NASA's TESS mission completes first year of survey, turns to northern sky

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Illustration of L 98-59b, the smallest exoplanet discovered by NASA's Transiting Exoplanet Survey Satellite. Credit: NASA's Goddard Space Flight Center/Ravyn Cullor

NASA's Transiting Exoplanet Survey Satellite (TESS) has discovered 21 planets outside our solar system and captured data on other interesting events occurring in the southern sky during its first year of science. TESS has now turned its attention to the Northern Hemisphere to complete the most comprehensive planet-hunting expedition ever undertaken.

TESS began hunting for exoplanets (or worlds orbiting distant stars) in the southern sky in July of 2018, while also collecting data on supernovae, black holes and other phenomena in its line of sight. Along

with the planets TESS has discovered, the mission has identified over 850 candidate exoplanets that are waiting for confirmation by ground-based telescopes.

"The pace and productivity of TESS in its first year of operations has far exceeded our most optimistic hopes for the mission," said George Ricker, TESS's principal investigator at the Massachusetts Institute of Technology in Cambridge. "In addition to finding a diverse set of exoplanets, TESS has discovered a treasure trove of astrophysical phenomena, including thousands of violently variable stellar objects."

To search for exoplanets, TESS uses four large cameras to watch a 24-by-96-degree section of the sky for 27 days at a time. Some of these sections overlap, so some parts of the sky are observed for almost a year. TESS is concentrating on stars closer than 300 light-years from our solar system, watching for transits, which are periodic dips in brightness caused by an object, like a planet, passing in front of the star.

On July 18, the southern portion of the survey was completed and the spacecraft turned its cameras to the north. When it completes the northern section in 2020, TESS will have mapped over three quarters of the sky.

"Kepler discovered the amazing result that, on average, every star system has a planet or planets around it," said Padi Boyd, TESS project scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland. "TESS takes the next step. If planets are everywhere, let's find those orbiting bright, nearby stars because they'll be the ones we can now follow up with existing ground and space-based telescopes, and the next generation of instruments for decades to come."

Here are a few of the interesting objects and events TESS saw during its first year.

Exoplanets

To qualify as an exoplanet candidate, an object must make at least three transits in the TESS data, and then pass through several additional checks to make sure the transits were not a false positive caused by an eclipse or companion star, but may in fact be an exoplanet. Once a candidate is identified, astronomers deploy a large network of ground-based telescopes to confirm it.

"The team is currently focused on finding the best candidates to confirm by ground-based follow-up," said Natalia Guerrero, who manages the team in charge of identifying exoplanet candidates at MIT. "But there are many more potential exoplanet candidates in the data yet to be analyzed, so we're really just seeing the tip of the iceberg here. TESS has only scratched the surface."

The planets TESS has discovered so far range from a world 80% the size of Earth to ones comparable to or exceeding the sizes of Jupiter and Saturn. Like Kepler, TESS is finding many planets smaller in size than Neptune, but larger than Earth.

While NASA is striving to put astronauts on some of our nearest neighbors—the Moon and Mars—in order to understand more about the planets in our own solar system, follow-up observations with powerful telescopes of the planets TESS discovers will enable us to better understand how Earth and the solar system formed.

With TESS's data, scientists using current and future observatories, like the James Webb Space Telescope, will be able to study other aspects of exoplanets, like the presence and composition of any atmosphere, which would impact the possibility of developing life.

Comets

Before science operations started, TESS snapped clear images of a newly discovered comet in our solar system. During on-orbit instrument testing, the satellite's cameras took a series of images that captured the motion of C/2018 N1, a comet found on June 29 by NASA's Near-Earth Object Wide-field Infrared Survey Explorer (NEOWISE).

TESS captured data on similar objects outside the solar system as well.

Exocomets

Data from the mission were also used to identify transits by comets orbiting another star: Beta Pictoris, located 63 light-years away. Astronomers were able to find three comets that were too small to be planets and had detectable tails, the first identification of its type in visible light.

Supernovae

Because TESS spends nearly a month looking in the same location, it can capture data on stellar events, like supernovae, as they begin. During its first months of science operations, TESS spotted six supernovae occurring in distant galaxies that were later discovered by ground-based telescopes.

Scientists hope to use these types of observations to better understand the origins of a specific kind of explosion known as a Type Ia supernova.

Type Ia supernovae occur either in star systems where one white dwarf draws gas from another star or when two white dwarfs merge. Astronomers don't know which case is more common, but with data

from TESS, they'll have a clearer understanding of the origins of these cosmic blasts.

Type Ia supernovae are a class of objects called a "standard candle," meaning astronomers know how luminous they are and can use them to calculate quantities like how quickly the universe is expanding. TESS data will help them understand differences between Type Ia supernovae created in both circumstances, which could have a large impact on how we understand events happening billions of light-years away and, ultimately, the fate of the universe.

Provided by NASA's Goddard Space Flight Center