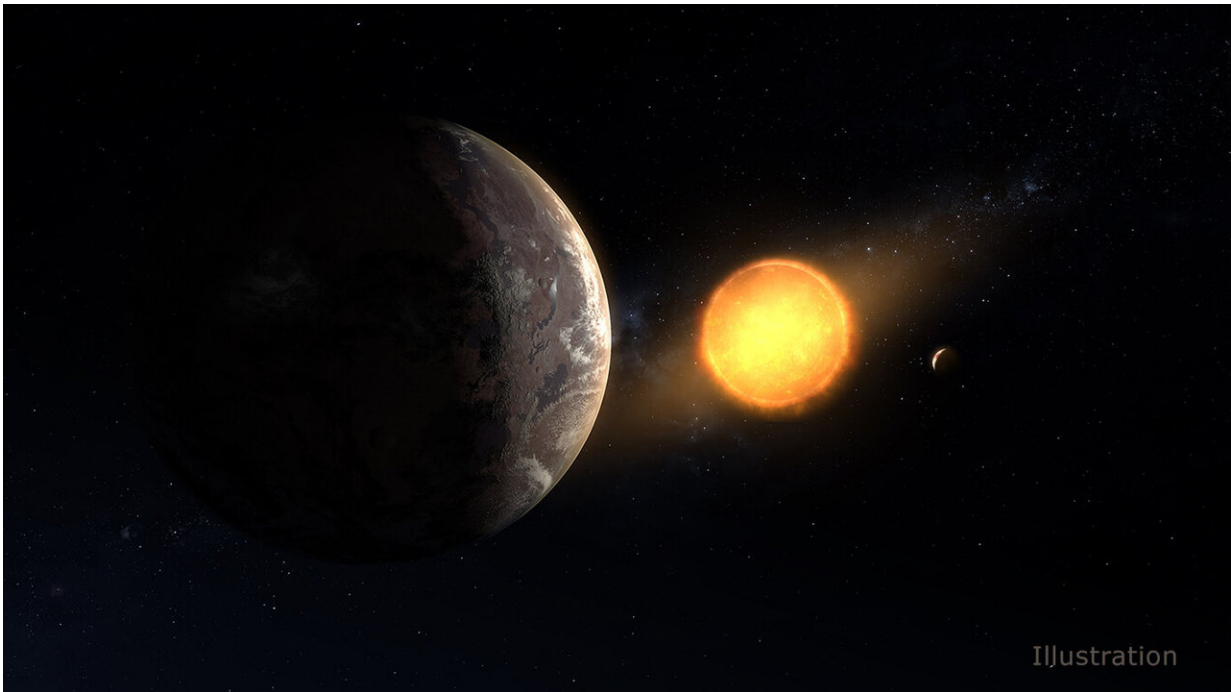


Earth-size, habitable-zone planet found hidden in early NASA Kepler data

April 15 2020, by Felicia Chou



This artist's concept shows what exoplanet Kepler-1649c could look like on its surface. The planet is the closest to Earth in size and temperature found yet in data from the Kepler space telescope. Credit: NASA/Ames Research Center/Daniel Rutter

A team of transatlantic scientists, using reanalyzed data from NASA's Kepler space telescope, has discovered an Earth-size exoplanet orbiting in its star's habitable zone, the area around a star where a rocky planet

could support liquid water.

Scientists discovered this planet, called Kepler-1649c, when looking through old observations from Kepler, which the agency retired in 2018. While previous searches with a computer algorithm misidentified it, researchers reviewing Kepler data took a second look at the signature and recognized it as a planet. Out of all the exoplanets found by Kepler, this distant world—located 300 light-years from Earth—is most similar to Earth in size and estimated temperature.

This newly revealed world is only 1.06 times larger than our own planet. Also, the amount of starlight it receives from its host star is 75% of the amount of light Earth receives from our Sun—meaning the exoplanet's temperature may be similar to our planet's as well. But unlike Earth, it orbits a red dwarf. Though none have been observed in this system, this type of star is known for stellar flare-ups that may make a planet's environment challenging for any potential life.

"This intriguing, distant world gives us even greater hope that a second Earth lies among the [stars](#), waiting to be found," said Thomas Zurbuchen, associate administrator of NASA's Science Mission Directorate in Washington. "The data gathered by missions like Kepler and our Transiting Exoplanet Survey Satellite [TESS] will continue to yield amazing discoveries as the science community refines its abilities to look for promising [planets](#) year after year."

There is still much that is unknown about Kepler-1649c, including its atmosphere, which could affect the planet's temperature. Current calculations of the planet's size have significant margins of error, as do all values in astronomy when studying objects so far away. But based on what is known, Kepler-1649c is especially intriguing for scientists looking for worlds with potentially habitable conditions.

There are other exoplanets estimated to be closer to Earth in size, such as TRAPPIST-1f and, by some calculations, Teegarden c. Others may be closer to Earth in temperature, such as TRAPPIST-1d and TOI 700d. But there is no other exoplanet that is considered to be closer to Earth in both of these values that also lies in the habitable zone of its system.



This artist's concept shows exoplanet Kepler-1649c orbiting around its host red dwarf star. This exoplanet is in its star's habitable zone (the distance where liquid water could exist on the planet's surface) and is the closest to Earth in size and temperature found yet in Kepler's data. Credit: NASA/Ames Research Center/Daniel Rutter

"Out of all the mislabeled planets we've recovered, this one's particularly exciting—not just because it's in the habitable zone and Earth-size, but because of how it might interact with this neighboring planet," said

Andrew Vanderburg, a researcher at the University of Texas at Austin and first author on the paper released today in *The Astrophysical Journal Letters*. "If we hadn't looked over the algorithm's work by hand, we would have missed it."

Kepler-1649c orbits its small red dwarf star so closely that a year on Kepler-1649c is equivalent to only 19.5 Earth days. The system has another [rocky planet](#) of about the same size, but it orbits the star at about half the distance of Kepler-1649c, similar to how Venus orbits our Sun at about half the distance that Earth does. Red dwarf stars are among the most common in the galaxy, meaning planets like this one could be more common than we previously thought.

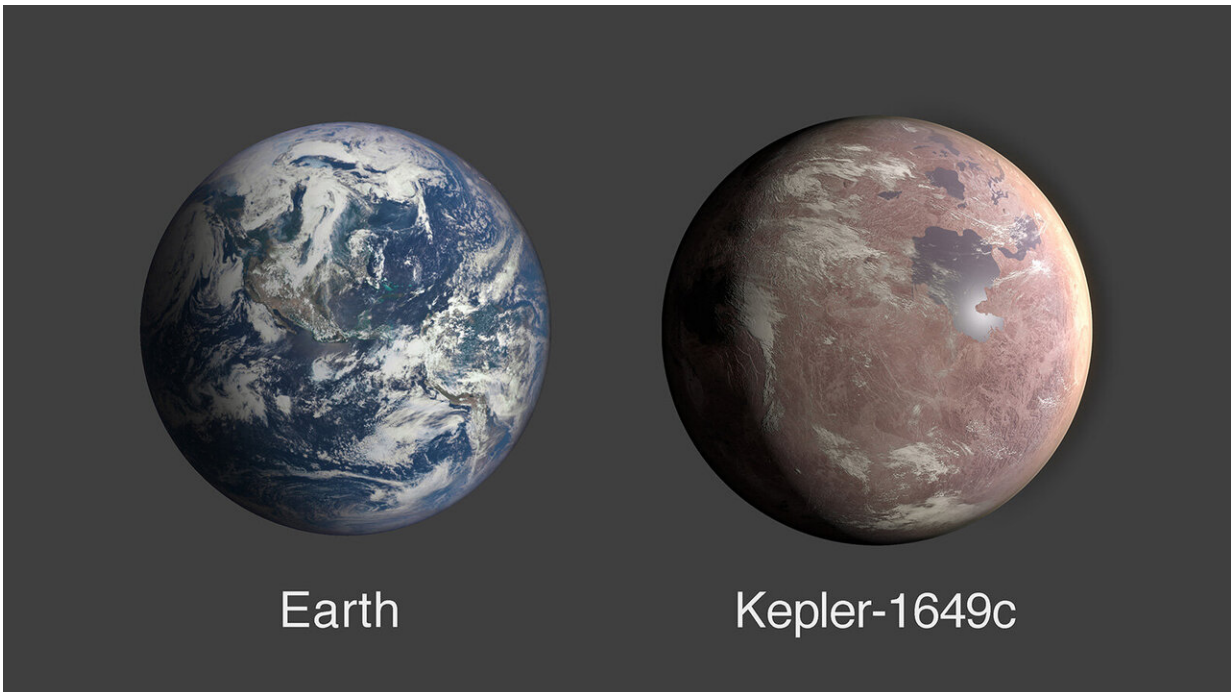
Looking for False Positives

Previously, scientists on the Kepler mission developed an algorithm called Robovetter to help sort through the massive amounts of data produced by the Kepler spacecraft, managed by NASA's Ames Research Center in California's Silicon Valley. Kepler searched for planets using the transit method, staring at stars, looking for dips in brightness as planets passed in front of their host stars.

Most of the time, those dips come from phenomena other than planets—ranging from natural changes in a star's brightness to other cosmic objects passing by—making it look like a planet is there when it's not. Robovetter's job was to distinguish the 12% of dips that were real planets from the rest. Those signatures Robovetter determined to be from other sources were labeled "[false positives](#)," the term for a test result mistakenly classified as positive.

With an enormous number of tricky signals, astronomers knew the algorithm would make mistakes and would need to be double-checked—a perfect job for the Kepler False Positive Working Group.

That team reviews Robovetter's work, going through each false positive to ensure they are truly errors and not exoplanets, ensuring fewer potential discoveries are overlooked. As it turns out, Robovetter had mislabeled Kepler-1649c.



This graphic compares the size of Earth and Kepler-1649c, an exoplanet only 1.06 times larger than Earth by radius. Credit: NASA/Ames Research Center/Daniel Rutter

Even as scientists work to further automate analysis processes to get the most science as possible out of any given dataset, this discovery shows the value of double-checking automated work. Even six years after Kepler stopped collecting data from the original Kepler field—a patch of sky it stared at from 2009 to 2013, before going on to study many more regions—this rigorous analysis uncovered one of the most unique

Earth analogs discovered yet.

A Possible Third Planet

Kepler-1649c not only is one of the best matches to Earth in terms of size and energy received from its star, but it provides an entirely new look at its home system. For every nine times the outer planet in the system orbits the [host star](#), the inner planet orbits almost exactly four times. The fact that their orbits match up in such a stable ratio indicates the system itself is extremely stable and likely to survive for a long time.

Nearly perfect period ratios are often caused by a phenomenon called orbital resonance, but a nine-to-four ratio is relatively unique among planetary systems. Usually resonances take the form of ratios such as two-to-one or three-to-two. Though unconfirmed, the rarity of this ratio could hint to the presence of a middle planet with which both the inner and outer planets revolve in synchronicity, creating a pair of three-to-two resonances.

The team looked for evidence of such a mystery third planet, with no results. However, that could be because the planet is too small to see or at an orbital tilt that makes it impossible to find using Kepler's transit method.

Either way, this system provides yet another example of an Earth-size planet in the [habitable zone](#) of a [red dwarf](#) star. These small and dim stars require planets to orbit extremely close to be within that zone—not too warm and not too cold—for life as we know it to potentially exist. Though this single example is only one among many, there is increasing evidence that such planets are common around red dwarfs.

"The more data we get, the more signs we see pointing to the notion that potentially habitable and Earth-size exoplanets are common around these

kinds of stars," said Vanderburg. "With red dwarfs almost everywhere around our galaxy, and these small, potentially habitable and rocky planets around them, the chance one of them isn't too different than our Earth looks a bit brighter."

More information: Andrew Vanderburg et al. A Habitable-zone Earth-sized Planet Rescued from False Positive Status, *The Astrophysical Journal* (2020). [DOI: 10.3847/2041-8213/ab84e5](https://doi.org/10.3847/2041-8213/ab84e5)

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