Exploring Exoplanet Properties

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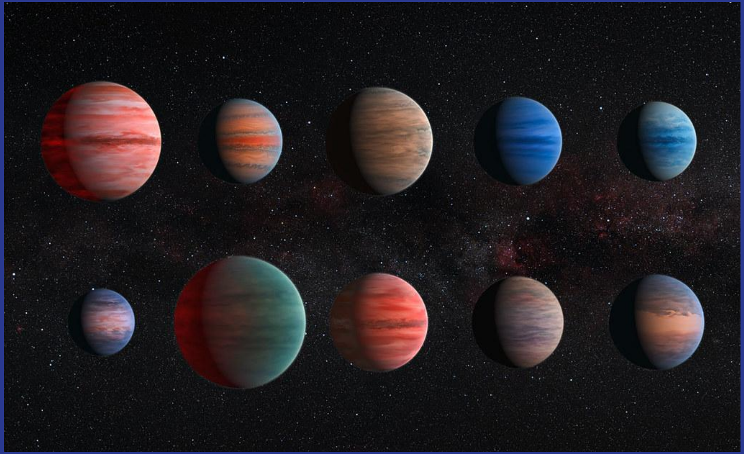


Introduction & Motivation

Intro:

- Our exoplanet system: GJ 436 b
- Explore how we measure exoplanet mass, radius, density
- Using Radial Velocity and transit data
- Compare data with M-R relation from Chen & Kipping (2016)
- Explore abundance of types of exoplanets!

Some Questions We Look to Answer:

- How can Radial Velocity measurements lead to a deeper understanding of the abundance of planet types in the Cosmos?
- How do our measurements of mass and radius compare to other exoplanets of similar mass and radii?

Methods

List of used Methods:

- NEA for data collection
- Google Colab for Python implementation
- Uncertainty for Relative Flux Calculation
- Lomb-Scargle Periodogram
- RadVel python Package
- Matplotlib for simple python plotting

Methods Continued…

Equations (shown on right):

- K-value equation
- Planet Mass equation
- Kepler’s 3rd Law
- Transit depth equation

$$K = \frac{M_p}{M_\star + M_p} \frac{na\sin(i)}{\sqrt{1-e^2}}$$

$$M_p = \frac{KM_\star\sqrt{1-e^2}}{\frac{2\pi}{T}\left(\frac{GM_\star T^2}{4\pi^2}\right)^{\frac{1}{3}}}$$

$$a = \left(\frac{GM_\star T^2}{4\pi^2}\right)^{\frac{1}{3}}$$

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

Results

Mass:

Approximate mass = 20.003 Earth Masses

Using Uncertainties:

Mass range is ± 1.99963 M_earth

Radius:

Radius = 4.10156 Earth Radii

Using Uncertainties:

Radius range is ± 0.24674 Earth Radii

Density:

Density = 1.59297 g/cm^3

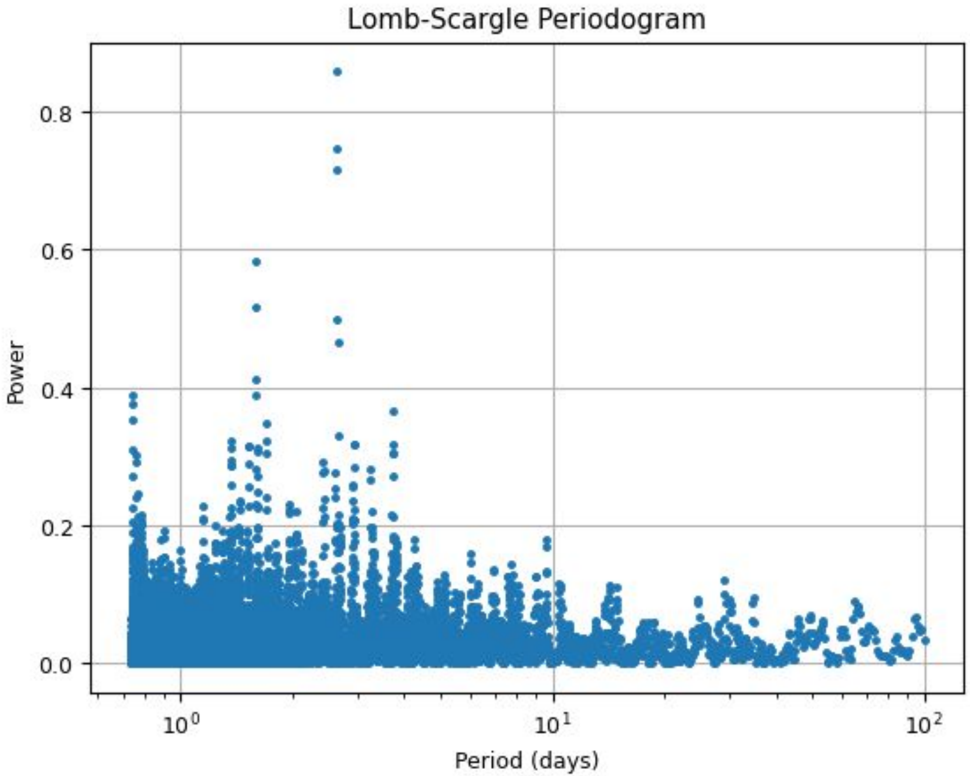
Uncertainty = ± 0.18585 g/cm^3

- Successfully found our exoplanets mass from the radial velocity data and radius from transit data
- Calculated uncertainties of each

Results Continued…

Lomb-Scargle Periodogram (Graph 1)

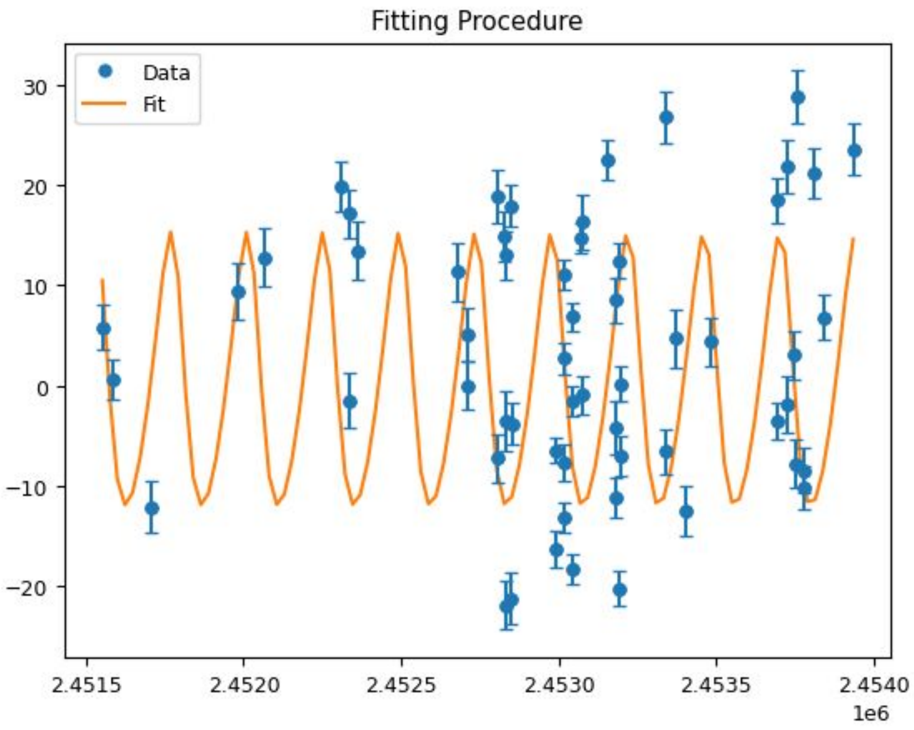
- Graph that determines period through unevenly spaced data
- More data at smaller periods
- Large spikes between 1-10
- Largest spike at our period
- future graphs (graph 2)
- Leads to calculations for mass



Results Continued…

RadVel (Graph 2)

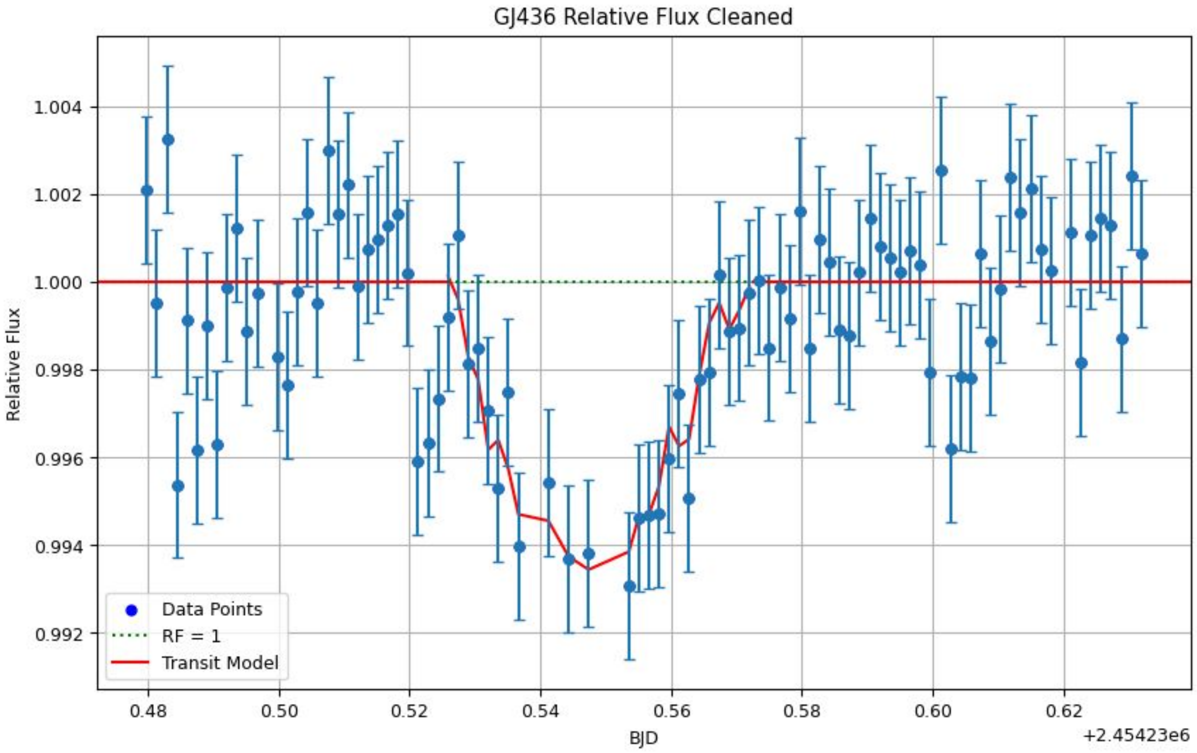
- “Fitting Procedure”
- Clearly sinusoidal
- Notice error bars
- Led to us finding our Mass value



Results Continued…

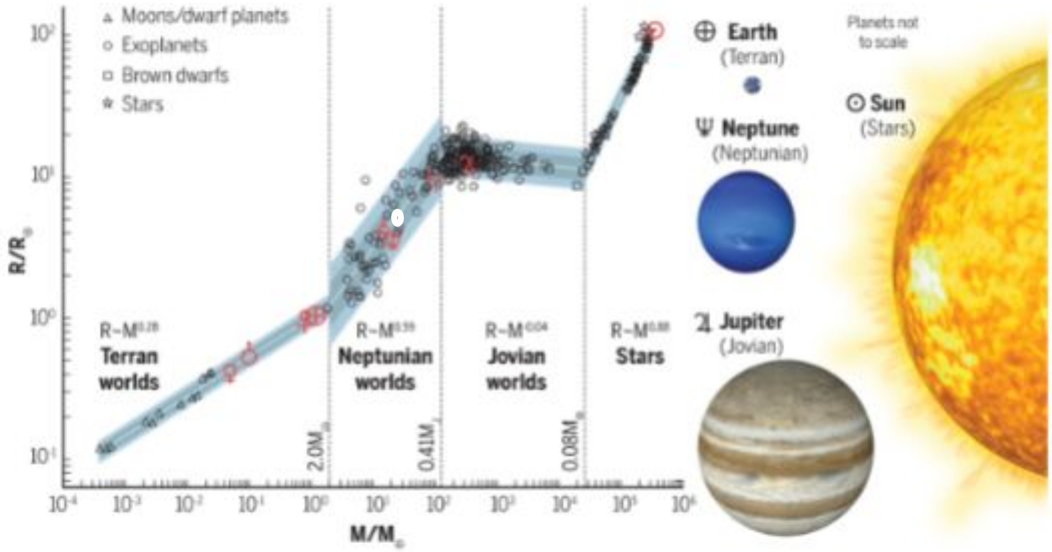
Transit Light Curve (Graph 3)

- Notice initial clear dip in middle of graph
- Error Bars from standard deviation
- This graph is “cleaned” (by 2σ)
- Red line (transit model)
- Clearly see transit depth
- Leads to radius calculation



Chen and Kipping (2016)

- Mass-radius relation from Chen and Kipping (2016)
- Our measurement of mass = 20.003 Earth masses
- Our measurement of radius = 0.3659 Jupiter Radii ~ 4 earth radii
- Our measurements would put our planet in the Neptunian worlds section of the M-R relation (White circle)



Chen & Kipping 2

Conclusion

We were able to successfully calculate the radius, mass, and density of our planet using RV and transit data.