Two planetary systems with potentially Earth-like conditions

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Astronomers studying planets outside the Solar System using NASA's Kepler mission have found two planetary systems that include a total of three super-Earth sized planets that receive a similar amount of stellar radiation as the Earth, placing them in the "habitable zone" of their respective systems. The discoveries are another step towards finding a similar world to Earth around a similar star to the Sun.

Kepler is a spacecraft named after the 17th century astronomer Johannes Kepler, who determined that planets orbit in ellipses rather than circles. Kepler's mission is to observe the brightness of approximately 150,000 stars in the neighborhood of the Sun. It looks for any periodic drop in brightness of the stars it observes. If other factors are accounted for, such as a star's own changes in brightness, then that signal is taken to be the indication of a planet in orbit blocking some of the star's light when it passes in front of the star. This is known as the transit method of discovering exoplanets. To date, Kepler has confirmed 122 planets and has 2,740 candidates.

Kepler-62 is the first newly discovered system with Earth-sized planets orbiting in the star's habitable zone. It is 1,200 light years away in the constellation Lyra and has five known planets. The two outermost planets, Kepler-62e and f, are the planets in the habitable zone, orbiting around their star in 122 and 267 days. Kepler-62e is 60 percent larger than Earth, while Kepler-62f is 40 percent larger, making it the smallest planet within a star's habitable zone discovered to date. Theoretical models of both planets suggest that they have a possible rocky composition.

The second system, designated Kepler-69, is orbited by three planets and located 2,700 light years away in the constellation Cygnus. Kepler-69c is the system's planet in the habitable zone and is 70 percent larger than the Earth. It orbits its star every 242 days. Its composition is currently unknown.

Both systems also have stars similar to the Sun. Kepler-62 is a star that is approximately two-thirds the mass and radius of the Sun, while Kepler-69 has a mass and radius respectively 81 percent and 93 percent that of the Sun.

While all three planets are further steps in discovering an Earth-like world in another solar system, the data collected so far on these worlds is insufficient to determine whether liquid water exists on the surface of any of the planets.

A star's "habitable zone" is a rough estimate, based on the knowledge of only our own solar system, of the distance a planet has to be in order to have liquid water on its surface. Astronomers take the luminosity of a given star and determine the range of orbits that are neither too hot nor too cold to sustain liquid water, given an atmospheric pressure similar to Earth's.

However, this still tells us little about whether liquid water is on the planet. Whether water exists on the surface of any body is determined not just by how much light is incoming, but how much energy from that light the surface of the planet retains. The Moon, for example, is within the Sun's habitable zone, but because it has no atmosphere (among other things) it does not retain the surface heat needed to have liquid water on its surface.

Venus and Mars are two other excellent examples of why atmospheric composition is so important. Venus is in the Sun's habitable zone and only gets 60 percent more light than the Earth, but its surface is hot enough to melt lead. Mars is near the outer range of the Sun's habitable zone but its atmosphere is extremely thin and the resulting surface atmospheric pressure is six-tenths of a percent of Earth's. Neither planet has liquid water

on its surface.

Furthermore, the actual composition of the newly discovered planets could be extremely strange. 51 Pegasi b is a gas giant similar to Jupiter less than 5 million miles away from its parent star, something thought impossible by our understanding of planetary formation. GJ 1214b is 6.5 times as massive as the Earth and is believed to be covered in vast oceans of super-pressurized water. Kepler-10b has a radius and mass 1.4 and 4.6 times the Earth's, but it orbits extremely close to its star, most likely being an extremely large ball of iron.

These are only a few of the considerations that need to be taken into account. Others include the actual composition of the planetary atmospheres, the geophysics of the exoplanets and a variety of other parameters. Until there are instruments to determine such information, there is only speculation as to whether these planets have liquid water on their surface, much less life.

Such a characterization of the atmosphere of an exoplanet would have been the primary mission goal of the Terrestrial Planet Finder (TPF). It was slated to work alongside Kepler, studying in detail planets that Kepler determined were within a star's habitable zone and study the composition of the exoplanetary atmospheres, if they exist at all. Essentially, it was tasked with seeing whether Earth-like planets are common or a rarity. NASA cut the mission in 2011 after budget cuts imposed by the Obama administration.

Other missions have been cut in recent years. NASA's Space Interferometry Mission, a spacecraft specifically designed to look for exoplanets in a star's habitable zone, was canceled in 2010. The European Space Agency's Darwin mission ended in 2007 after funding to explore the technology necessary for the mission was ended. There are currently no new missions slated to increase our ability to search for Earth-like worlds.