

New study estimates billions of Earth-sized planets orbiting Sun-like stars in the Milky Way galaxy

Bryan Dyne
9 November 2013

Astronomers at the University of California, Berkeley and the University of Hawaii, Manoa have used data from NASA's Kepler spacecraft to estimate that there are billions of Earth-sized planets that orbit the "habitable zone" of Sun-like stars within the Milky Way galaxy. The findings, published by Erik Petigura et al. in the November 4 issue of the *Proceedings of the National Academy of Sciences*, are an important step in the investigation of how many planets exist that resemble Earth.

This is not a wholly unexpected result. Ever since Kepler was launched in 2009, it has become more and more apparent that stars with planetary systems are the norm rather than the exception. Every week, the data from Kepler's four-year mission reveals several new planets orbiting their parent stars. According to the NASA Exoplanet Archive, Kepler currently has 3,602 candidates and 170 confirmed exoplanets. It is predicted that 90 percent of the candidates will eventually be confirmed.

The Kepler mission was launched in March 2009 to simultaneously observe 150,000 nearby stars to see how many of them have planets, particularly those that are approximately Earth-sized and with orbits similar to Earth's. To do this, the spacecraft uses a 95-megapixel camera to observe extremely faint changes in each star's brightness. Each of these dips in brightness is potentially a planet crossing in front of, or transiting, the star. Follow-up investigations by ground-based telescopes such as the Keck telescopes in Hawaii show whether or not each dimming of a star is a transiting planet or other phenomenon, such as dimming caused by sunspots.

Proposals for missions like Kepler have existed since 1992. It was only approved in 2001 as NASA's Discovery Mission #10 after the technology to detect Earth-sized planets was proven feasible and planets

around Sun-like stars were detected by already existing instruments. The first such exoplanetary system was only discovered in 1995.

This study looks at 42,000 of the stars Kepler observed, all of them similar to the Sun in temperature, mass and age. After examining the brightness drops of each star, Petigura found 603 candidate planets orbiting Sun-like stars. Of these, 10 planets met the criteria set in the paper for an Earth-sized planet within a star's habitable zone, defined as the planet being between one and two Earth radii in size and being between half and twice the distance the Earth is from the Sun, respectively.

Given this baseline, and the understanding that Kepler misses a large but precisely known percentage of exoplanets by virtue of its detection method, the researchers were able to make a series of extrapolations based on differing constraints of what habitable zone means. The loosest constraint, described above, finds that the occurrence for Earth-sized planets orbiting in a Sun-like star's habitable zone is 22 percent. Given that the Milky Way galaxy has an estimated 40 billion stars similar to the Sun, the amount of Earth-sized planets orbiting those stars at orbits similar to Earth is 8.8 billion. The most conservative estimate gives 1.4 billion.

This is an astounding number. By no means does it say that there are billions of *Earths* in the Milky Way, but it does give a much better idea of how much *potential* there is for Earth-like worlds in our galaxy. It provides an answer to the third factor in the so-called Drake equation.

The Drake equation takes the rather complex question of finding alien life that humans could communicate with and simplifies into seven parameters that can be independently investigated. These seven factors are:

- The average star formation rate
- The fraction of stars with planets

- The potential for those planets to support life
- The fraction of planets that develop life
- How many planets develop *intelligent* life
 - The number of civilizations so advanced that they release detectable signals into space
 - The length of time during which these civilizations release signals into space

Before Kepler, only the first two factors of the Drake equation could be reliably estimated. In many respects, it was in fact Kepler's primary mission to determine the third factor, how many planets exist that have the potential, based on whether the planet is within the star's habitable zone, for life. The spacecraft has also further constrained the second parameter, showing that the fraction of stars with planets is most likely 1.

This numbers will of course change. Kepler's data is extremely preliminary. There is as yet no large body of data about the chemical makeup of the planets Kepler has found, only that given the amount of sunlight they receive, they could conceivably have liquid water on their surface. There is still no data on the atmospheres and geophysics on these potentially Earth-like planets. On the other hand, given that the number of planets to study is in the billions, it is almost certain that at least some of these planets have geophysical and atmospheric conditions similar to Earth, especially given that chemical building blocks of life on Earth are common throughout the Universe (see "Extra-solar planet could sustain Earth-like life").

The last four factors of the Drake equation are currently unknown not because they are unknowable, but because there a great many difficulties an ascertaining those values. The first steps have been taken in the development of the field of astrobiology, which looks at the development of complex molecules in early Earth-like environments. They are, however, inadequate and will remain so under the present social structure. The resources that would be required to conduct a thorough search for extraterrestrial life—whether by looking for chemical signatures or actual communications—are instead stymied by an economic system that focuses all scientific effort into the service of immediate profit interests.

It is also worth mentioning that even what is known about the Drake equation is biased toward Earth-like planets with presumably Earth-like life. While the only known life is on Earth, other forms of life are not restricted to being formed primarily of water and carbon. In many ways, the Drake equation based on finding life similar to that of Earth's can be seen as the lower limit to

the myriad of possibilities of life in the universe.

This is not simply through the forms of life. While the habitable zone for Earth-like life is based on distance from the parent star, it is entirely plausible that a very large moon of a gas giant receives a great deal of heat from the gas giant instead of the star, providing enough heat for liquid water to exist on the surface. Or perhaps life could develop in underground oceans heated by tidal forces, a scenario which could be true of Jupiter's moon Europa. Given that every new discovery of exoplanets has challenged our understanding of planetary formation, any future discoveries of life will expand our understanding of how it could come to exist.

Further studies to more accurately estimate whether life exists in the galaxy would involve developing instruments to directly measure the atmospheres of these planets, something wholly possible with current technology. In fact, a whole series of missions, starting with Kepler, was outlined in the early 1990s toward a path of spacecraft that would not only detect Earth-sized planets but *measure their atmospheric properties* by the 2010s.

These eventually evolved into the proposed Space Interferometry Mission and its successor, the Terrestrial Planet Finder. They were canceled in 2010 and 2011, respectively. At this time, no further exoplanet missions are seriously funded. The global crisis of capitalism has dealt a serious blow to the process of exploration and discovery that is essential for the development of science and human culture as a whole.



To contact the WSWS and the
Socialist Equality Party visit:

wsws.org/contact