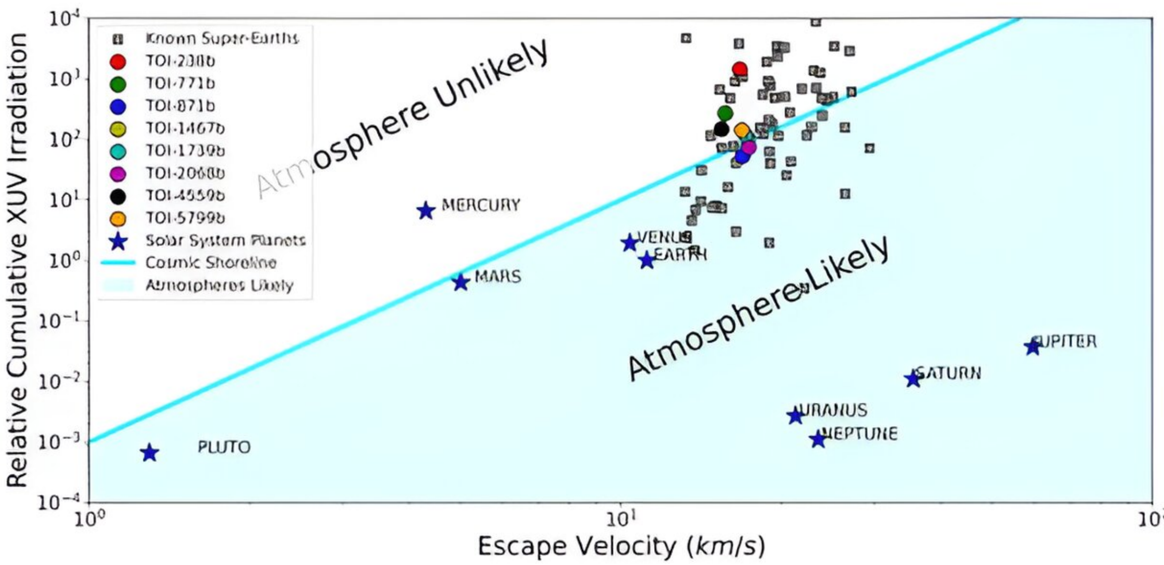
PHYS.ORG

TESS finds eight more super-Earths

November 6 2023, by Evan Gough



This figure from the study shows how the cosmic shoreline divides exoplanets that retain their atmospheres from exoplanets that lose their atmospheres via XUV radiation from their stars. Several of the planets in this study are clustered right near the shoreline, making them ‘keystone planets’ and a juicy target for further study. Credit: Mistry et al. 2023

NASA's Kepler spacecraft has discovered most of the confirmed exoplanets that we know of. But its successor, TESS (Transiting Exoplanet Survey Satellite), is catching up. New research announces the validation of eight more TESS candidates, and they're all Super-Earths.

TESS's planet-hunting mission has a more refined goal than its predecessor, Kepler. TESS was specifically built to detect exoplanets transiting in front of bright stars in Earth's neighborhood. It's found about 400 confirmed exoplanets, but there's a list of exoplanets awaiting confirmation that contains almost 6,000 candidates. There are only two ways to confirm all these exoplanets-in-waiting: further observations and statistical methods.

What all those unconfirmed candidates amount to is data. They're hiding in TESS's data, waiting for clever scientists to validate them. Further observations can help uncover them, but not alone.

The Validation of Transiting Exoplanets using Statistical Tools (VaTEST) project uses statistical tools and machine learning to comb through all of TESS's data, looking for elusive exoplanets. In the VaTEST project, scientists are not only able to confirm planets while working around false positives; they're also able to characterize exoplanet atmospheres suitable for further study.

A team of scientists presented their results in a paper titled "VaTEST III: Validation of 8 Potential Super-Earths from TESS Data." Their paper is under review at the Publications of the Astronomical Society of Australia and is currently available on the preprint server *arXiv*. The lead author is Priyashkumar Mistry, a Ph.D. student at the University of New South Wales, Australia.

False positives are a persistent problem in exoplanet science. When you think about it, it's easy to see why. TESS is looking for tiny dips in starlight around distant stars caused by an exoplanet passing in front of the stars. One blip isn't enough; we need several, and there has to be a rhythm to them. But other things can give false impressions of a transiting planet, for example, eclipsing binary stars. Even a star's natural variability can cloud the signals.

So TESS has gathered an enormous amount of data that has to be worked through, sorting out false positives from real signals, and that's what VaTEST does. In this paper, the team has validated eight more Super-Earths.

"We have validated eight potential super-Earths using a combination of ground-based telescope data, high-resolution imaging, and the statistical validation tool known as TRICERATOPS," the authors write.

Planet	Earth Masses	Earth Radii
TOI-238b	3.6	1.6
TOI-771b	2.8	1.4
TOI-871b	3.8	1.6
TOI-1467b	4.4	1.8
TOI-1739b	4	1.7
TOI-2068b	4.4	1.8
TOI-4559b	2.7	1.4
TOI5799b	3.7	1.6

Not only did they find eight more super-Earths, but they've identified six of them that are excellent candidates for additional study. "Among all these validated planets, six of them fall within the region known as' keystone planets,' which makes them particularly interesting for study," they explain.

A keystone planet is an idea that has its roots in biology. In biology, a keystone species is one that defines an entire ecosystem. A great example is coral in coral reefs. Coral reefs are a distinct ecosystem anchored by coral.

In exoplanet science, a keystone planet is a planet that helps explain the overall population of exoplanets. In particular, it helps explain the radius gap we see in exoplanet populations. There's a scarcity of planets between 1.5 and 2 Earth radii. It's probably caused by photoevaporation mass loss. A star's powerful radiation, especially in X-ray and UV emissions (XUV), can strip away a planet's atmosphere over time, possibly creating a dearth of 1.5 to 2 Earth radii planets.

"It is noteworthy that planets within the size range investigated herein are absent from our own solar system, making their study crucial for gaining insights into the evolutionary stages between Earth and Neptune," the authors explain. "These keystone planets play a pivotal role in advancing our understanding of the radius-valley phenomenon around low-mass stars."

There's another concept that relates to super-Earths and the radius gap, and it focuses on why some planets lose their atmospheres and fall below the gap and why others don't. It's called the "cosmic shoreline," and it's a statistical trend that links exoplanets together.

The cosmic shoreline is a dividing line between planets that have retained their atmospheres and planets that have lost them due to XUV radiation from their stars.

"In this study, we validate eight exoplanets using TESS, ground-based transit photometry, high-resolution imaging, and a statistical validation tool," the authors explain. The researchers say that more precise mass measurements are needed to understand them better and that for three of the planets, these more precise measurements may be attainable.

Not only are some of these planets in the radius gap, but two of them are suitable for further atmospheric study with the JWST and its powerful instruments. "We also found that two of our validated planets, TOI-771b and TOI-4559b, are amenable for transmission spectroscopy using JWST," the authors write.

When the JWST was being designed and built, scientists hoped that it would be able to scrutinize the atmospheres of Super-Earths. There are none of these worlds in our own solar system, so deciphering their atmospheres can help us understand where super-Earths fit into the exoplanet population, how they evolve, and how they relate to the radius gap and the cosmic shoreline.

The team simulated the atmospheres of the eight super-Earths and also what the JWST will likely see when it examines the atmospheres. The results are intriguing, showing signs of carbon dioxide, water, and, most intriguingly, methane. Methane can be a biosignature, though there's a lot of uncertainty. Finding it in any exoplanet atmosphere will help scientists understand its presence more fully, whether it's an actual biosignature or not.

"However, real observations of the validated planets using the JWST are required to confirm our transmission spectra analysis," the paper concludes.

More information: Priyashkumar Mistry et al, VaTEST III: Validation of 8 Potential Super-Earths from TESS Data, *arXiv* (2023). DOI: 10.48550/arxiv.2311.00688

Provided by Universe Today

Citation: TESS finds eight more super-Earths (2023, November 6) retrieved 12 May 2024 from https://phys.org/news/2023-11-tess-super-earths.html