

**Exoplanet Detection Methods:  
Transit and Radial Velocity Techniques**

Chimi Rinzin Wangmo

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## Abstract

Exoplanets, planets orbiting stars outside our solar system, have become a major focus of modern astronomy. Detecting these distant worlds is challenging due to their small size and faint light compared to their host stars. Two of the most effective and widely used techniques for exoplanet discovery are the transit method and the radial velocity method. This paper explores how each method works, their advantages and limitations, and examples of notable exoplanet discoveries.

## Introduction

The study of exoplanets allows astronomers to understand planetary formation, system evolution, and the potential for life beyond Earth. Since the first confirmed exoplanet discovery in 1992, thousands have been detected, largely due to advances in observational techniques. This paper focuses on two primary detection methods: the transit method and the radial velocity method.

### Transit Method

#### Principle

The transit method involves monitoring the brightness of a star over time. When an exoplanet passes in front of its host star, it causes a small but detectable dip in starlight, known as a transit.

#### Detection Process

1. Continuous observation of a star's light curve.
2. Identification of periodic dips indicating an orbiting planet.
3. Calculation of planet size and orbital period based on the depth and duration of the dip.

#### Advantages

- Can determine planet size and orbital period.
- Enables atmospheric studies using transmission spectroscopy during transit.

## Limitations

- Only works for planets whose orbital plane aligns with Earth's line of sight.
- Can produce false positives due to binary stars or stellar activity.

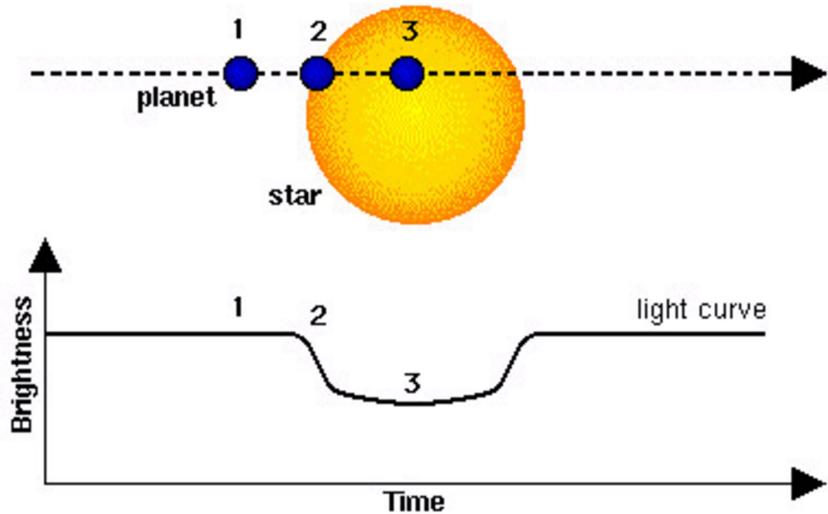


Figure 1. Transit Method Illustration

## Radial Velocity Method

### Principle

The radial velocity method detects variations in a star's motion caused by gravitational pull from an orbiting planet. This motion causes a Doppler shift in the star's spectral lines, allowing astronomers to infer the planet's presence.

### Detection Process

1. Observe the star's spectrum for redshift (moving away) and blueshift (moving toward Earth).
2. Analyze periodic changes to determine the planet's mass and orbit.

## Advantages

- Effective for planets that do not transit their stars.
- Can estimate planet mass and orbital eccentricity.

## Limitations

- Less sensitive to small, Earth-sized planets.
- Requires precise instruments and long-term monitoring.

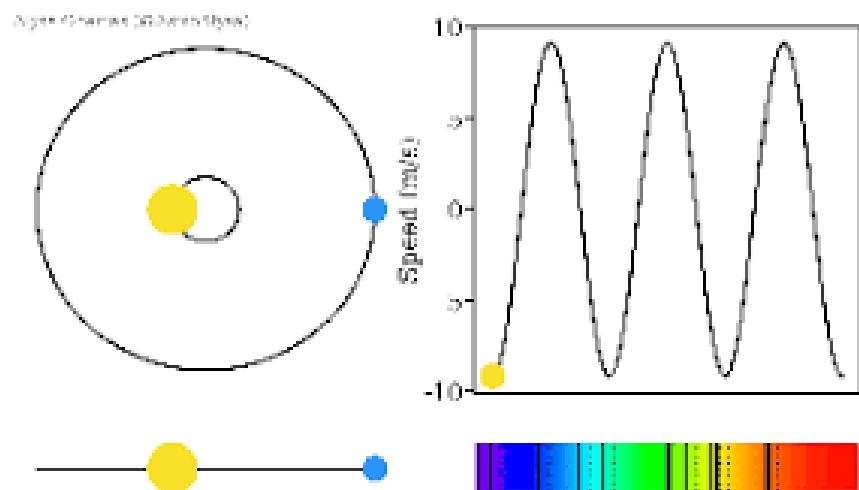


Figure 2. Radial Velocity Method Illustration

## Notable Discoveries

- **Kepler-22b** (transit method) – A super-Earth in the habitable zone.
- **51 Pegasi b** (radial velocity method) – The first confirmed exoplanet orbiting a Sun-like star.

## Conclusion

The transit and radial velocity methods have revolutionized exoplanet science. While each has limitations, together they provide complementary data that helps astronomers identify and characterize distant worlds. As technology improves, these methods will continue to uncover smaller and more Earth-like planets, expanding our understanding of the universe.