

Extra-solar planet could sustain Earth-like life

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Scientists investigating the growing number of extra-solar planets, or exoplanets, have concluded that the planet Gliese 581 d is the first to be confirmed to have a possibility of sustaining Earth-like life. A recent study by a team of researchers led by Robin Wordsworth shows that Gliese 581 d is the first rocky planet discovered that potentially has atmospheric conditions allowing for liquid water on its surface.[1]

Speculations of the existence of exoplanets began as early as the 16th century. Giordano Bruno suggested, based on the Copernican model of the solar system, that if the Sun is merely a star and if planets orbit the Sun, then the stars seen in the night sky must also have planetary systems. Isaac Newton made the same observation two centuries later in the conclusion of his *Principia Mathematica*.

While the idea that the solar system is not unique in having a planetary system has been around for centuries, the first definitive confirmation of an exoplanet occurred in 1992 around pulsar PSR 1257+12. Pulsars are the fantastically dense remnants of supernova that emit a stream of radiation and rotate very fast and with great regularity.

Radio astronomers Aleksander Wolszczan and Dale Frail, who were studying the object, noted a slight anomaly in the rotation, indicating a nearby mass, the first planet to be discovered outside the solar system. The system is now known to have three planets, with a fourth unconfirmed.

Using pulsars provides an accurate indicator of a planet's existence, but this search method will not find most planets, due to the rarity of pulsars compared to other stars. In addition, no planet bathed in the radiation of the nearby pulsar could harbor Earth-like life.

However, in the mid-1990s advances in technology allowed for the indirect detection of the gravitational influence of planets on parent stars that are not pulsars. In addition, studying periodic drops in the apparent brightness of stars has become a method of direct detection of exoplanets.

The Gliese planetary system was discovered from gravitational perturbations on the parent star. The first planet was discovered in 2005 and the second in 2007. The third and fourth planets were announced in 2009 and data indicating the existence of fifth and sixth planets was released in 2010. Currently, however, the claim of fifth and sixth planets is disputed within the astronomical community.

A large amount of research has gone into determining the habitability of the planets within the Gliese system. The first criterion that must be met is whether any of the planets are within the star's "habitable zone." This is the range of orbits at which the surface temperature of the planet produced by the energy output of the star is capable of sustaining liquid water.

In 2010, a team of astronomers led by Steven Vogt announced that the planet Gliese 581 g was a planet approximately the mass of Earth and well within the habitable zone. However, studies since then have brought the existence of the planet into question, suggesting that the data on 581 g is anomalous.

Gliese 581 d, the third planet discovered in that system, is now considered a potentially habitable planet. The planet is most likely a rocky world with a minimum mass of five and a half times that of Earth and twice Earth's radius. It is also tidally locked, which means one side of the planet is always facing its star, much as one side of the Moon is always facing the Earth, or one side of Mercury facing the Sun.

Atmospheric modeling was the primary tool of

Wordsworth's team. No current technology is capable of directly analyzing the content of an exoplanet's atmosphere. However, certain basic assumptions can be made. It is known that the most common light elements in the universe, beyond hydrogen and helium, are nitrogen, oxygen and carbon. These are commonly seen to form molecular nitrogen, water and carbon dioxide in observed nebula. Using this knowledge, various types of atmospheres can be hypothesized and tested in simulations. What Wordsworth's team discovered is that it is possible for a stable atmosphere to develop that allows for the presence of liquid water on the side facing the star.

This result is by no means a confirmation of habitability for unprotected humans on the surface of Gliese 581 d. Many variables in the exoplanet's geophysics could create unknown situations that would create uninhabitable conditions, such as tectonics and potential runaway greenhouse effects.

Additionally, the surface gravity of the planet is known to be approximately twice that of Earth, which could cause many long-term issues for any human presence on the surface.

Ultimately, a spectroscopic analysis will be required to discover exactly what elements are in the atmosphere of Gliese 581 d and in what percentages, before any consideration could be given to visiting the planet in the far future. While this is technically possible now, the planned missions to do so have been canceled due to cost overruns and NASA's internal politics.

Even if Gliese 581 d turns out to be uninhabitable, much has been and will be learned in the study of the planet and of the system. Astronomers are fine-tuning their ability to find multiple planets within a distant solar system. They can now discover planets close to Earth's volume and mass. They can potentially determine the atmospheric composition of a planet 20 light years away.

If Gliese 581 d is indeed capable of sustaining human life, the discovery would be all the more spectacular. The relative proximity of the system means that it is only a short hop—at least on the scale of the galaxy—to future colonists looking to lead humanity to the stars.

Notes:

1. Wordsworth, et al. "Gliese 581d is the first discovered terrestrial-mass exoplanet in the habitable zone." *The Astrophysical Journal Letters*, Volume 733,

Issue 2, article id. L48 (2011). arXiv:1105.1031v1 [astro-ph.EP].



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