

Extrasolar Planets

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Opening Discussion

- Have you seen anything interesting in the news?
- Magnetic fields and the slowing of the Sun.
- What can cause stars to go boom? Will we have warning?
- Visiting moons of other planets.
- What happens to planets in a supernova?
- Is there Uranium on the Moon?
- Why aren't comets like Jovian planets? Why don't asteroids or comets accrete to form planets?
- Are meteors asteroids or comets?

More Minute Essays

- What other solar system formation theories are there? What happens if we find a planet going the wrong direction?
- Formation of the Jovian moons. Only Earth's Moon and Charon likely formed from a giant impact. How do rings form?
- No impact craters from giant impacts.
- Can you form stars without planets?
- What would we do if a comet was headed towards us?

A Bit of History

- Prior to 1995 we couldn't say if there were any planets outside of our Solar System. The nebular theory would imply that they should be common, but they had never been observed.
- Large telescopes could resolve planets around other stars were it not for the fact that the stars are so much brighter than the planets.
- In 1995 the first extrasolar planet around a normal star was announced. It didn't fit expectations. Since then we have found many other planets. Some match expectations and some don't.

Philosophical Implications

- Let's pause for a second and ask why discovering planets outside of our Solar System is significant. It has implications that are as big as those that came with the Copernican revolution.

Detection Methods

- Since we generally can't see the planets directly, you might wonder how we can detect planets around other stars. There are several methods, one of which has been the most successful so far.
- Some methods use the fact that the planet pulls on the star as it orbits. Doppler method measures radial speed of the star. Astrometry method measures changes in position.
- Some methods use light from stars. Transits happen when a planet passes between us and a star. Lensing watches the brightness of distance stars as other stars pass in front of them.

Doppler Method

- The most successful method to date has been the Doppler method. The best instruments currently available can measure the speed of a star accurate to 3 m/s.
- This method tells you orbital period, eccentricity, and an estimate of the mass.
- Because it only measures radial velocity, the mass measurement depends on the inclination of the orbit to our line of sight.
- If you know the mass of the star you can calculate orbital distance.

Known Exoplanets

- Go to <http://exoplanets.org> or <http://cfa-www.harvard.edu/planets/> for a list of the currently known extrasolar planets and various information on them.
- Nearly all have been discovered by the Doppler method.
- Some things about them should really jump out at you. They are all big and they are all fairly close to their stars.
- 51Peg is a prototype for so called hot Jupiters. These are gas giants that orbit very close to their stars.

Why are they so different?

- It turns out we are finding these planets because we can't find anything more like our own Solar System. Doppler method is most sensitive to big planets near stars. Other methods have other strengths, but detecting an Earth sized planet is very hard.
- The bigger question is, how can we explain these with the nebular theory? Do these planets invalidate the nebular theory?

Minute Essay

- What do you think are the implications of planets being common?