Project 2 Presentation

Group 9

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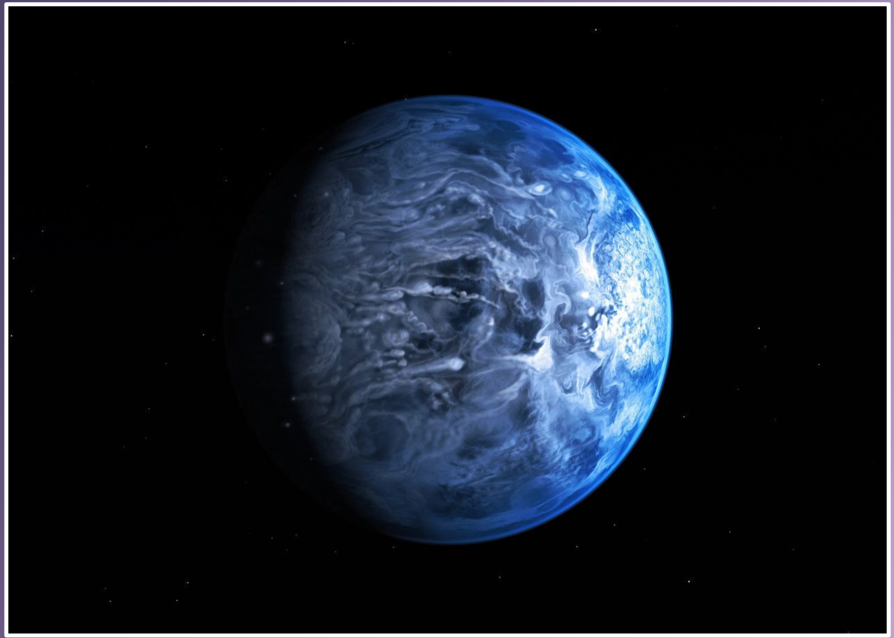
Motivation

- Exoplanets has become a central focus of Astronomy.
- Extract information from observational data.
- What is the influence of uncertainties?
- Understand the range of properties of exoplanets.



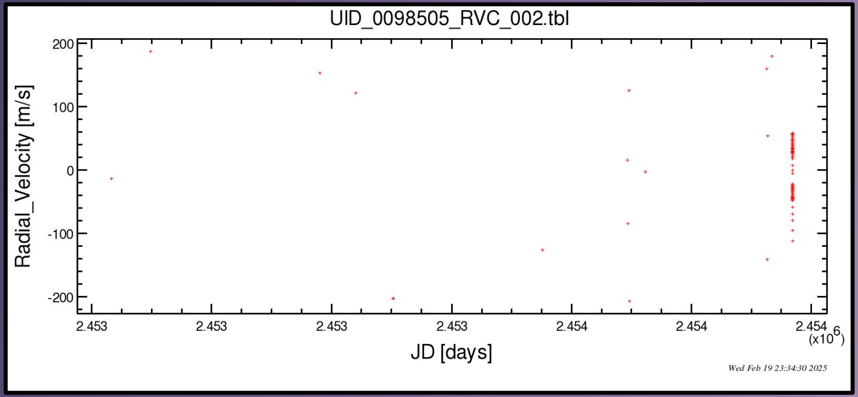
HD 189733 b

Methods

Download data from NEA:

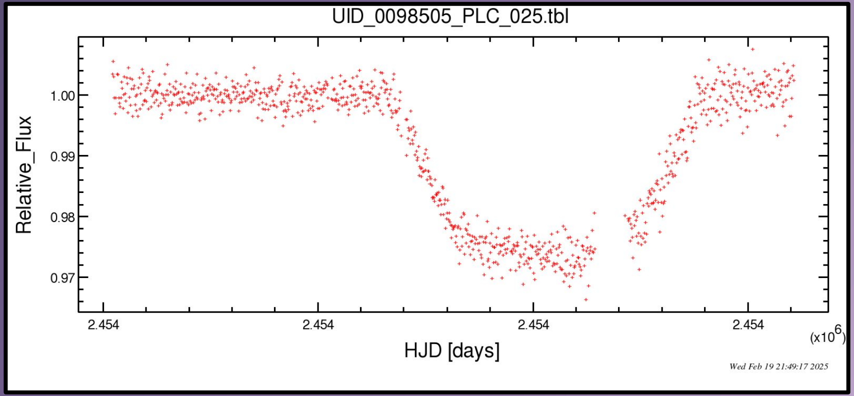
Radial Velocity Data

- 86 points



Transit Data

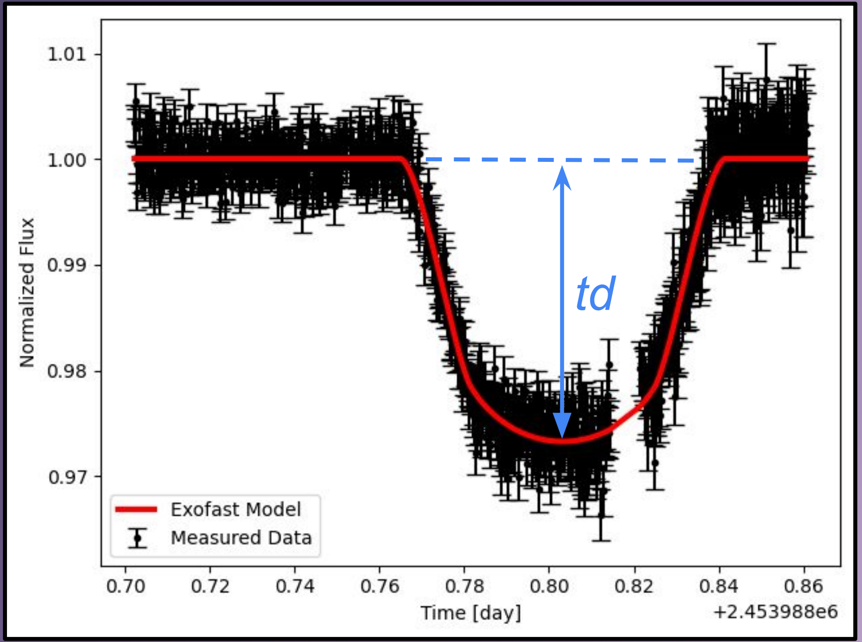
- 910 points
- Clear light curve



Methods – Transit

Use EXOFAST to curvefit flux data:

- Exofast transit depth: td = 0.024686348 (normalized flux)
- Came with associated measurement uncertainties



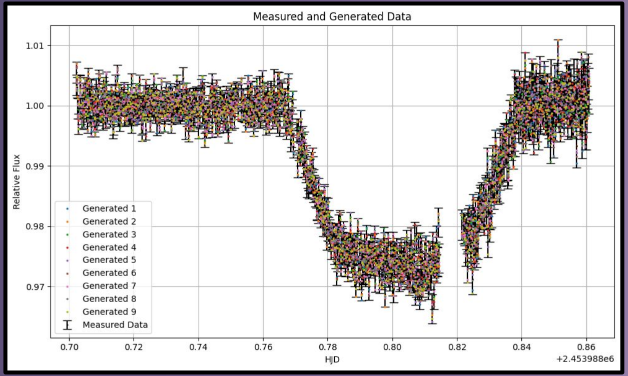
Methods – Transit

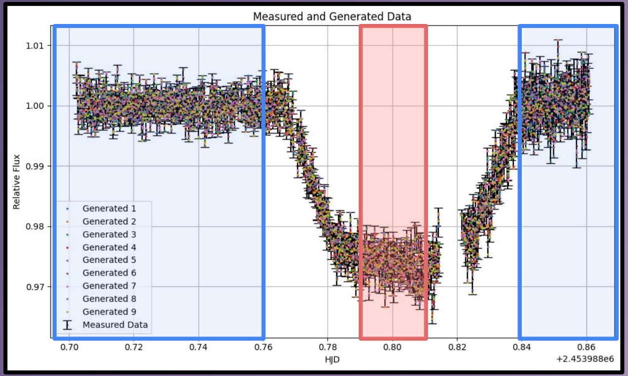
“Monte Carlo” Uncertainty Analysis:

- Generated 9 additional vectors between error bars
- <u>Estimated </u>the transit depth for each
    - Avg_high - Avg_low

	Transit Depth
0	0.024686
1	0.026249
2	0.026278
3	0.025955
4	0.026211
5	0.026112
6	0.026347
7	0.026218
8	0.026259
9	0.026424

Mean: 0.02607105
Standard deviation: 0.00047800





Methods - Radial Velocity

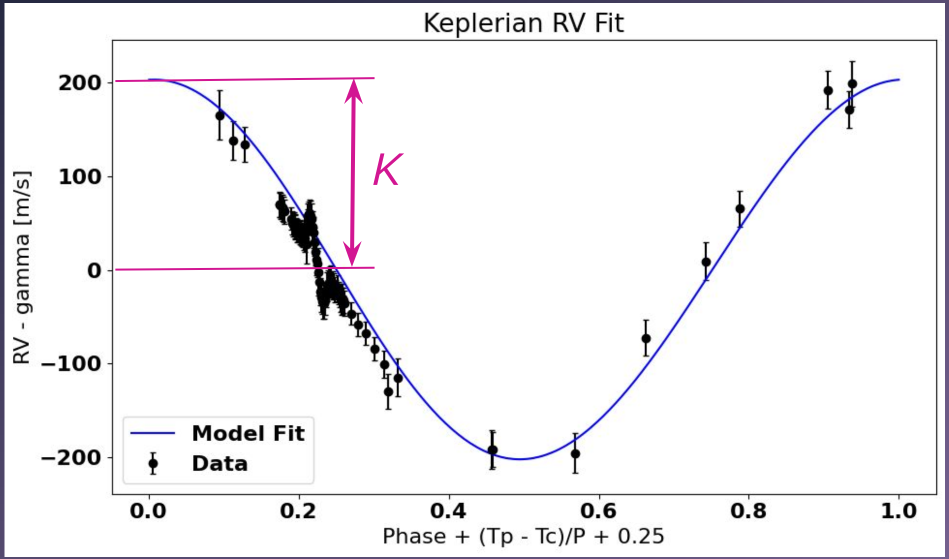
HIRES 10m – 86 datapoints

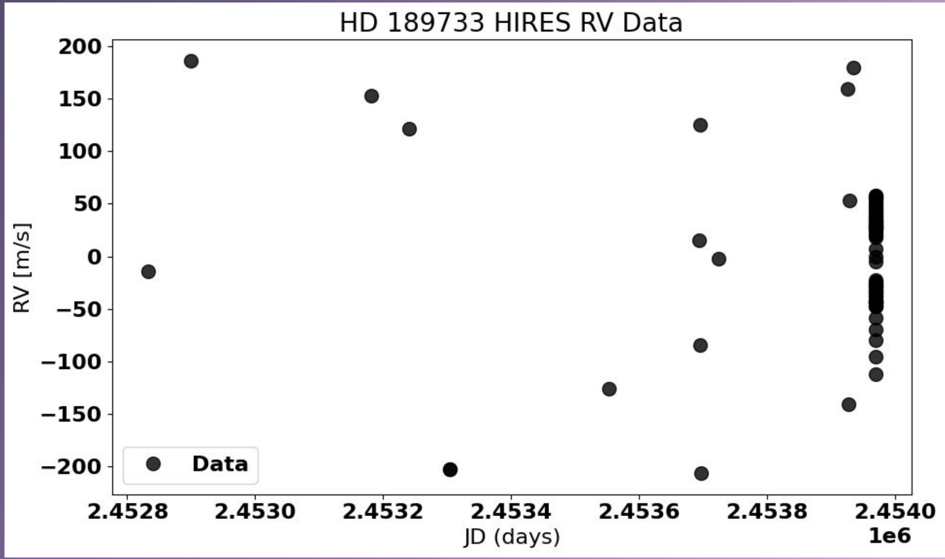
Data conditioning with EXOFAST

– Renormalization ($\chi_\nu^2 \cong 1.04 \Rightarrow$ Error Scaler $\beta \cong 16.42$)

– Centering ($\gamma \cong -11.8$)

– Phase folding & standardization





Methods – Radial Velocity

```
0: K = 202.28 m/s
1: K = 201.59 m/s
2: K = 200.71 m/s
3: K = 200.49 m/s
4: K = 205.24 m/s
5: K = 202.97 m/s
6: K = 206.18 m/s
7: K = 202.76 m/s
8: K = 203.29 m/s
9: K = 202.36 m/s
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Average K = 202.84 ± 1.79 m/s
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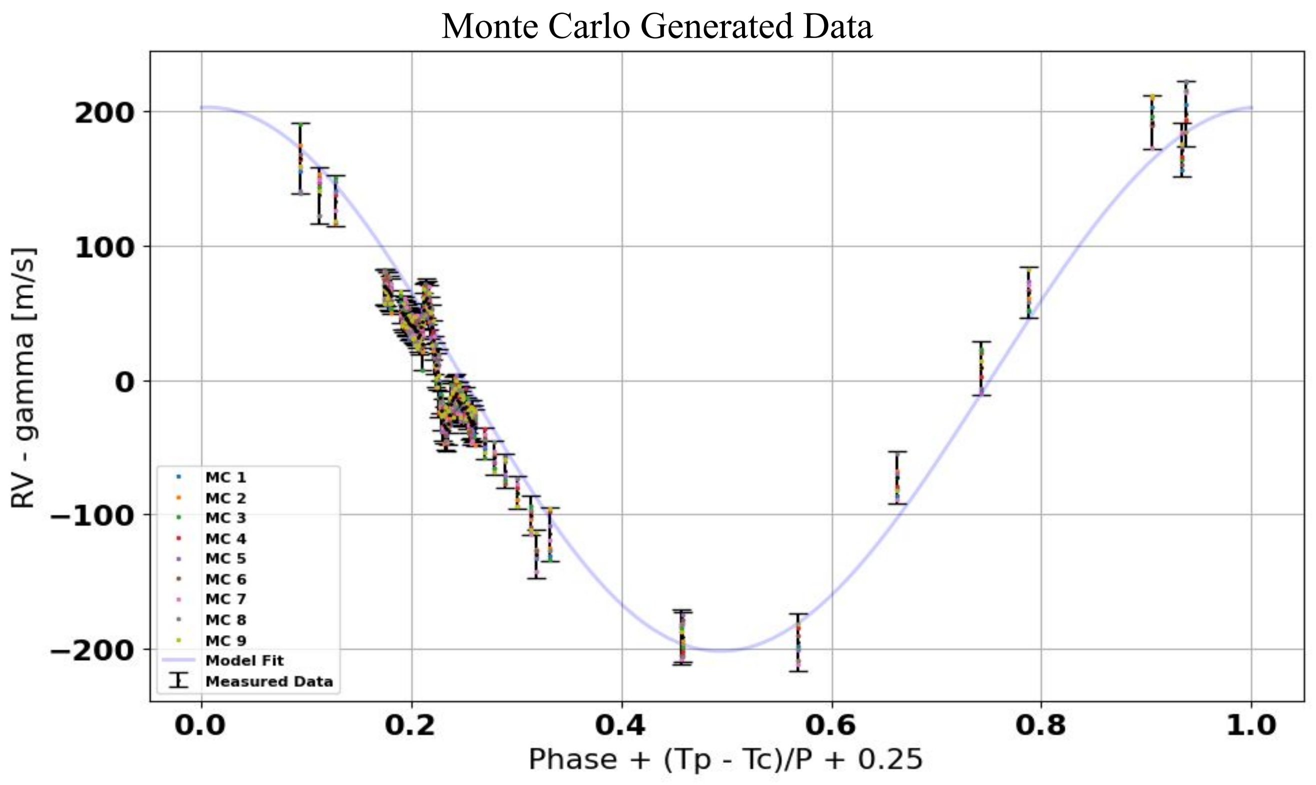
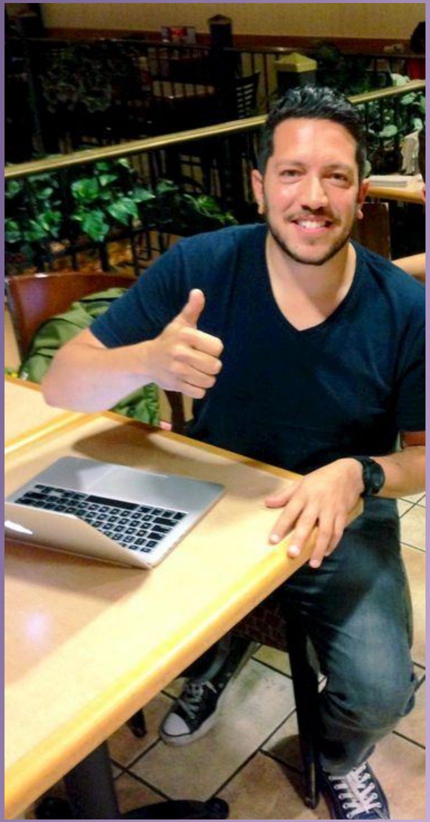


Results – Radial Velocity

$$M_p \sin i = K \left(\frac{P}{2\pi G}\right)^{1/3} (M_\star + M_p)^{2/3} (1 - e^2)^{1/2}$$

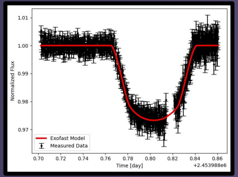
Estimate	NEA	
$\boxed{\bar{K} = 202.84 \pm 1.79 \text{ m/s}}$	$\boxed{K = 205.0 \pm 6.0 \text{ m/s}}$	1.1 ± 3.1 % Error
$\boxed{\bar{M}_p = 364.59 \pm 3.08\ M_\oplus}$	$\boxed{M_p = 359 \pm 25\ M_\oplus}$	1.6 ± 7.0 % Error
$\bar{M}_p = 1.15 \pm 0.01\ M_{\text{♃}}$	$M_p = 1.13 \pm 0.08\ M_{\text{♃}}$	



Results – Transit

Relate transit depth to ratio of planet/star radii

Bounded transit depth:
td = 0.24686 +/- 0.00048



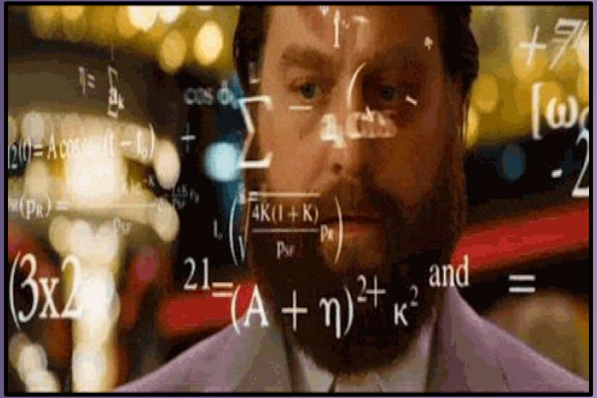
$$\delta = (R_p/R_s)^2 \Rightarrow R_p/R_s = \sqrt{\delta}$$

Rp/Rs = 0.15712 +/- 0.02186

Rs ~ 0.7801 R_sun (NEA)

Rp_estimated ~ 85270 +/- 11860 km

Not bad!

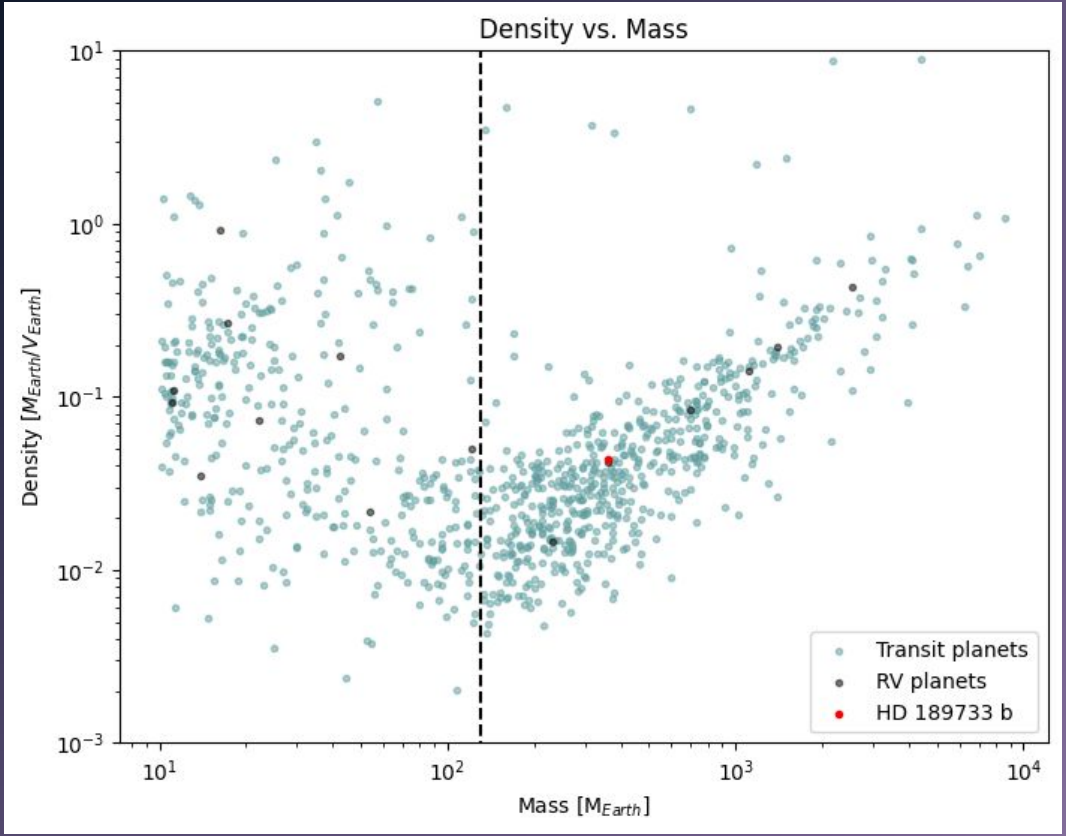


NEA

R_p/R_*	0.15534±0.00011
R_p ($R_\oplus$)	12.54±0.43

Rp_NEA ~ 79892 +/- 2740 km

Conclusion - Density

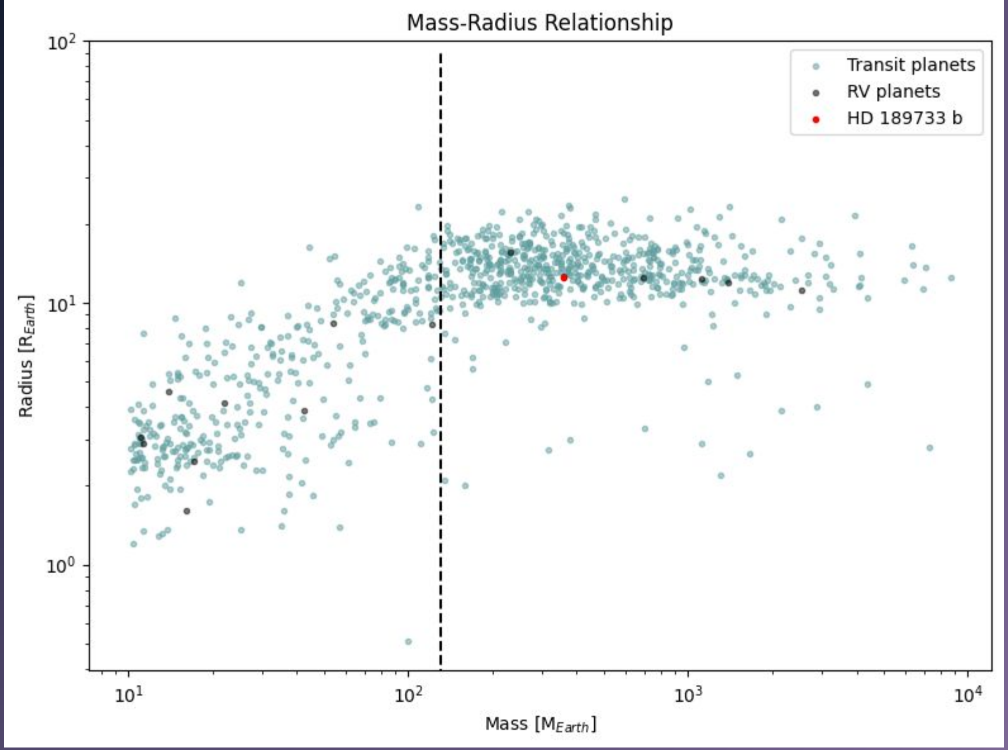


$$\rho = \frac{M}{V}$$

$\rho_{\text{HD 189733 b}} \sim 1000$ kg/m^3

$\rho_{\text{Earth}} \sim 5495$ kg/m^3

Conclusions - Comparison



According to Chen and Kipping (2016):

- $M_{HD\ 189733\ b} \sim 365.5\ M_{Earth}$
- $R_{HD\ 189733\ b} \sim 12.9\ R_{Earth}$

Our Values:

- $M_{HD\ 189733\ b} \sim 359\ M_{Earth}$
- $R_{HD\ 189733\ b} \sim 12.54\ R_{Earth}$

Questions?