

Geometry: Exoplanets

1 The Kepler Telescope

The **Kepler Observatory** is a telescope designed to find exo-planets, which are planets outside our solar system. It looks for **transit** dips in the light of a star that happen when the planet passes in front of the star

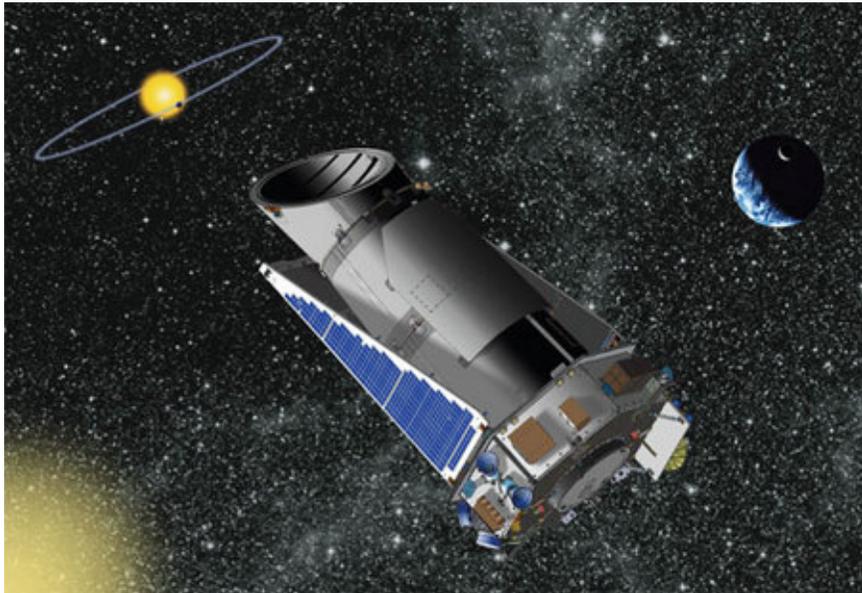


Figure 1: The Kepler Telescope observing a planet outside our solar system.

Kepler is designed to find planets like Earth that could potentially support life.

2 Planetary Transit

A **transit** happens when a planet orbits in front of a star, partially blocking some of the light from the star. By measuring how much light was blocked for how long, astronomers can determine how long a year is on an exo-planet, and how fast the planet is orbiting its host star.

3 Light Curve

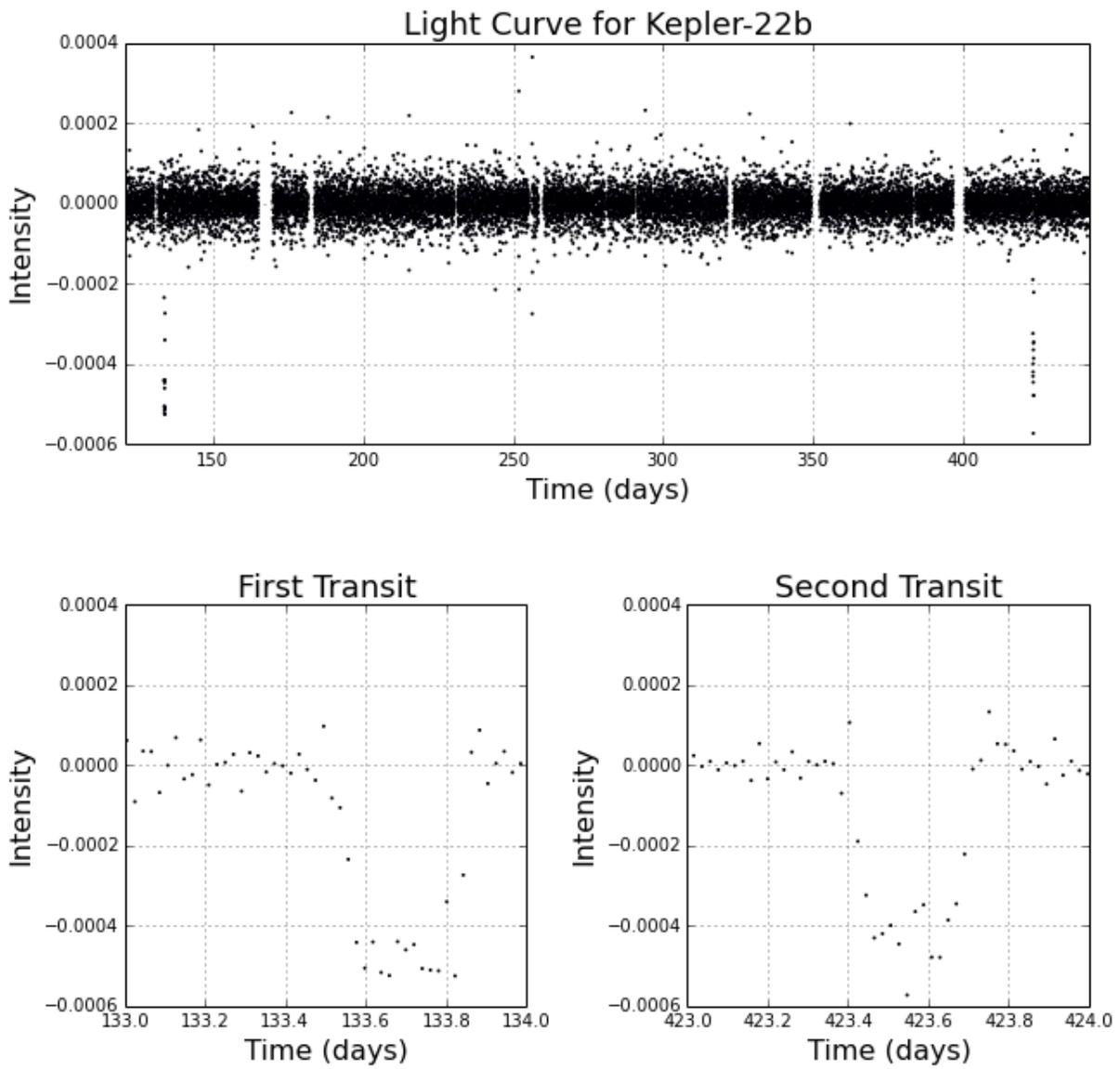


Figure 2: Kepler data for a potential planet called Kepler-22b

4 Kepler's Third Law

Kepler's Third Law reads

$$\frac{T^2}{d^3} = \frac{4\pi^2}{GM}$$

where:

- T is the length of a year on the planet, in days,
- d is the distance from the planet to the star in kilometers,
- M is the mass of the star in solar masses and
- G is the gravitational constant.

Question 1

Rewrite Kepler's Third Law, solving for the distance, d :

Question 2

From the data on the previous page, how long is a year on Kepler-22b?

Question 3

If $G = 1 \times 10^{21}$ and the star has a mass of $M = 0.97 M_{\odot}$, how far is the planet from its star?

5 Is it as big as Earth?

We can figure out how big the planet is by looking at how much starlight the planet blocks. The amount of light the planet has blocked out is given by the **ratio** of the areas:

$$\frac{A_{\text{planet}}}{A_{\text{star}}} = \Delta_{\text{light}}$$

Problem 1

Δ_{light} is the dip in light that happens when the planet passes in front of the star. Look at the dip in the data. How deep does Δ_{light} go?

Problem 2

If the radius of the star is $R_{\text{star}} = 6.7 \times 10^5 \text{ km}$, what is the area of the star?

Problem 3

What is the area of the planet?

Problem 4

What is the radius of the planet?

Problem 5

If the radius of the Earth is 6371 km , what is the **fraction** of Kepler-22b's radius to Earth's radius? I.e. how many times bigger is Kepler-22b than Earth?