ExoPlex: Build a Planet

Estimate Planetary Properties of the Trappist System

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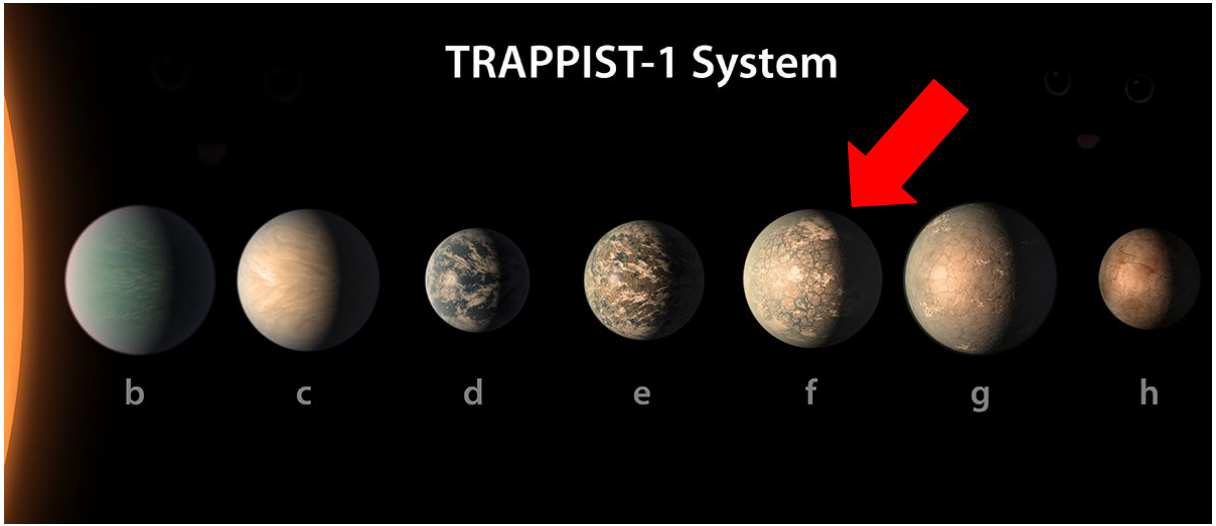
Introduction

Goal:

- Build a model planet based on stellar parameters
- Use Exoplex to model planet composition

Use stellar parameters of Trappist 1 to build a planet analogous to Trappist 1f



Background: Trappist 1 System

Trappist 1 (Star)

- Radius: 0.12 R_{sun}
- Mass: 0.09 M_{sun}
- Luminosity: 0.0005 L_{sun}

Trappist 1f (planet)

- 5th planet
- Discovered via Transit Method
- Mass: 1.04 M_{Earth}
- Radius: 1.05 R_{Earth}
- Orbital Radius: .0385 AU

Artist representation of the surface of Trappist 1f
Credit: NASA JPL-Caltech

Method: ExoPlex

Input:

- Stellar Parameters:
  - [Fe/Mg]
  - [Si/Mg]
- Planet Parameters:
  - Mass

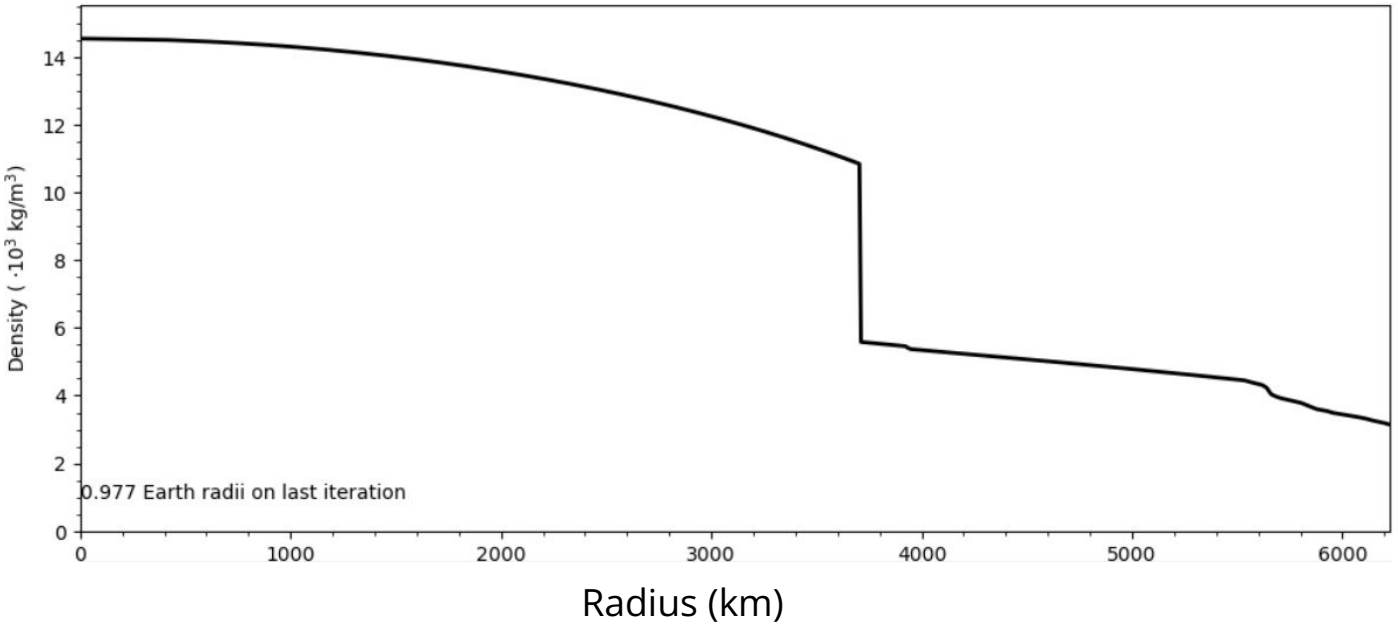
Output:

- Radius
- As a function of radius:
  - Density
  - Pressure
  - Gravity
  - Temperature
- Core Mass Fraction
- Core Radius Fraction
- Core Mantle Boundary

Initial Results: Trappist 1f

ExoPlex Input:

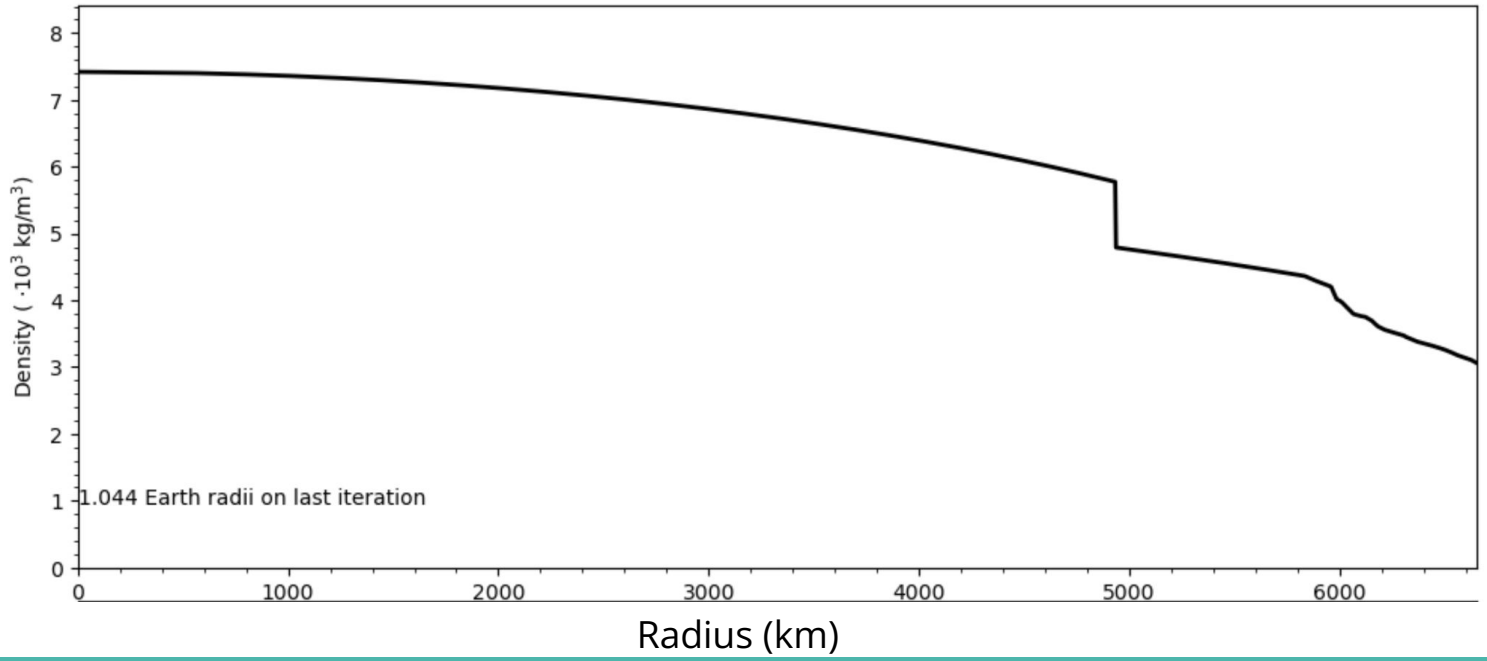
```
%run Group_1.py --mass=1.039 --FeMg=1.72 --SiMg=1.124
```



A More Detailed Look

ExoPlex Input:

```
%run Group_1.py --mass=1.039 --FeMg=1.72 --SiMg=1.124 --wt_frac_O_core=0.255
```



Stellar Irradiation

- Inputs
  - Orbital Distance: 0.0385 AU
  - Trappist 1 Luminosity: 0.0005 Lsun

$$T_{\mathrm{eq}} = \left(\frac{L\,(1 - A_B)}{16\sigma\pi a^2} \right)^{1/4}$$

- Flux on Trappist 1-f: 463 W/m^2
- Equilibrium Temperature: 212K
  - Earth Teq: 250K

Discussion

- Trappist-1f seems analogous to Earth
  - Similar mineralogy
  - Similar irradiation and equilibrium temperature
  - Similar densities
- Literature suggests atmosphere and high water composition on 1f
- Future: Run Exoplex with alternate parameters

References

“NASA Exoplanet Archive.” *NASA Exoplanet Archive*, https://exoplanetarchive.ipac.caltech.edu/.

https://iopscience.iop.org/article/10.3847/1538-4357/aad95d/pdf