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New Step Toward Finding Earth 2.0

Astronomers have developed a more accurate way to estimate the masses of exoplanets, an important step toward the ultimate goal of finding Earth's twin among the orbs circling nearby Sun-like stars.

They'll need something like this, exoplanet seekers say, if they hope to ultimately find what's popularly dubbed Earth 2.0—an Earth-mass planet orbiting a Sun-like star at a distance similar to Earth's orbit. Researchers described the new work earlier this year at the winter meeting of the American Astronomical Society in Kissimmee, Fla.

Measuring an Exoplanet's Mass

Astronomers typically calculate the mass of an exoplanet by using a method known as radial velocity (see http://bit.ly/RadialV). The method relies on tracking the motion of a star that moves slightly back and forth, or wobbles, due to the tug of an orbiting planet. As seen by a distant observer, the forward motion shifts the color of starlight toward the blue end of the spectrum, and the backward motion shifts the light toward the red, an effect known as the Doppler shift. Knowing the magnitude of the wobble and how frequently it recurs allows scientists to measure the planet's mass as well as how far the planet's orbit lies from the star.

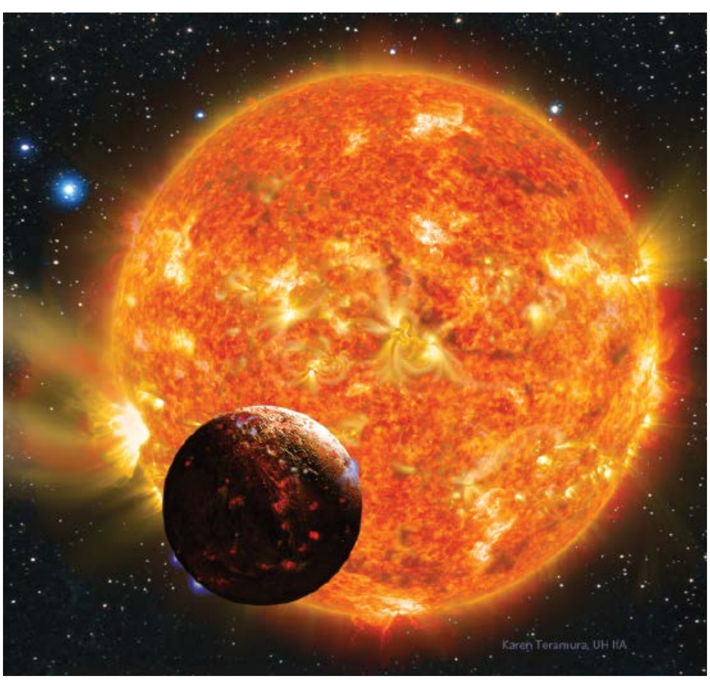
Confounding Star Spots

Although the radial velocity method has been used to detect more than 500 of the roughly 2000 known exoplanets, a common feature on the surface of stars can confound the results.

Just as dark blemishes called sunspots dot our Sun, star spots fleck the surfaces of stars. As a star spot rotates with its star's surface, it moves toward an observer then recedes, inducing a Doppler shift that can mimic the shift caused by the wobble of a star due to an orbiting planet.

Stars wobble significantly enough from heavy planets orbiting close to them that the additional color shift due to star spots poses little challenge to exoplanet observers. However, in the quest to find the much smaller shift caused by a less massive, Earth-like planet at a much greater distance—like Earth's—from the star, the interfering signals from these dark blemishes loom large, said astronomer Samuel Grunblatt of the University of Hawai'i at Mānoa in Honolulu.

Using our own star as an example, he noted that sunspot activity generates a Doppler shift that's between 10 and 100 times more than the shift caused by Earth's tug. In effect, our sunspot activity drowns out the wobbles that Earth induces on the Sun.



Karen Teramura, UHIfA

This close-orbiting exoplanet found in 2013 is known as the Hell planet because of its nearness to its star, Kepler-78.

Model for Star Wobble

Although instruments aren't yet sensitive enough to record the stellar wobble induced by Earth 2.0, Grunblatt and his colleagues are gearing up for such a detection and have developed a model that can more accurately account for the confounding star spot signal than earlier attempts.

Previous strategies have usually assumed that at any given time, the signal due to a star spot can be known exactly. But that didn't sit well with Grunblatt and his colleagues.

"If we don't know what [Earth's] sunspot activity is going to be tomorrow, how can we assume that we can know what [activity on] an unresolved star hundreds of light-years away is going to look like in a month?" he explained. Because star spots come and go and change shape over time, the team modeled them as having somewhat unpredictable traits instead of assuming they evolve in an entirely predictable manner.

The team applied its model to a test case—a previously detected Earth-mass planet, dubbed the Hell planet because it lies within roasting distance of its star, Kepler-78. The researchers found that their model yielded a mass estimate slightly more precise than previous results.

In addition to presenting the new technique at the Florida meeting , Grunblatt and his colleagues described the work in the 1 August 2015 issue of *The Astrophysical Journal* (see http://bit.ly/ApJ-paper).

"The power of their method is that it can be applied to Earth-size planets in longer period orbits," said exoplanet astronomer Artie Hatzes of the Thüringian State Observatory in Tautenburg, Germany, who did not participate in the study.

Other Approaches

A team that includes astronomer Suzanne Aigrain at the University of Oxford in England has worked on a similar model. The researchers reported their findings in the 21 September 2015 issue of *Monthly Notices of the Royal Astronomical Society* (see http://bit.ly/Rajpaul_et_al).

Aigrain said that she and her collaborators incorporate other information in their model, such as the activity of the star's chromosphere, the layer that sits above a star's visible surface. In contrast, Grunblatt and his colleagues adopted a more basic strategy, using only radial velocity information and the rotation period of the star to eliminate the star spot signal.

During a stellar observation, "if [our] approach was found not to work well, then Grunblatt's more basic approach would be a pretty robust one to fall back on," said Aigrain.

Methods like these "will become more and more important in the search for smaller and cooler planets," she added.

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