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Characterisation of transiting planets in the habitable zone

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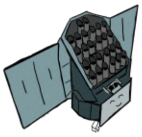
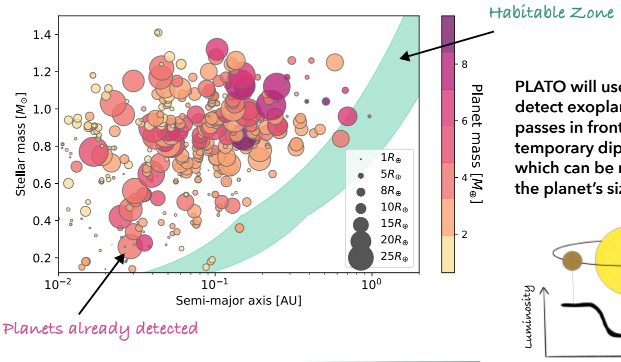
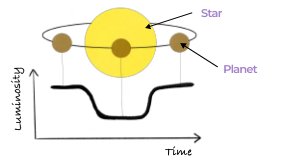


The PLATO (ESA) MISSION

The PLATO mission is expected to be launched in 2026. It is the ultimate transit discovery space mission, with the objective of detecting and characterising Earth-like planets in the habitable zone of Sun-like stars. More than 5600 exoplanets have already been discovered but very few are in the habitable zone of their host stars.

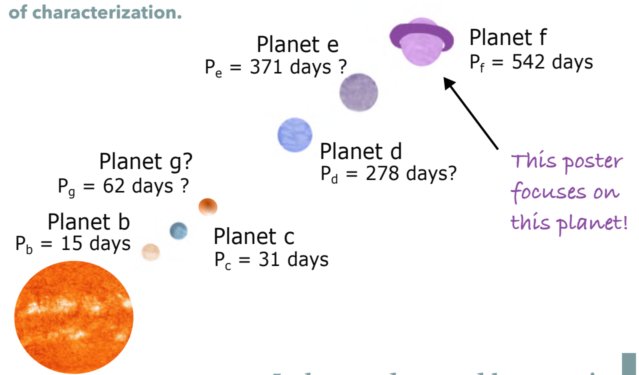


PLATO will use the method of transits to detect exoplanets: When an exoplanet passes in front of its host star, it causes a temporary dip in the star's brightness, which can be measured to determine the planet's size



The system around HIP41378: a testbed for PLATO

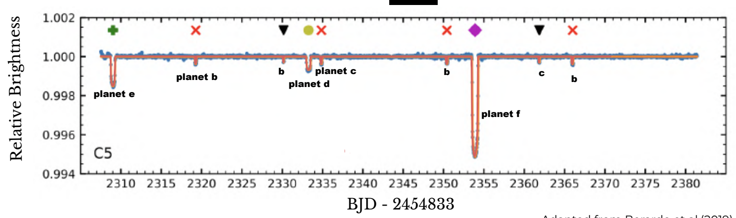
HIP41378 is a fascinating planetary system hosting at least 5 transiting planets discovered by the K2 mission in 2016. HIP41378f (P = 542 days), the most well-known of the three outer planets has been observed to transit 5 times. This planet, having a size of about Saturn and a temperate climate, is classified as a 'Super-Puff' due to its unusually low density that still needs to be fully understood. The HIP41378 system will provide valuable insights and help us prepare for the upcoming PLATO mission. The study of long-period planets presents unique challenges in terms of characterization.



How can we better understand the nature of planet HIP41378 f and the architecture of the planetary system?

5 planets detected by transits

[redacted] Two K2 campaigns, six sectors of TESS

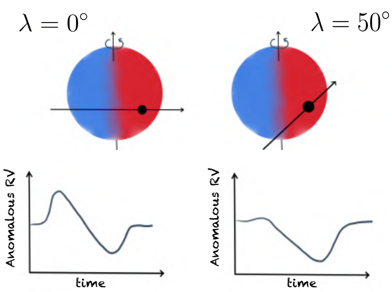


Adapted from Berardo et al.(2019)

Four transits of planet f have already been obsersed thanks to space-based instruments. In 2022 we observed the 5th transit from the ground using the Rossiter-McLaughlin effect. This enables us to follow-up the planet and understand if the planetary orbits is aligned or misaligned with the stellar rotation axis.
Problem : The transit is 19 hours long... longer than the duration of a night!

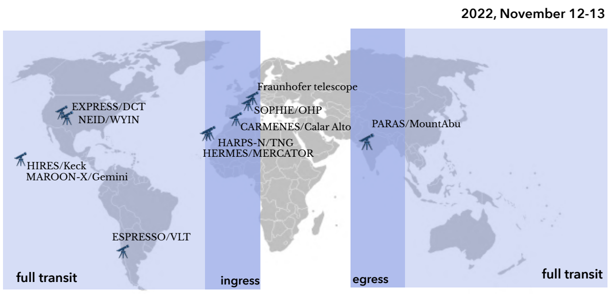
This analysis is important to plan future PLATO follow-up of long-period planets.
HIP41378f is the planet with the longest orbital period with a measured obliquity.

The principle of the Rossiter-McLaughlin effect

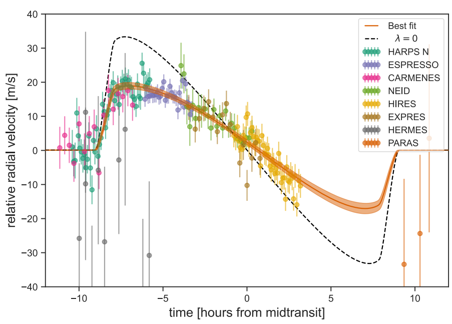


The Rossiter-McLaughlin (RM) effect is the measurement of the stellar radial velocity variation during planetary transit. With this method it is possible to measure the projected obliquity of a system.

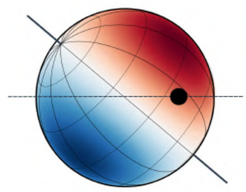
A Worldwide campaign of observations to detect the transit of HIP41378f



With a duration of 19 hours, the transit can only be observed in its totality by combining observations from different places on Earth. **All the instruments listed on the map had planned observations for this unique event.** Eight of them were able to observe a part of the transit.
The challenge is now to combine the observations from these different instruments with different techniques of radial velocity reduction.



Result: From the analysis we can conclude that **the planetary orbit is misaligned with the stellar rotation axis.** This is a step forward a better understanding of planetary formation and evolution.



This is a view of the star and the planetary orbits with **a projected obliquity of ~ 50 degrees and a stellar inclination of ~ 70 degrees**

References: Akinsanmi et al. (2020), Alam et al. (2022), Berardo et al.(2019), Lund et al. (2019), McLaughlin (1924), Rossiter (1924), Santerne et al. (2019), Vanderburg et al. (2016)