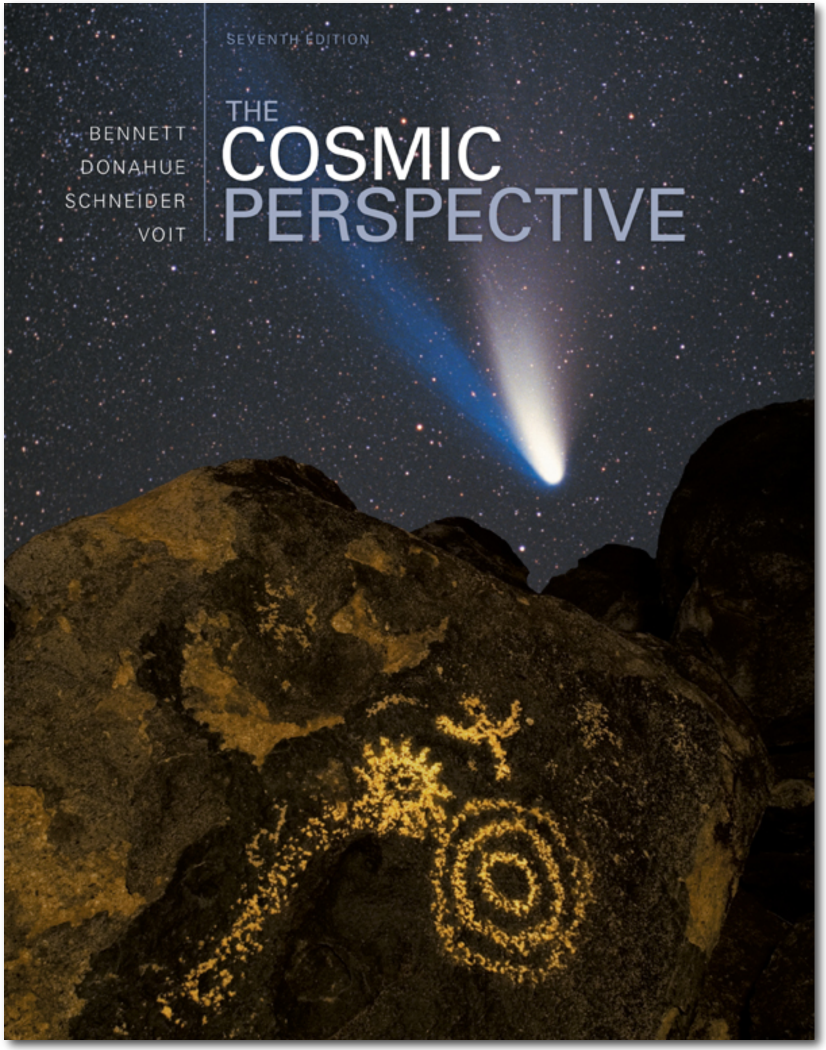
The Cosmic Perspective

Seventh Edition



Other Planetary Systems: The New Science of Distant Worlds

13.1 Detecting Planets Around Other Stars

- Why is it so challenging to learn about extrasolar planets?
- How can a star's motion reveal the presence of planets?
- How can changes in a star's brightness reveal the presence of planets?

Seeing a planet around another star is difficult in part because the reflected light from a planet is at least __________ than the star.

a) one thousand times fainter
b) one hundred thousand times fainter
c) one million times fainter
d) one hundred million times fainter
e) one billion times fainter

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Which of the following techniques has been used to find the most extrasolar planets, prior to the *Kepler* mission?

a) the astrometric technique
b) the Doppler technique
c) transits and eclipses
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a) the mass of the planet
b) the orbital period of the planet
c) the size of the planet
d) the size of the planet's orbit

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What is the astrometric technique for discovering extrasolar planets?

a) It is the observation of changes in the star's spectrum due to the gravitational effects of an orbiting planet.
b) It is the observation of changes in the star's brightness as a planet passes in front of the star.
c) It is the observation of changes in the position of the star due to the gravitational effects of an orbiting planet.
d) It is the observation of changes in the star's spectrum due to the presence of the spectral signature of the planet in the same observation.

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What is the difference between a transit and an eclipse?

a) A transit is when the planet passes in front of the star and an eclipse is when it passes behind the star.
b) An eclipse is when the planet passes in front of the star and a transit when it passes behind the star.
c) There is no difference. These are two terms referring to the same event.
d) A transit is when a star's position changes due to a planet, and an eclipse is when a star's brightness changes due to a planet.

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Which technique of extrasolar planet detection can tell us about the composition of a planet's atmosphere?

a) direct detection
b) transits and eclipses
c) the Doppler technique
d) all of the above
e) A and B

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Which technique of extrasolar planet detection can tell us about the orbital period of a planet?

a) direct detection
b) transits and eclipses
c) the Doppler technique
d) astrometry
e) all of the above

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13.2 The Nature of Planets Around Other Stars

- What properties of extrasolar planets can we measure?
- How do extrasolar planets compare with planets in our solar system?

What are the orbits of most extrasolar planets like?

a) They are larger than the orbit of Jupiter.
b) They are more eccentric than the orbit of Mars.
c) They are more inclined than the orbit of Pluto.
d) They are nearly circular.

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What is the biggest surprise about extrasolar planetary systems?

a) Most of the systems only have one planet.
b) Many systems have several planets larger than Jupiter.
c) Many systems have very large planets orbiting close to the star.
d) Most of the planets do not fit into the categories of terrestrial or jovian planets.

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What is a *hot Jupiter*?

a) a gas giant with a larger than usual source of internal energy
b) a gas giant whose atmosphere is heated to high temperatures due to its small distance from its star
c) a gas giant with a large orbital eccentricity
d) a gas giant with large amounts of radioactive material
e) a gas giant that has an extremely high interior temperature

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13.3 The Formation of Other Solar Systems

- Can we explain the surprising orbits of many extrasolar planets?
- Do we need to modify our theory of solar system formation?

How can we explain the presence of gas giants so close to their stars?

a) The nebular theory has been modified to allow for the formation of gas giant planets close to a star.
b) The hot Jupiters are close to cool stars, and so are not actually very hot and have the same history as gas giants in our solar system.
c) These gas giants formed far from the star and migrated inward due to gas drag in the nebula.
d) These gas giants formed far from the star and migrated inward due to the effects of waves in the nebula.
e) These gas giants formed from a star, and then were captured by another star in a much closer orbit.

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Why do many extrasolar planets have large orbital eccentricities?

a) Their eccentricities are increased by close gravitational encounters with other planets while they migrate.
b) Their eccentricities are increased by orbital resonances with other planets.
c) The effect of waves in the nebula on the planet increases the planet's eccentricity.
d) all of the above
e) A and B

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e) **A and B**

Why are most extrasolar planetary systems so different than ours?

a) There is a large diversity of planetary systems predicted by the nebular theory, and we would not expect any two to be similar.
b) It is easier to detect planets that are massive and close to their stars, and harder to detect systems like our own.
c) The Sun's nebula was affected by a nearby supernova making it the exception, rather than the rule.
d) Our planetary system has been affected to an unusual degree by giant impacts, causing it to be different than the extrasolar planetary systems that we now see are more typical.

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13.4 The Future of Extrasolar Planetary Science

- How will future observations improve our understanding?

How does the *Kepler* mission search for Earth-like planets?

a) It searches for the dip in a star's brightness when an Earth-like planet transits (passes in front of) the star.
b) It searches for the perturbations in the star's motion caused by Earth-like planets using the Doppler technique.
c) It measures the spectra of extrasolar planets to look for the signature of nitrogen-oxygen atmospheres.
d) It measures the perturbations in a star's brightness caused by gravitational microlensing from Earth-like planets.

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How will astrometry be improved to allow detection of extrasolar planets with future telescopes?

a) by using a very large space-based telescope with a deployable reflective mirror
b) by using interferometry (combining the signals of two or more space telescopes) to obtain better angular resolution
c) by using radio telescopes positioned around the world to create a telescope with an effective size as large as the planet
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