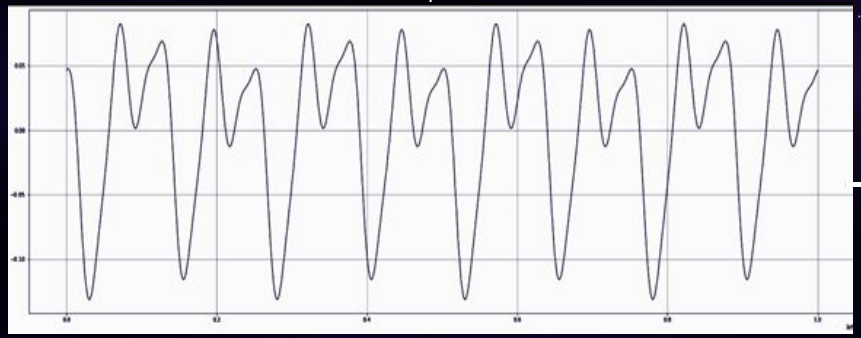
ASTROMETRY DEPICTION

Raw Data

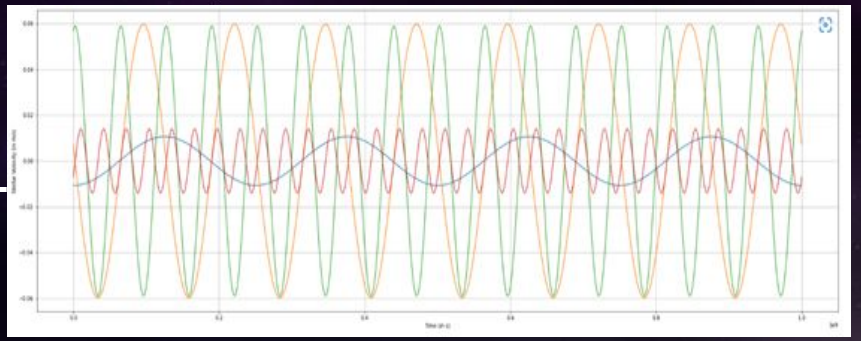


Signature Frequencies





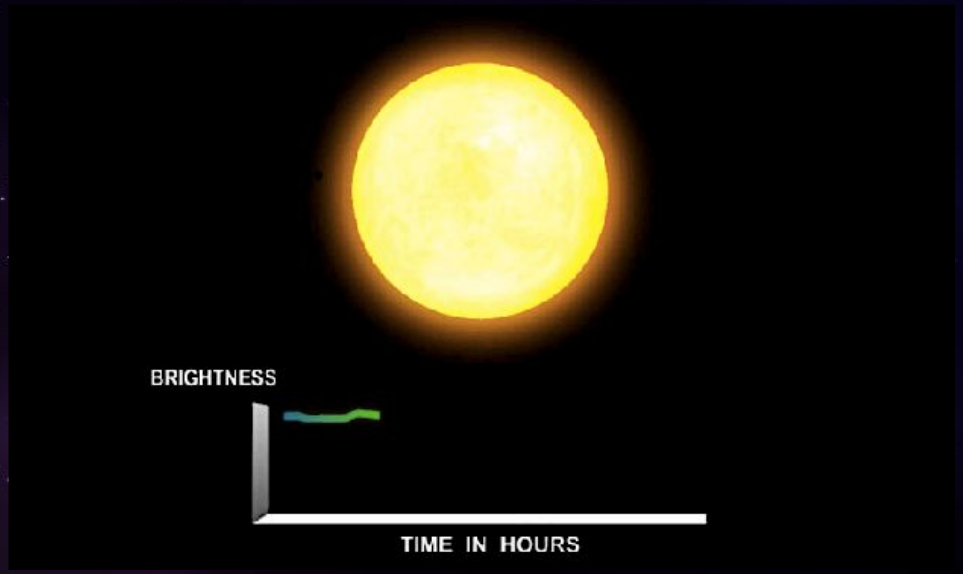
Noise Reduction



Individual Sine Curves

4. TRANSIT PHOTOMETRY

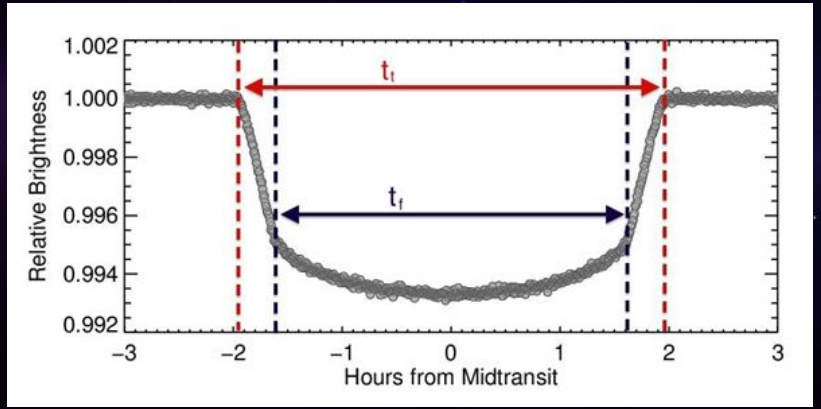
Planet too small to observe directly creates a Dip in Luminosity of Star as it passes by



Analyzing 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.

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



04 Solar Flares

Sun Ejects Shower of Charged Particles in its 11 Year Cycle

Why Bother Studying Flares?

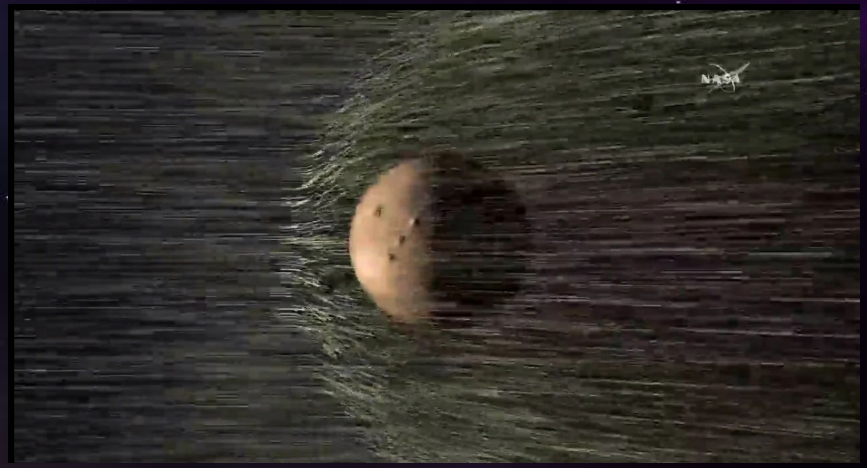
01%

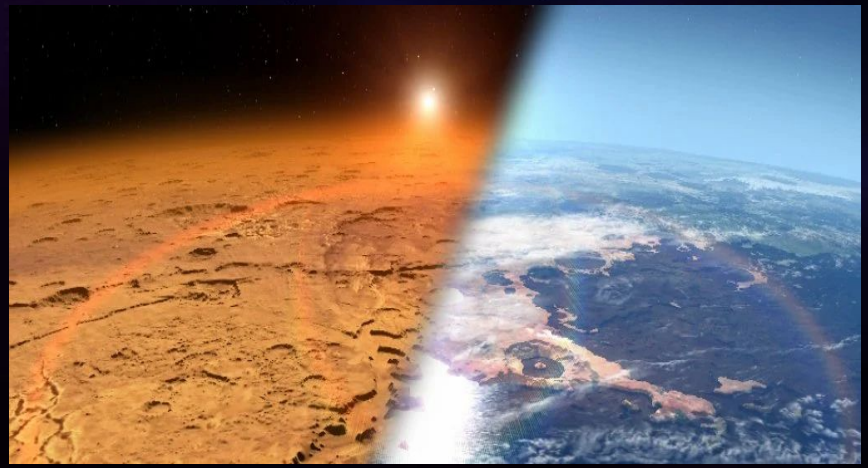
Mars has only 1% of Earth's Atmosphere in volume

4000%

Cosmic Radiations on Mars is 40 times higher than Earth

Solar Flares Turned Mars Into An Inhabitable Barren Desert

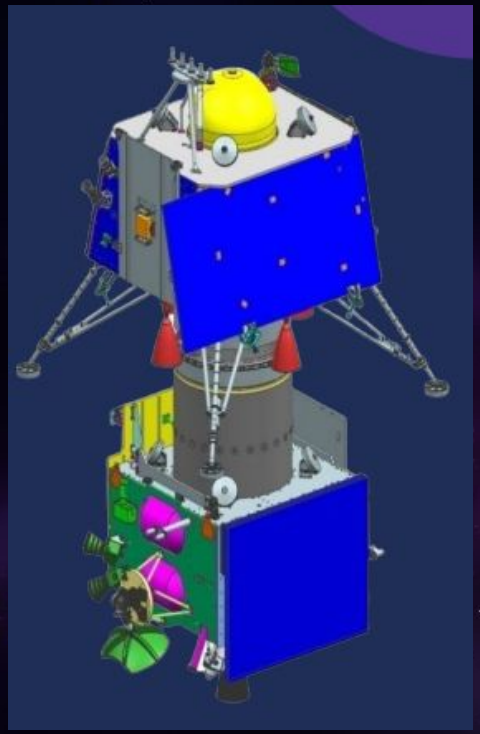




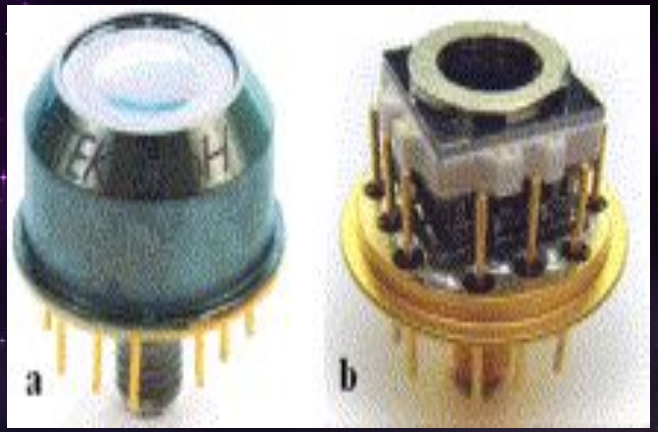
Solar Flare Analysis

Data Capturing

Solar brightness can be measured as a function of number of photos striking the observational area per unit time

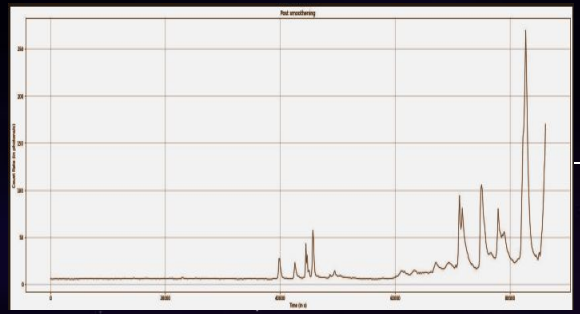


Solar Flare X-Ray Monitor

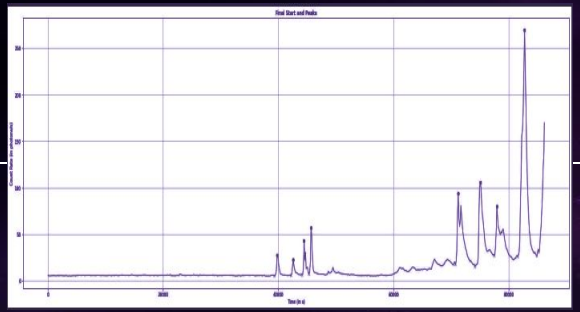


The Flare Theory

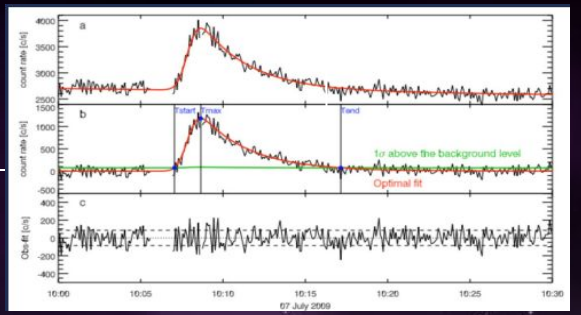
Pre-Processing



Isolating Flares



Curve Fitting



JUX Package for Pypi

So What's JUX Again?

With all the Algorithms & Codes used in XUVI, we present to you a new version of JUX.

JUX is a ready-to-use package & it is now Freely Available on Open Source Pypi Python Package Manager.

CONCLUSION

For this Project, we Observed and Analyzed Data About

- Spectroscopes
- Exoplanets
- Solar Flares

We developed Python Codes for Standard & Contrived Algorithms, made our own Spectroscope & Published JUX.

MENTEES: Nandan Madhuj, Ritik B Kumar, Shreya Rajak, K Arnav, Jaya Santhi, Priyanshu Bhatia

WHAT'S NEXT?

XUVI has given us Insights on How to Work with both Computational & Theoretical Data & also Analyse them.

We are glad mention that we further use this Exposure to participate in **LUNAROTHON**!

Thank You

"COSMOS IS WITHIN US"