FACT SHEET:
PLANET-FINDING TECHNIQUES

Do Earth-like planets exist around nearby stars? If so, do these planets harbor life? Since the first discovery in 1995 of a planet orbiting a star outside of our solar system, astronomers have found dozens of extrasolar planets. These planets have never actually been seen, but instead discovered indirectly using methods that permit us to infer the planets' existence through their effects on their parent stars.

Observing extrasolar planets is extremely difficult for three main reasons: the planets are at an immense distance from Earth; they appear very faint; and they are overwhelmed by the blinding glare of their parent stars. The largest and most powerful telescopes on Earth are still incapable of seeing these planets.

The only successful method of detecting extrasolar planets, used by Dr. Geoff Marcy of the University of California, Berkeley, and Dr. Paul Butler of the Carnegie Institution of Washington, is known as the Doppler detection method, or the radial velocity method. Astronomers have detected 90 planets with this method, which involves measuring the speed of a star as it approaches and recedes. To do this, astronomers look at the change in the wavelength of light emitted by a star over the course of time. This changing wavelength is called the "Doppler shift" of light, resulting from the star and its companion planet orbiting a common center of mass. For example, Jupiter's orbit causes a slight wobble (back and forth motion) in the Sun, introducing velocity changes of about 12 meters per second (about 27 miles per hour).

Astronomers can detect these wavelength shifts by analyzing the spectra of starlight. Light waves from a star moving toward Earth become compressed and shift toward the blue end of the spectrum. If a star is moving away from Earth, the light waves spread out and shift toward the red end of the spectrum. The larger the planet and the closer it is to the host star, the faster the star moves about the center of mass. This causes a larger color shift in the spectrum of starlight. It is not surprising that most of the early extrasolar planet discoveries were of massive planets orbiting very close to their stars. Such planets exert the most extreme gravitational effects on their stars and are the easiest to detect. Many of the first planets discovered with the Doppler method are up to 300 times as massive as Earth, and move in orbits even smaller than Mercury's.

Some of the other techniques being explored by astronomers in search of extrasolar planets are astrometry, the transit method and gravitational microlensing. Like the Doppler method, astrometry attempts to detect the motion of a star caused by a planet's gravitational effect. But unlike the Doppler method, astrometry tries to measure the motion of a star across the sky. No planet detections have been confirmed thus far using astrometry; however, NASA plans to use the method to detect extrasolar planets with a spaceborne telescope on its Space Interferometry Mission scheduled for launch in 2009.

In the transit method of detection, if a planet passes directly between a star and an observer's line of sight, it dims the star. With sensitive instruments, astronomers can detect this dip in brightness and calculate the orbit, size, mass and density of the planetary companions. The effect on the star's light is proportional to the size of the planet. A terrestrial planet in an Earth-like orbit, for example, would make a tiny dip in stellar brightness that would only last a few hours. To date, the only successful use of this technique was a 1999 confirmation by transit detection of a planet previously detected with the Doppler method.

Gravitational microlensing involves finding objects that emit no light or are otherwise undetectable. This method uses the theory that gravity bends space, part of Einstein's theory of general relativity. When a planet passes in front of its parent star along our line of sight, the planet's gravity behaves like a lens, focusing the light rays and causing a temporary increase in brightness and change of the star's apparent position. This technique may bear fruit in the future.

The Doppler method has so far only yielded large planets that probably don't sustain life. However, astronomers continue to search for smaller planets and multiple-planet systems -- solar systems like our own in which Earth-size planets orbit nearby stars like our Sun. More information about planet detection methods is at the following websites:

http://exoplanets.org
http://www.kepler.arc.nasa.gov/Capabilities.html .
http://planetquest.jpl.nasa.gov/science/finding_planets.html

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