

Astronomers uncover evidence that there could be many more Earth-sized planets than previously thought

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Some exoplanet searches could be missing nearly half of the Earth-sized planets around other stars. New findings from a team using the international Gemini Observatory and the WIYN 3.5-meter Telescope at Kitt Peak National Observatory suggest that Earth-sized worlds could be lurking undiscovered in binary star systems, hidden in the glare of their parent stars. As roughly half of all stars are in binary systems, this means that astronomers could be missing many Earth-sized worlds.

Earth-sized planets may be much more common than previously realized. Astronomers working at NASA Ames Research Center have used the twin telescopes of the international Gemini Observatory, a Program of NSF's NOIRLab, to determine that many planet-hosting stars identified by NASA's TESS exoplanet-hunting mission are actually pairs of stars—known as binary stars—where the planets orbit one of the stars in the pair. After examining these binary stars, the team has concluded that Earth-sized planets in many two-star systems might be going unnoticed

by transit searches like TESS's, which look for changes in the light from a star when a planet passes in front of it. The light from the second star makes it more difficult to detect the changes in the host star's light when the planet transits.

The team started out by trying to determine whether some of the exoplanet host stars identified with TESS were actually unknown binary stars. Physical pairs of stars that are close together can be mistaken for single stars unless they are observed at extremely high resolution. So the team turned to both Gemini telescopes to inspect a sample of exoplanet host stars in painstaking detail. Using a technique called speckle imaging, the astronomers set out to see whether they could spot undiscovered stellar companions.

Using the 'Alopeke and Zorro instruments on the Gemini North and South telescopes in Chile and Hawai'i, respectively, the team observed hundreds of nearby stars that TESS had identified as potential exoplanet hosts. They discovered that 73 of these stars are really binary star systems that had appeared as single points of light until observed at higher resolution with Gemini. "With the Gemini Observatory's 8.1-meter telescopes, we obtained extremely high-resolution images of exoplanet host stars and detected stellar companions at very small separations," said Katie Lester of NASA's Ames Research Center, who led this work.

Lester's team also studied an additional 18 binary stars previously found among the TESS exoplanet hosts using the NN-EXPLORE Exoplanet and Stellar Speckle Imager (NESSI) on the WIYN 3.5-meter Telescope at Kitt Peak National Observatory, also a Program of NSF's NOIRLab.

After identifying the binary stars, the team

compared the sizes of the detected planets in the binary star systems to those in single-star systems. They realized that the TESS spacecraft found both large and small exoplanets orbiting single stars, but only large planets in binary systems.

These results imply that a population of Earth-sized planets could be lurking in binary systems and going undetected using the transit method employed by TESS and many other planet-hunting telescopes. Some scientists had suspected that transit searches might be missing small planets in binary systems, but the new study provides observational support to back it up and shows which sizes of exoplanets are affected.

"We have shown that it is more difficult to find Earth-sized planets in binary systems because small planets get lost in the glare of their two parent stars," Lester stated. "Their transits are 'filled in' by the light from the companion star," added Steve Howell of NASA's Ames Research Center, who leads the speckle imaging effort and was involved in this research.

"Since roughly 50% of stars are in binary systems, we could be missing the discovery of—and the chance to study—a lot of Earth-like planets," Lester concluded.

The possibility of these missing worlds means that astronomers will need to use a variety of observational techniques before concluding that a given binary star system has no Earth-like planets. "Astronomers need to know whether a star is single or binary before they claim that no small planets exist in that system," explained Lester. "If it's single, then you could say that no small planets exist. But if the host is in a binary, you wouldn't know whether a small planet is hidden by the companion star or does not exist at all. You would need more observations with a different technique to figure that out."

As part of their study, Lester and her colleagues also analyzed how far apart the stars are in the binary systems where TESS had detected large planets. The team found that the stars in the exoplanet-hosting pairs were typically farther apart than binary stars not known to have planets. This

could suggest that planets do not form around stars that have close stellar companions.

"This speckle imaging survey illustrates the critical need for NSF telescope facilities to characterize newly discovered planetary systems and develop our understanding of planetary populations," said National Science Foundation Division of Astronomical Sciences Program Officer Martin Still.

"This is a major finding in [exoplanet](#) work," Howell commented. "The results will help theorists create their models for how planets form and evolve in double-star systems."

More information: Speckle Observations of TESS Exoplanet Host Stars. II. Stellar Companions at 1-1000 AU and Implications for Small Planet Detection, arXiv:2106.13354 [astro-ph.SR] arxiv.org/abs/2106.13354

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