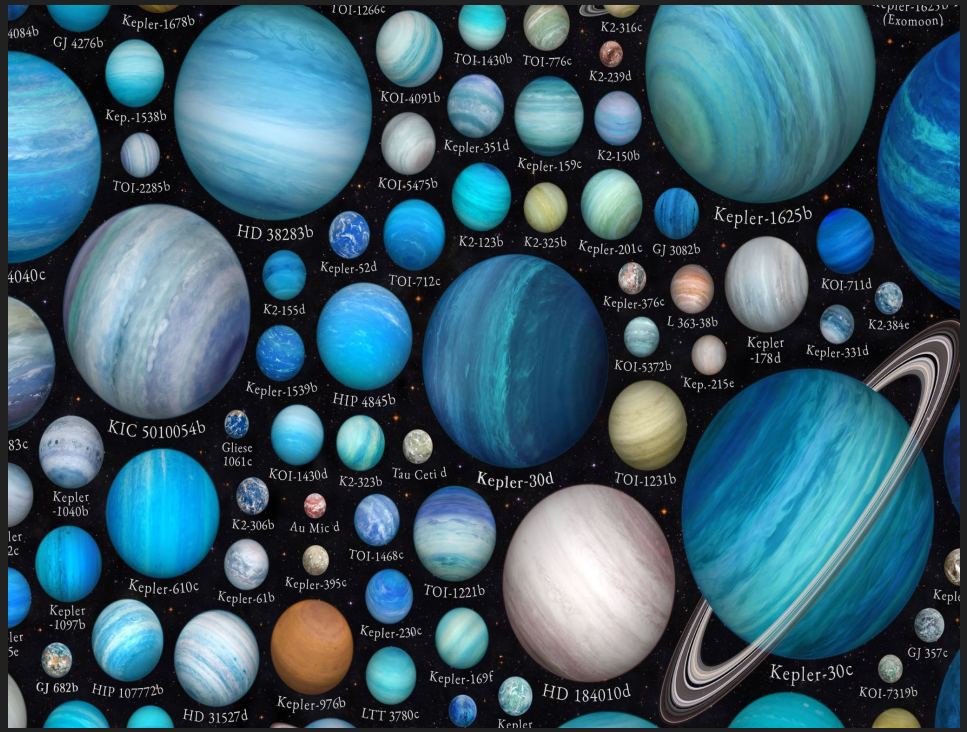
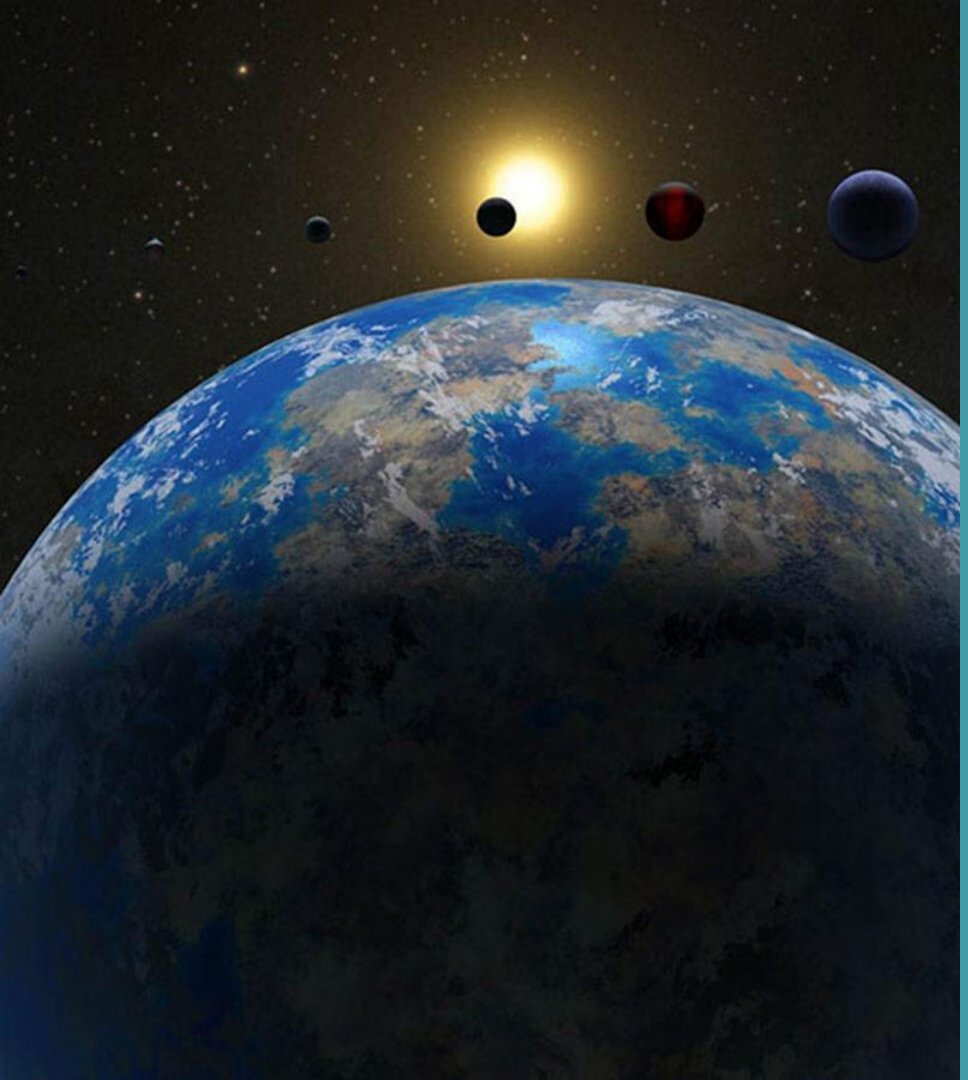
What is GJ436 b

Lead Programmer Ethan Johnson, Report writer Rachel Price, and Presentor Malachi Roark

Motivation



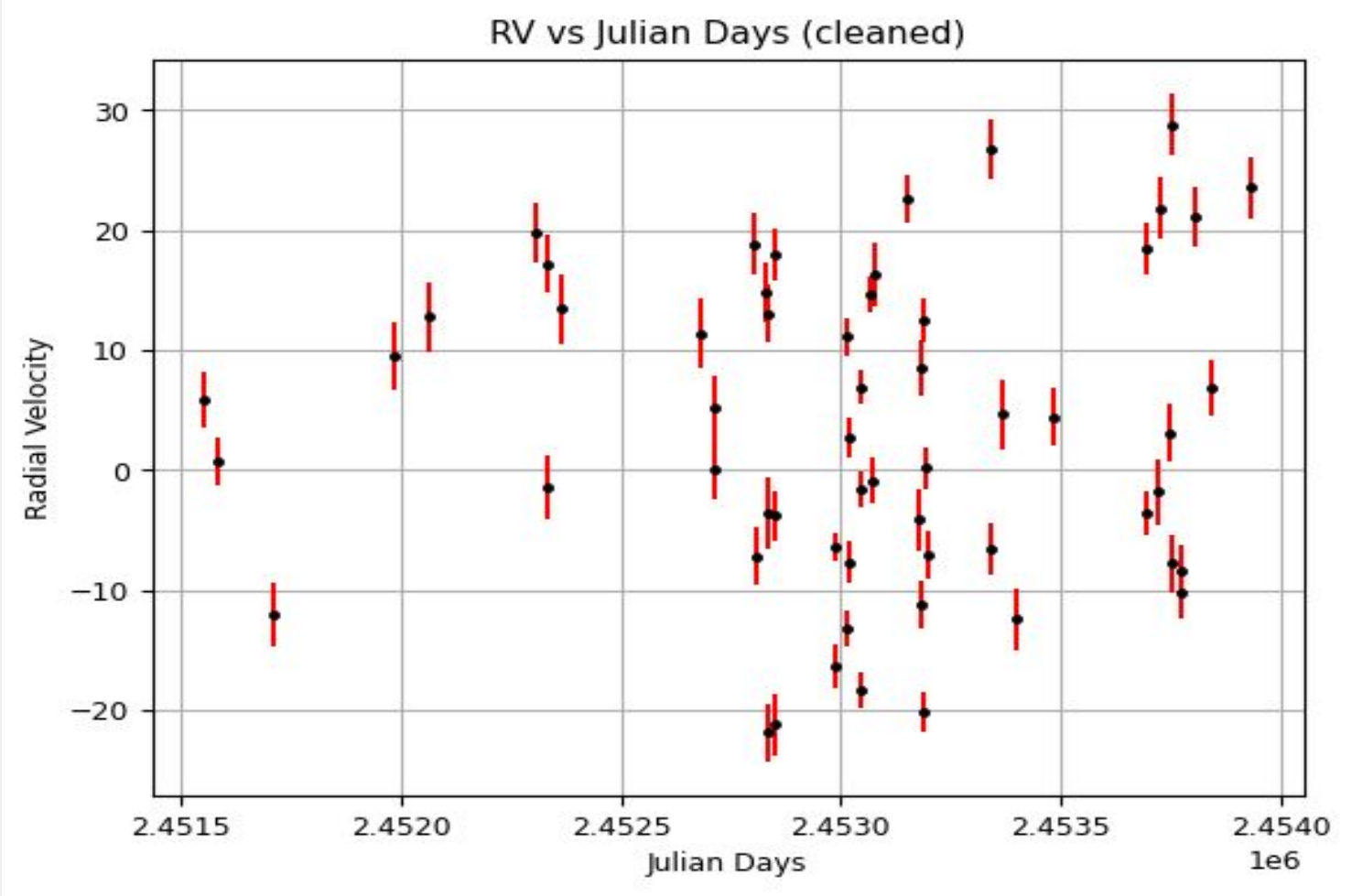
- Understanding formation of planets
- Separation between Earth and Jupiter like planets
- Composition using density



Radial Velocity

Filtering the Data for GJ 436b

- Data within 2 SD

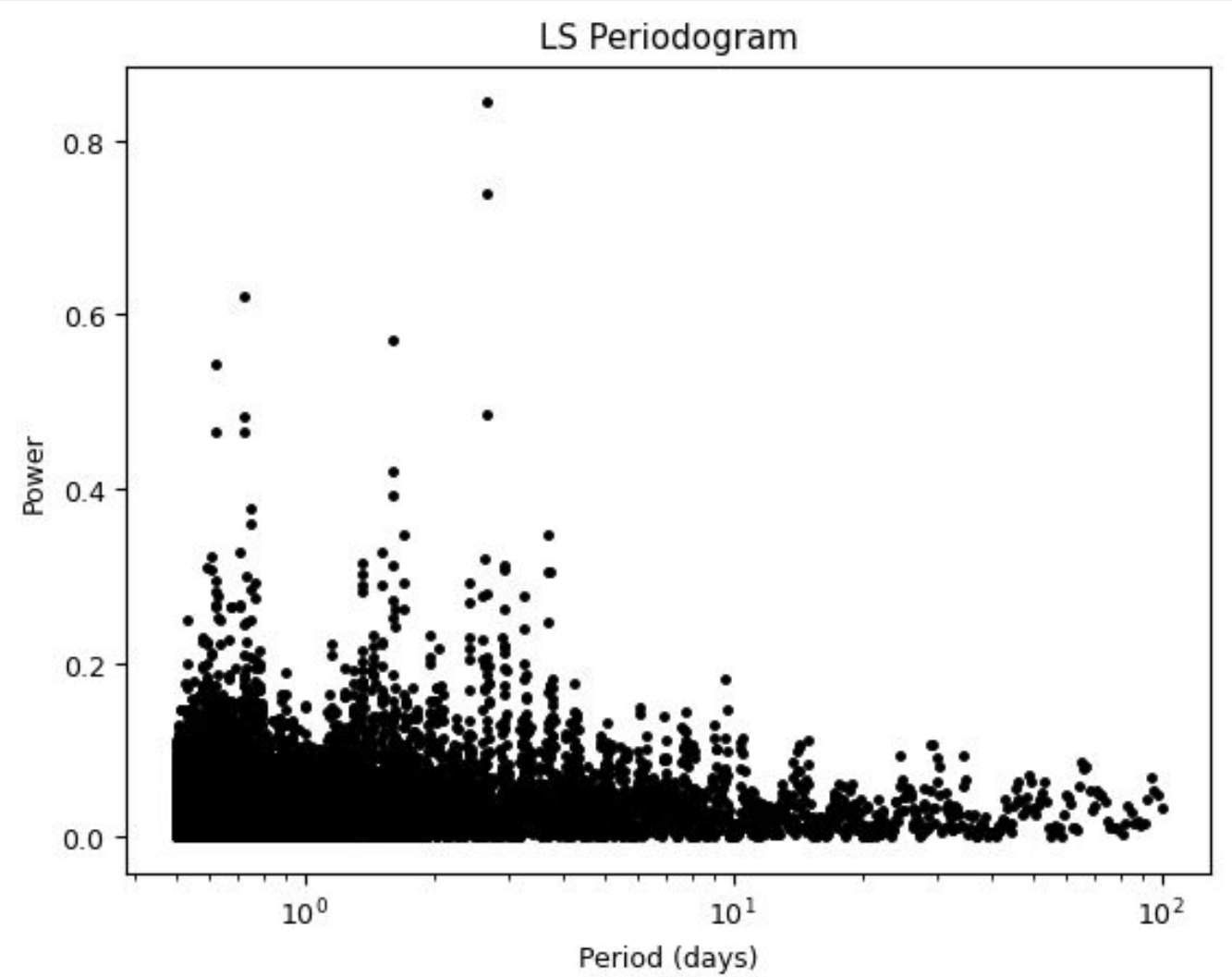

RV vs Julian Days (cleaned)
Radial Velocity
30
20
10
0
−10
−20
2.4515
2.4520
2.4525
2.4530
2.4535
2.4540
Julian Days
1e6

Finding the Period

Using Lomb Scargle periodogram

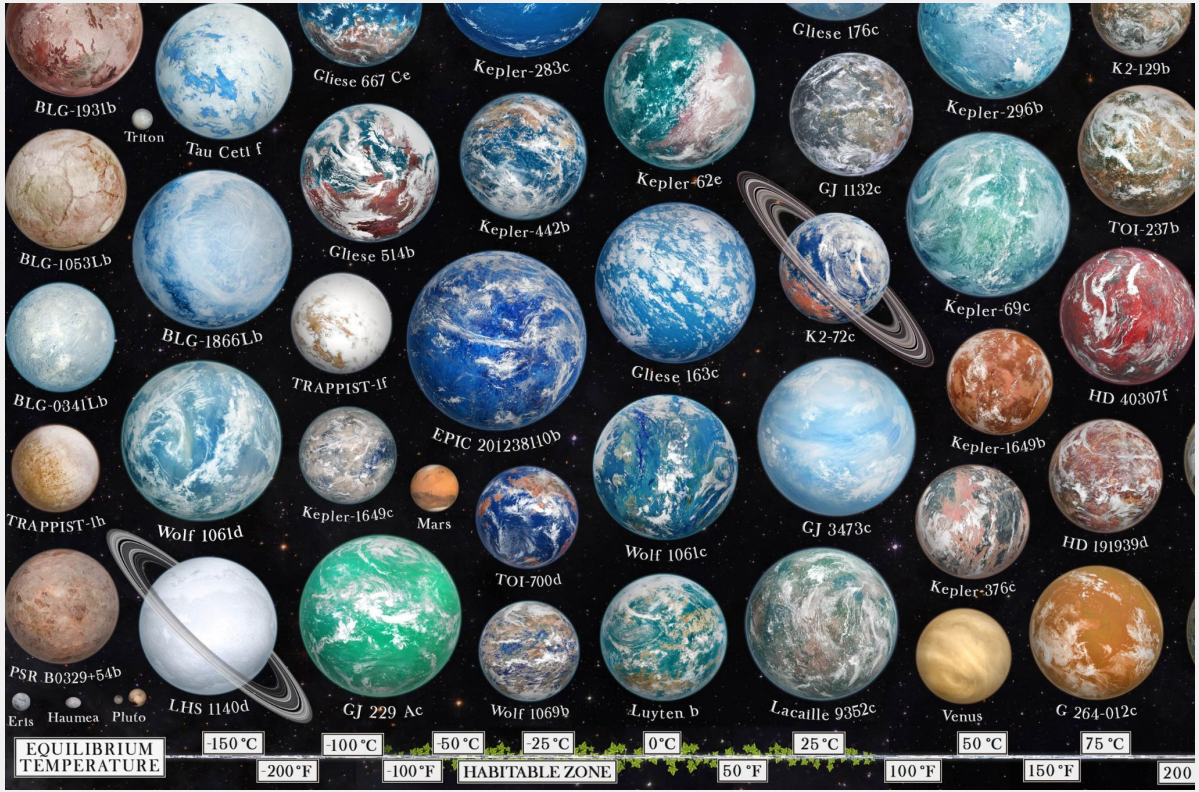
Lomb Scargle Periodogram

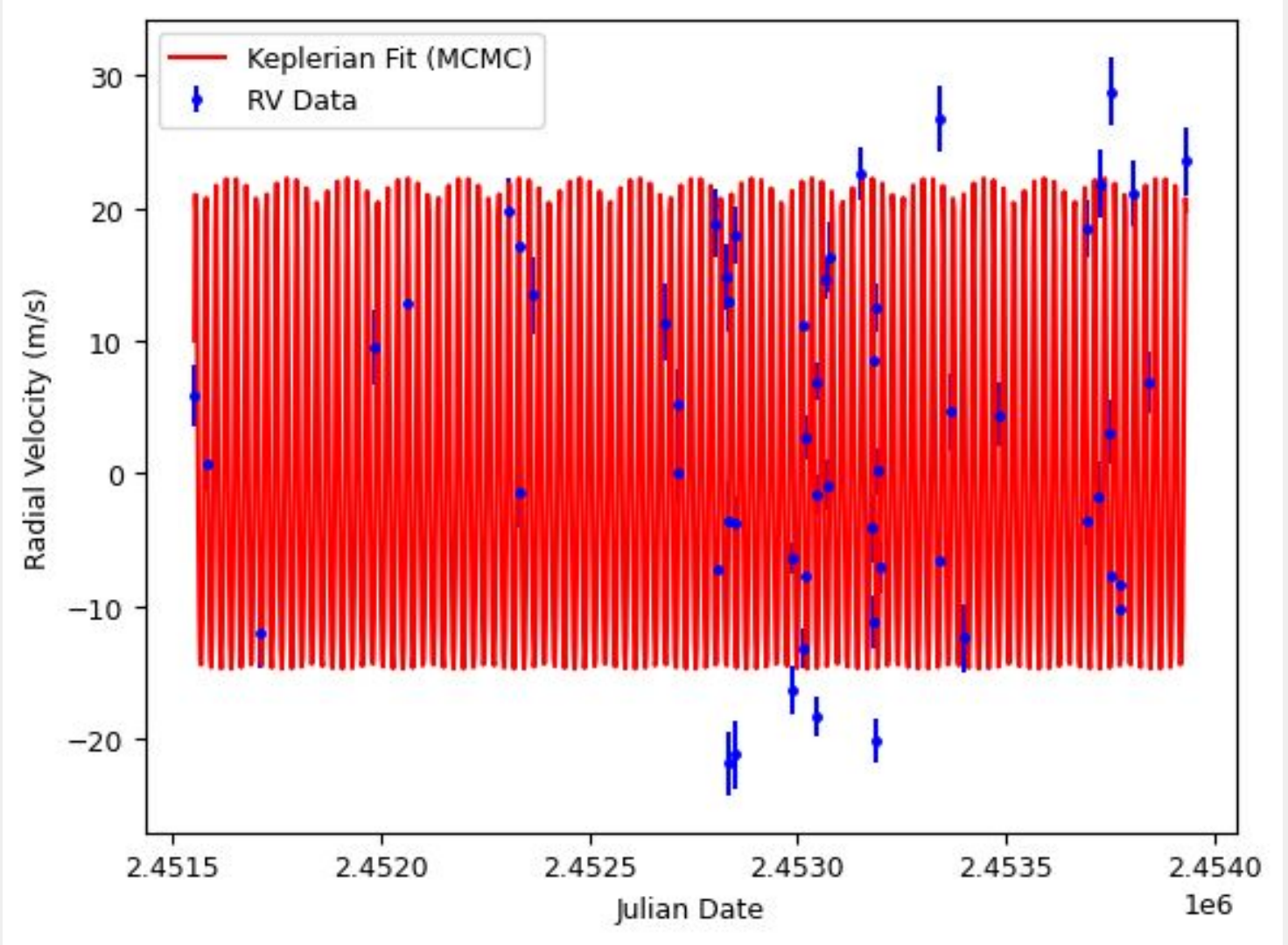
- Detects periodic signals
- Used radial velocity, radial velocity uncertainty, and Julian Days
- $P = 1 \div f$
- $P = 2.64$ days


LS Periodogram
Power
0.0
0.2
0.4
0.6
0.8
10^0
10^1
10^2
Period (days)

Finding Mass

- Markov chain Monte Carlo and kepler's third law
- Gave averages of the given data set
- Rearranging to solve for the Mass gives the result:
- $M = 22.73\ M_{\oplus}$
- Lower Uncertainty $= -0.69 M_{\oplus}$
- Upper Uncertainty $= 3.15\ M_{\oplus}$

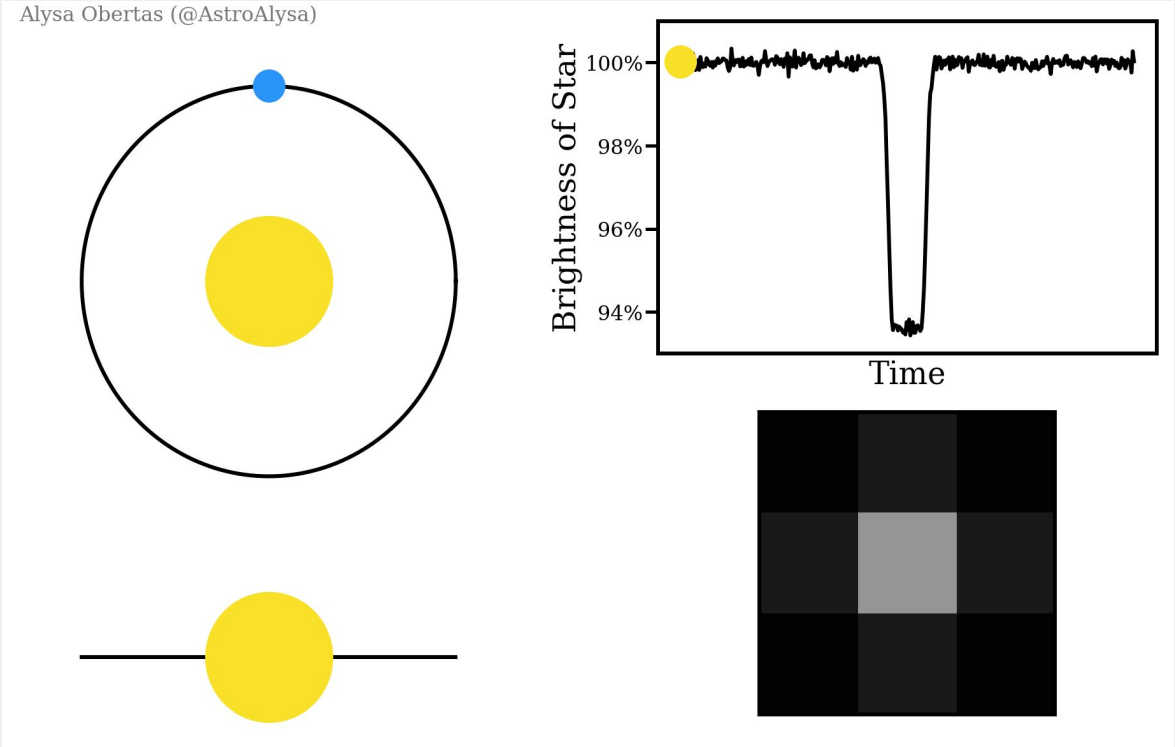



Keplerian Fit (MCMC)
RV Data
Radial Velocity (m/s)
30
20
10
0
−10
−20
2.4515
2.4520
2.4525
2.4530
2.4535
2.4540
Julian Date
1e6

Magnitude

Filtering the Data for GJ 436b

- Points within 2 SD
- Graph looks like an upside-down top hat
- Relationship of radi
  - Star v.s Planet

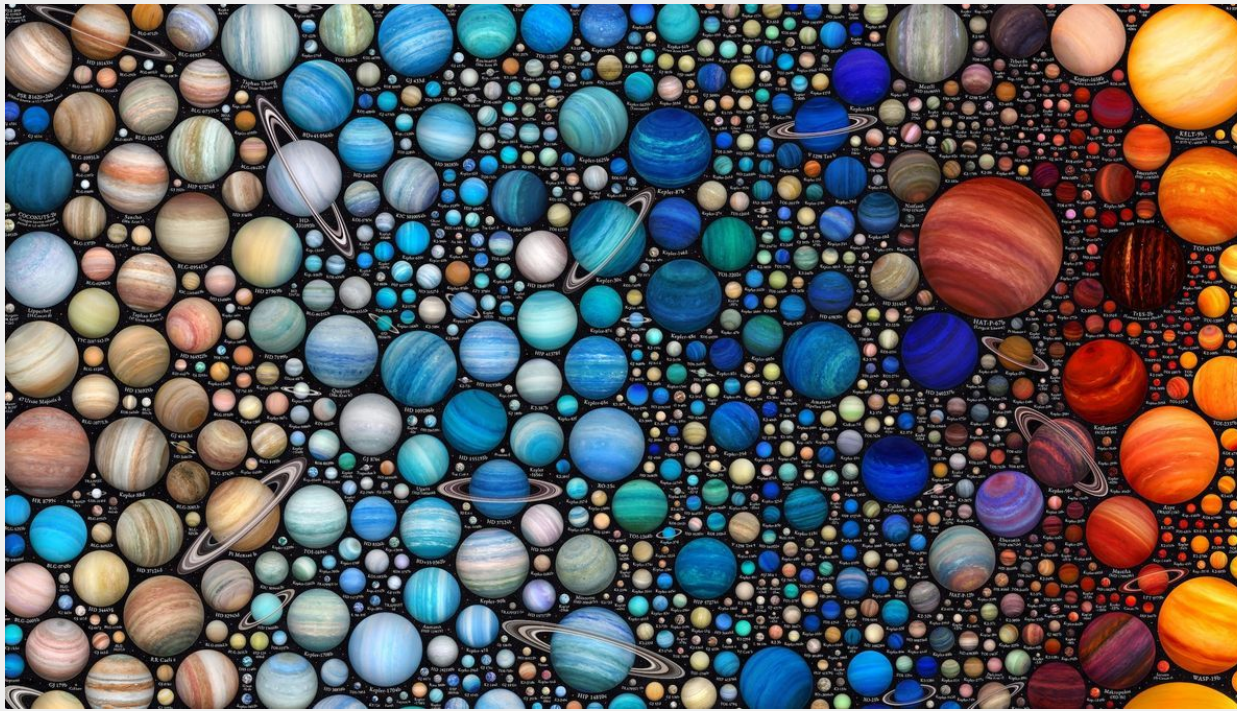


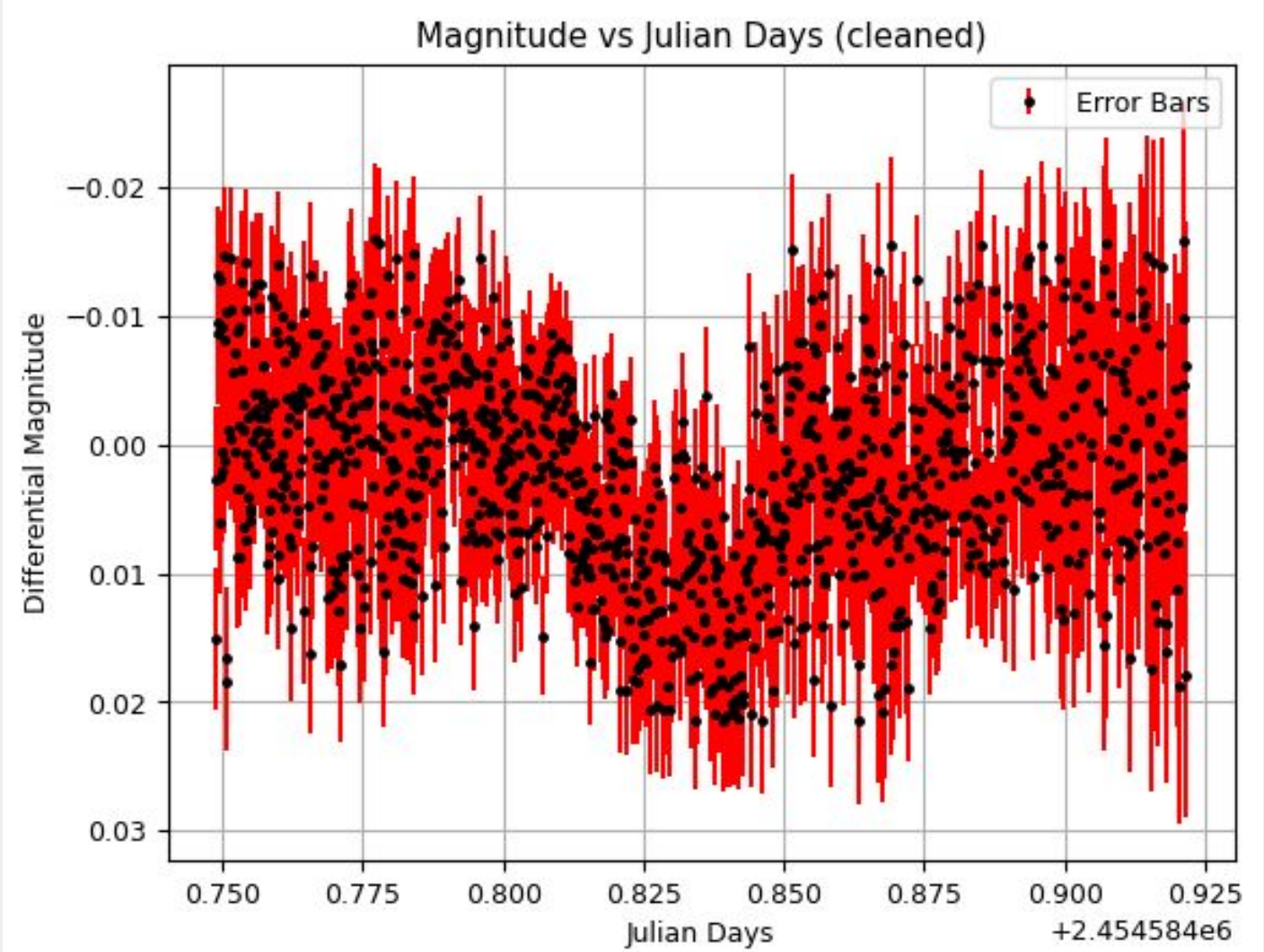
Magnitude Cont.

- Used Markov chain Monte Carlo to approximate the Radius
- Used the average transit
- Formula to Find the Relationship is as follows

$$R_p = R_\star \cdot \sqrt{\delta}$$

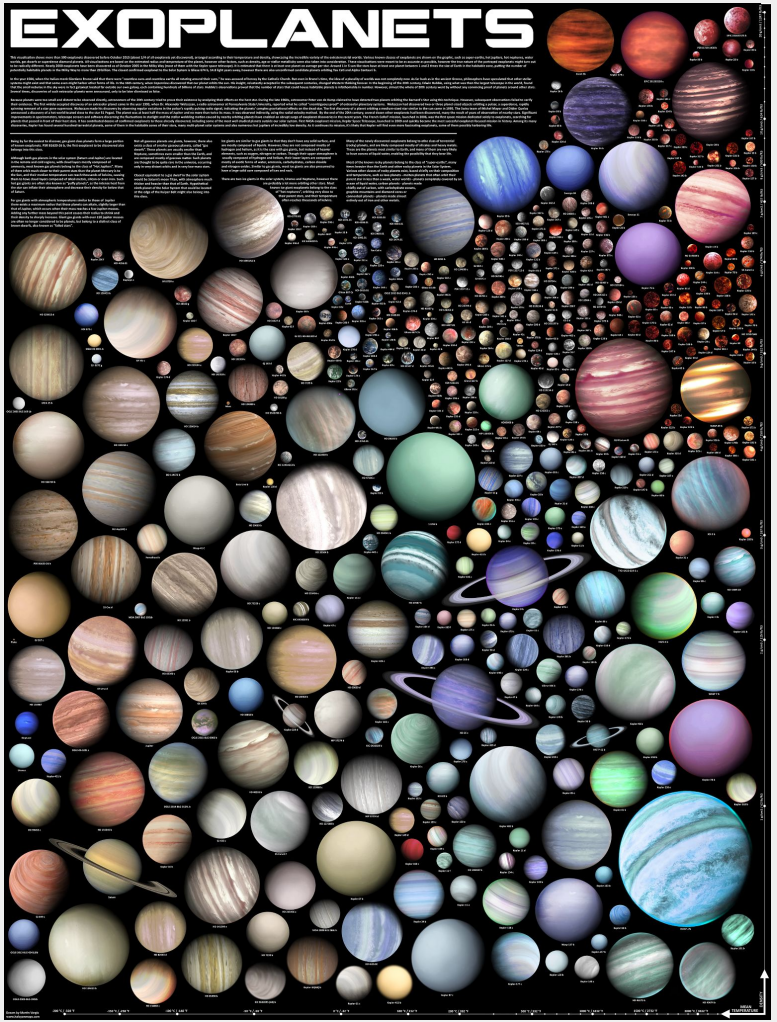
- $R_p = 4.71\ R_\oplus$
- Lower Uncertainty = $-0.099\ R_\oplus$
- Upper Uncertainty = $0.095\ R_\oplus$

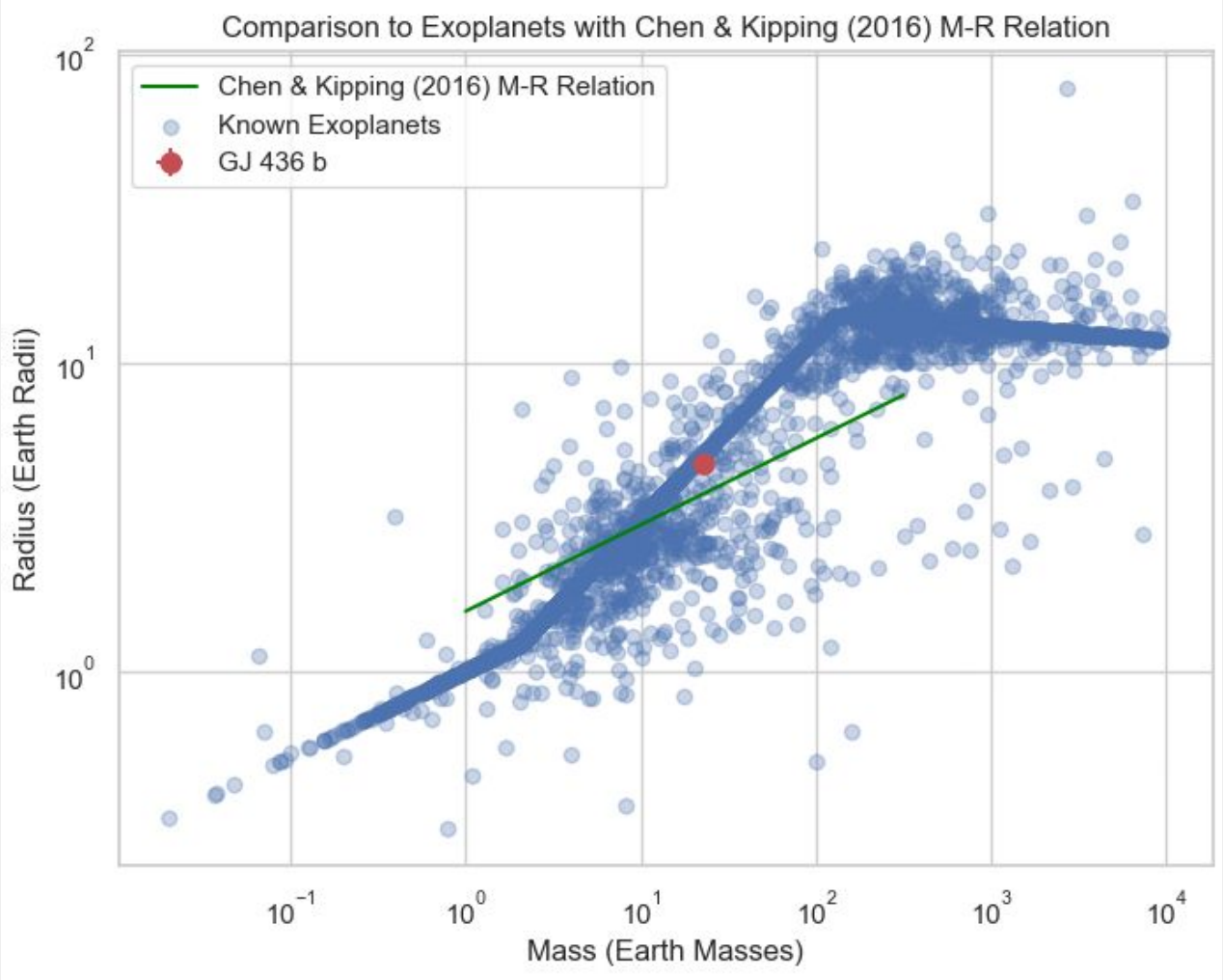



Magnitude vs Julian Days (cleaned)
Error Bars
Differential Magnitude
−0.02
−0.01
0.00
0.01
0.02
0.03
0.750
0.775
0.800
0.825
0.850
0.875
0.900
0.925
Julian Days
+2.454584e6

Finding Density

- $\rho = M_{\oplus}/V$
- V = Volume of a sphere
- Min $M_{\oplus}$ and $R_{\oplus}$ for min ρ
- Max $M_{\oplus}$ and $R_{\oplus}$ for max ρ
- ρ = 1.99 g cm-3
- Upper uncertainty = 0.256 g cm-3
- Lower uncertainty = -0.104 g cm-3




Comparison to Exoplanets with Chen & Kipping (2016) M-R Relation
Chen & Kipping (2016) M-R Relation
Known Exoplanets
GJ 436 b
Radius (Earth Radii)
Mass (Earth Masses)
10^{2}
10^{1}
10^{0}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}

IN Conlusion

GJ436B IS . . .

- Comparable to Neptune
- Neptune is roughly 4 $R_{\oplus}$ And 17 $M_{\oplus}$
- Neptune's density is 1.64 g cm-3
- Thus must share the similar composition.
- However, considered a Hot Neptune