The PLATO mission could be the most successful planet hunter ever, scientists believe

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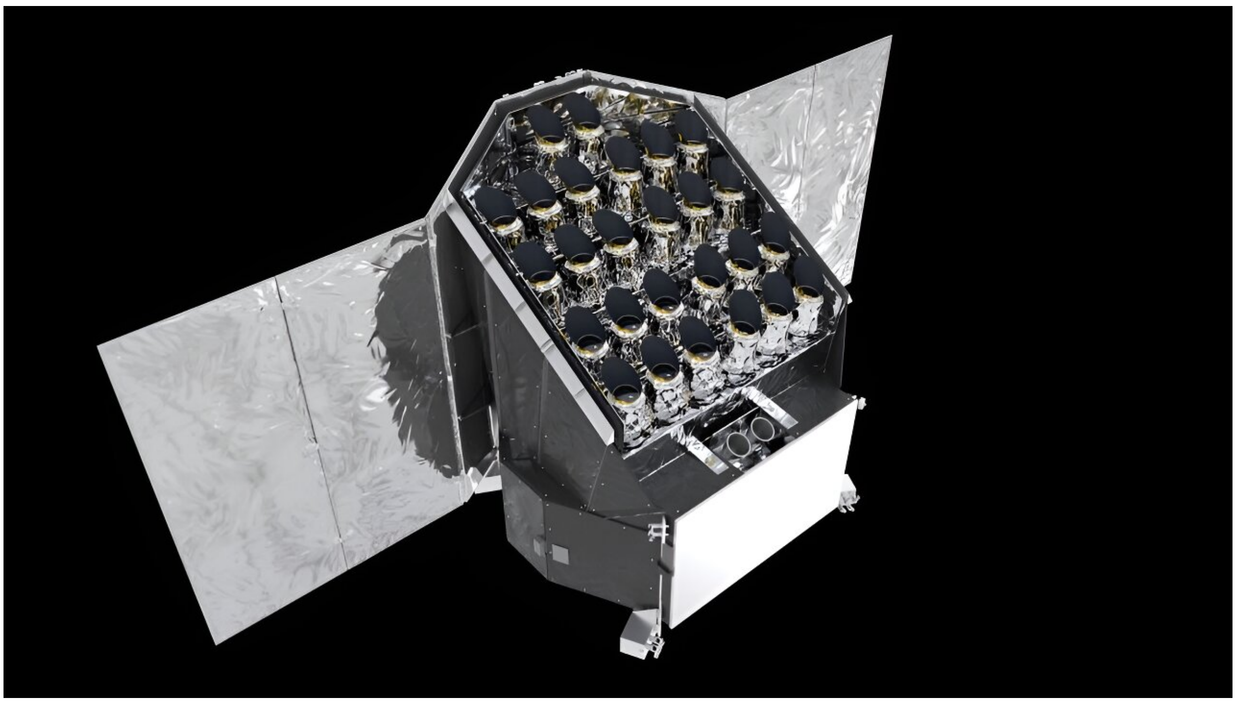


Artist's impression of the ESA's PLATO mission. Credit: ESA/ATG medialab

In 2026, the European Space Agency (ESA) will launch its next-generation exoplanet-hunting mission, the PLAnetary Transits and Oscillations of stars (PLATO).

This mission will scan over 245,000 main-sequence F, G, and K-type (yellow-white, yellow, and orange) stars using the Transit Method to look for possible Earth-like planets orbiting Solar analogs. In keeping with the "low-hanging fruit" approach (aka. follow the water), these planets are considered strong candidates for habitability since they are most likely to have all the conditions that gave rise to life here on Earth.

Knowing how many planets PLATO will likely detect and how many will conform to Earth-like characteristics is essential to determining how and where it should dedicate its observation time.

According to a new study that will be published in the journal *Astronomy & Astrophysics*, the PLATO mission is likely to find tens of thousands of planets. Depending on several parameters, they further indicate that it could detect a minimum of 500 Earth-sized planets, about a dozen of which will have favorable orbits around G-type (sun-like) stars.

The study was conducted by researchers from the Institute of Planetary Research (IFP) and Institute of Optical Sensor Systems at the German Aerospace Center (DLR), the Department of Geological Sciences at the Freie Universität Berlin (FU Berlin), and the Center for Astronomy and Astrophysics at the Technical University Berlin (TUB). The study details can be found on the pre-print server, *arXiv*.

Filip Matuszewski, a Ph.D. candidate with the Grenoble Planetary and Astrophysics Institute (IPAG) at the Université Grenoble Alpes, led the study as part of his thesis while studying at FU Berlin and the Extrasolar Planets and Atmospheres.

To assess the number of exoplanets PLATO could detect, Matuszewski and his team developed a tool named the Planet Yield for PLATO Estimator (PYPE). This tool combines a statistical approach with occurrence rates from planet formation models and data obtained by the

Kepler space telescope. This allowed them to estimate how many exoplanets PLATO will detect during four years based on a fraction of the observation fields selected for the all-sky PLATO stellar input catalog (PIC).

As Matuszewski explained to Universe Today via email:

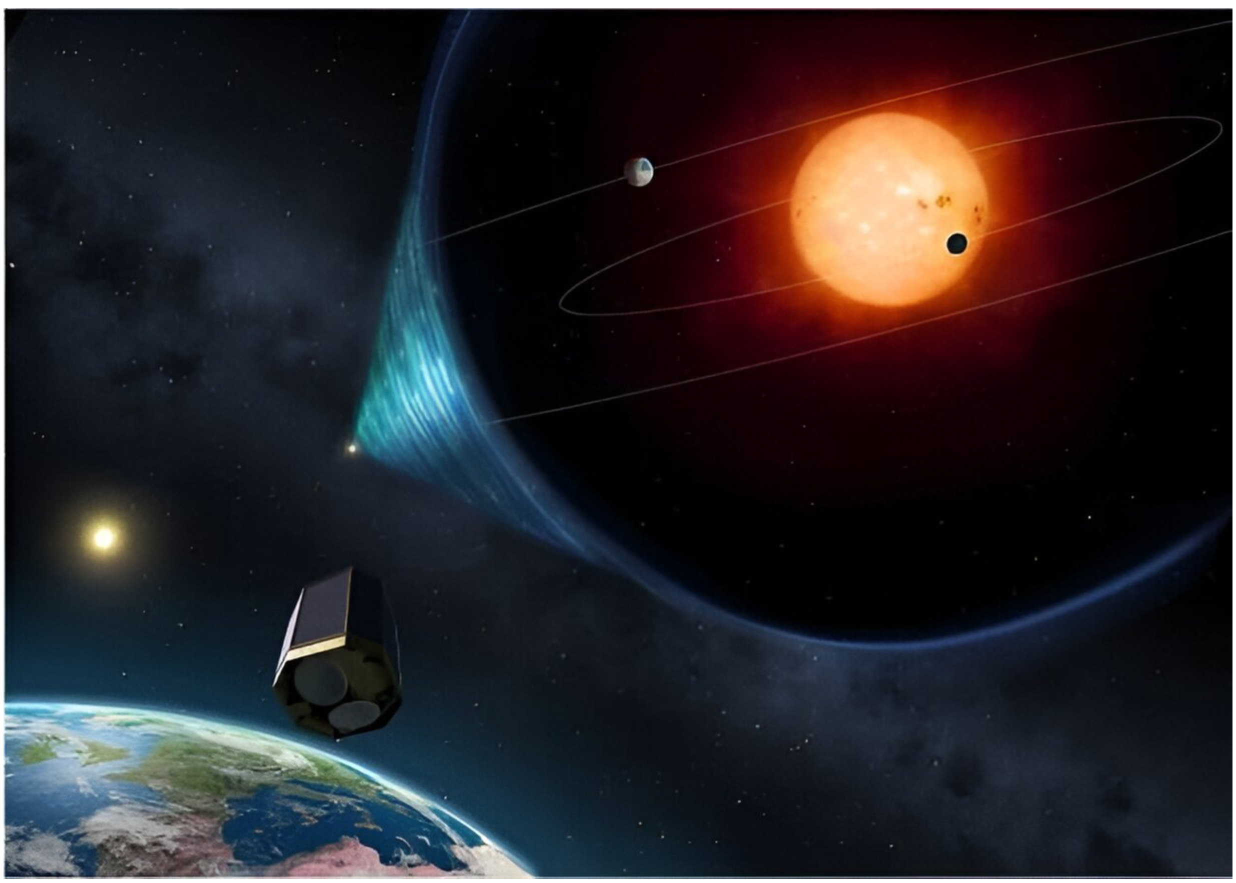
"First, we needed a synthetic population of planets (our own little universe, if you will). To do this, we took a planetary population model, which is basically a simulation of 1000 protoplanetary disks evolving into planetary systems (Christoph Mordasini of the University of Bern, Switzerland, provided us with these planetary systems). Since the resulting systems are quite different from what we currently know about exoplanets, we wanted to include data from Kepler. Based on the occurrence rates from Kepler, we formed our own two-planet populations to use as a comparison."

The second step, said Matuszewski, consisted of the team estimating how many stars PLATO will observe in just one field of view (~125,000) and assigning a planetary system (based on our own) to each. Next, they considered how many of these planets would have the proper orientation to make transits relative to PLATO (is it edge-on to the telescope?), thus producing a visible dip in brightness. For a plant orbiting a star the same size as our sun with an orbital period of 365 days, the probability of this happening (aka. transit probability) is just 0.47%.

But when one considers the number of stars PLATO will observe, that still leaves tens of thousands of candidates available for study. Last, they employed a detection efficiency model that accounts for the performance of PLATOs cameras and various noise sources to see if the transit signal would be stronger than the background noise.

"That is the basic function of PYPE," said Matuszewski. "From there, we can tweak the program to give us results for various false scenarios and time periods. How many planets do we find looking here for two years and there for two years? What if we look at a particular field for longer?"

When they applied the PYPE to the observatory's four-year primary mission, the team obtained some very encouraging results. Depending on what fields it observes and for how long, the orbital period of the planets, the orientation of the planets, and other factors, they found that PLATO is likely to detect thousands or tens of thousands of exoplanets.



Artist’s impression of the Planetary Transits and Oscillations of stars (PLATO) mission. Credit: ESA

Even more encouraging, they found that a statistically significant number of these planets are likely to be similar to Earth. As Matuszewski explained, "Using the most conservative planet population model and mission scenario, we estimate a minimum of 500 Earth-sized planets to be detected in the nominal mission duration of four years."

"That includes every type of star and every distance to the star. If we look at Earth-sized planets with an orbital period range of 250-500 days around G stars (Earth-Sun analogs), we estimate up to 12 detections. This is for the 2+2 year observation with the most optimistic planet model."

In the past 20 years, the number of known exoplanets has grown exponentially, with 5,483 confirmed detections in 4,087 systems (and another 9,770 candidates awaiting confirmation) as of July 30th, 2023. The discovery and characterization of these exoplanets have informed (and challenged) prevailing theories about planet formation and occurrence rates.

However, there remain some unanswered questions and a significant margin of uncertainty regarding how common certain types of planets are (related to gaps in the exoplanet census).

The purpose of this study, and those like it, is to establish estimates that can be compared to observational data. The way the results deviate from the estimates will help inform planet formation models and provide scientists with a better idea of how common exoplanets are—accounting for size, mass, composition, orbital period, etc.

In particular, PLATO's results will show just how common Earth-like planets orbiting G-type solar analogs are, which will help narrow the search for worlds that are likely to be habitable—and inhabited.

More information: F. Matuszewski et al, Estimating the number of planets that PLATO can detect, *arXiv* (2023). DOI: 10.48550/arxiv.2307.12163

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