

The Exoplanet Transit Method

Lucia Goldberg, Mahum Khan, Ellie Mak

The Components

1. The Graph
2. Horizontal Translation
3. Circular Orbit

Understanding an Exoplanet Transit

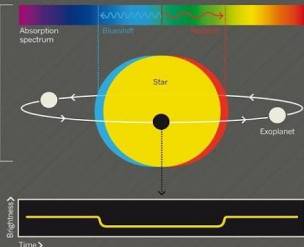
The Graph

PLANET-HUNTING FOR BEGINNERS

Of the handful of techniques for finding exoplanets — planets orbiting stars other than our Sun — two are by far the most productive.

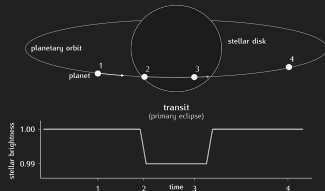
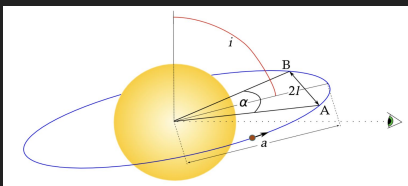
RADIAL VELOCITY

Radial velocity is the motion of a star caused by the gravitational influence of its orbiting planets. It can be measured through increases (blue-shift) or decreases (red-shift) in the frequency of light the star emits. Radial-velocity measurements can detect only planets whose orbits tug the star towards and away from the observer. The exact orbit of an exoplanet is hard to determine, so radial-velocity measurements let researchers deduce only the time a planet takes to orbit the star (its orbital period), how its orbit deviates from circular and its minimum mass. Radial velocity is most sensitive to massive planets with short orbital periods.



TRANSITS

When a planet crosses, or "transits," the face of its star, it dims the star's light by a small but detectable amount. The probability that any planet's transit will be visible from Earth is low, and is dictated by the ratio of the diameter of the star to the diameter of the planet's orbit. Large planets with short period orbits of small stars are most likely to be seen transiting, and lots of stars must be surveyed for any transits to be found. Transits let researchers deduce the radius of a planet and its orbital period. Astronomers can sometimes study a planet's atmosphere as starlight filters through or reflects off it. This gives information on atmospheric composition, temperature and cloud formation.



Kepler-186 f

$$R(\text{star}) = .47 * \text{sun} = 327283115.85 \text{ m} = 3.2728 * 10^8 \text{ m}$$

$$R(\text{planet}) = 1.17 * \text{Earth} = 7454153.1051 \text{ m} = 7.4542 * 10^6 \text{ m}$$

$$R(\text{orbit}) = .432 \text{ AU} = 6.46263 * 10^{10} \text{ m}$$

$$\text{Orbital period: } 129.9 \text{ days} = 3117.6 \text{ hr}$$

$$\text{Mass}(\text{star}) = 0.48 * \text{Mass}(\text{sun}) = 9.5472 * 10^{29} \text{ kg}$$

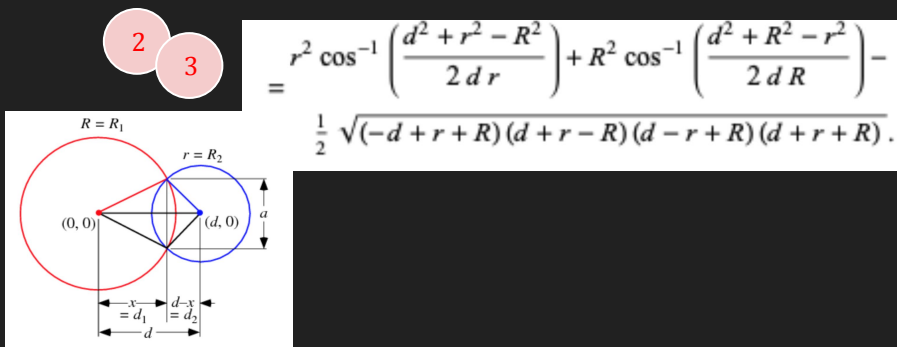
$$\text{Mass}(\text{planet}) = 1.44 * \text{Mass}(\text{earth}) = 8.59968 * 10^{24} \text{ kg}$$

$$\text{Planet to star radius ratio} = .021$$

$$\text{Velocity} = C/T = .432 \text{ AU} * 2 * \pi / 129.9 = 3125935478000 \text{ m/days} = 3.1259 * 10^{12} \text{ m/days} = 1.3024 * 10^{11} \text{ m/hr}$$

PLANET TYPE	DISCOVERY DATE
Super Earth	2014
MASS	PLANET RADIUS
1.71 Earths	1.17 x Earth
ORBITAL RADIUS	ORBITAL PERIOD
0.432 AU	129.9 days
ECCENTRICITY	DETECTION METHOD
0.04	Transit

Components of the Code



Final Step: Animate!

Why Kepler-186f?

- The first validated Earth-size planet to orbit a distant star in the habitable zone (a distance where liquid water might pool on the planet's surface)
- A planet the size of Kepler-186f is likely to be rocky
- Kepler-186f is near the outer edge of the habitable zone, orbiting its star once every 130 days and receiving one-third the energy that Earth does from the sun.
- If you could stand on the surface of Kepler-186f, the brightness of its star at high noon would appear as bright as our sun is about an hour before sunset on Earth.
- The Kepler-186 system, home to four inner planets, is about 500 light-years from Earth in the constellation Cygnus



Horizontal Translation

Goal: animate the exoplanet's linear transit across the sun

- Plotted subplots, created an empty array to hold positions of the planet
- Used `ax.scatter` to plot the sun as a dot at the center of the graph
- Used `np.append` to plot the moving exoplanet as a series of dots moving horizontally across the screen, passing through the center of the sun

Circular Orbit

Exoplanet transit equations assume circular orbit

(Insert information about circular orbit once working)

Sources

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