Six new extra-solar planets discovered using new technique

Tim Joy
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While space missions such as the Mars Pathfinder mission or the International Space Station capture most public attention, exciting new developments in our understanding of the cosmos are being made from earth-based telescopes. On November 29, the leading team of planet finders announced the discovery of six new extra-solar planets or planets outside our solar system. The findings increase the number of such planets by 25 percent and bring the total number to 28.

For a field of science that only moved from speculation into reality five years ago, the discovery of planets orbiting distant stars is akin to Galileo's discovery of the moons of Jupiter in the 17th century with one of the first telescopes. Galileo's observations provided the first glimpses of new worlds and helped popularise the theories of Copernicus. The detection of planets outside our solar system poses fresh theoretical questions concerning planetary systems and makes more tangible the prospects of life forms beyond the earth.

For the past three years, Steven Vogt, professor of astronomy and astrophysics at the University of California, with colleagues Geoffrey Marcy, Paul Butler and Kevin Apps have conducted a search for nearby stars. Using the High Resolution Echelle Spectrograph (HIRES), designed and built by Vogt, on the Keck I Telescope in Hawaii, the team surveyed 500 stars similar in size, age and brightness to the Sun.

The six new planets range in mass from 0.8 to 6.5 times the mass of Jupiter and are probably similar in composition to Jupiter, a giant ball of hydrogen and helium gas about 317 times the mass of the earth. The distance of the new planetary systems from earth is between 65 and 192 light years.

Five of the six planets orbit in what is know as the “habitable zone” of their stars—that is, within a region where temperatures allow water to exist in liquid form. For instance, the planet orbiting the star HD 134987 in the constellation Libra had an average orbital distance of 0.81 astronomical units (AU—the distance from the earth to the Sun) and an estimated equilibrium surface temperature of 42 degrees Centigrade—well within the habitable zone of its star. But at 1.58 times the mass of Jupiter, it would have little in common with Earth.

It is unlikely that a system with Jupiter-sized planets at low orbits would include Earth-like planets—the smaller planet would be ejected by the gravitational pull of the larger one. But it is possible that the large planet could have orbiting moons that may have conditions to support life. Vogt commented: “For a planet in the habitable zone of its star, such moons offer the possibility of liquid water and the eventual emergence of life”.

Like most of the other extra-solar planets discovered so far, the orbits of the new planets tend to be oval rather than circular. One of the stars, HD 222582, has a planet with the most eccentric orbit—coming as close as 0.39 AU to the parent star and receding to 2.31 AU to its furthest point during its 576-day orbit. “It is beginning to look like neatly stacked circular orbits, such as we see in our own solar system, are relatively rare,” Vogt said.

Astronomers are able to detect the presence of a planet by examining a slight wobble in the motion of the star caused by the gravitational pull of the planet. Vogt's team used a new method to measure this wobble by what is known as the Doppler effect. As the distant star moves relative to the earth, the light from the star shifts in frequency—towards blue as it approaches and towards red as it departs. If the star were isolated then this shift would be constant. The existence of a planet orbiting the star would cause slight variations, or

"wobbles," in the frequency shift.

The light from the star passes through a bottle of iodine vapour placed at the focus of the telescope to remove specific frequencies from the spectrum; these missing frequencies are then used as a reference to calculate any shift. By observing the star over time and using a computer to analyse the light spectrum, it is possible to discern shifts in wavelength to an accuracy of 1 part in 100 million. The orbit of a planet will cause these wobbles to be periodic. By examining the magnitude of each shift, the path of the orbit and the minimum mass of the planet can then be calculated using the laws of motion.

Some astronomers have challenged this method claiming that the stars themselves are oscillating. Others have pointed out that the strongest and most easily detected oscillations should occur at high frequencies. But Vogt and his colleagues recently demonstrated the validity of their technique by predicting and measuring the dimming of a star as a planet passed in front of it.

The size, composition and orbit of the new planets will add to the scientific debate about the formation of planets. The findings further challenge the conventional theory that planets form from an outer edge of a spinning disk of gas and dust orbiting around a star. One of the planets, also discovered by a team at the University of Geneva, had a mass over three quarters the size of Jupiter but orbiting very close to its star (0.15 AU) over a short time (24.36 days). At present there is no clear understanding as to how such large planets could form so close to a star.

The researchers also gathered data on four previously discovered planets. Two of the planets showed signs in their orbits indicating the existence of a companion object. At present it is not clear whether the companion objects are further planets or other larger objects such as brown dwarfs—a type of star. The discovery comes only seven months after the first multi-planet system outside our own, around the star Upsilon Andromedae, was identified. Vogt commented: "It will take years of additional observations to work out the masses and orbits of these companions, but the evidence suggests that there are a large number of multi-planet systems out there."

The latest discoveries add significantly to what is a rapidly expanding field of astronomy. The National Aeronautics and Space Administration (NASA) is expected to launch a network of space-based telescopes in the year 2005 to start a five-year mission looking for new planets—a development that would greatly enhance prospects of new discoveries.