

Title: ESPRESSO characterizes the small transiting exoplanet population with extreme precision radial velocities

Abstract:

The most common planets in the Galaxy are super-Earths and sub-Neptunes. These planets, with masses and radii between those of Earth and Neptune, are intriguing as we do not find such planets in the Solar System, raising the question of what their likely compositions are. Likewise, they are the most promising candidates for habitability. However, due to their small size and low mass, they are also the hardest planets to detect and characterize, requiring the best possible facilities.

The ESPRESSO spectrograph at the Very Large Telescope in Chile is the leading instrument for the characterization of the lowest-mass planets with extreme precision radial velocity (EPRV), thanks to its exquisite 10 cm/s instrumental RV precision and the large collection area of the VLT, which enables the acquisition of high signal-to-noise spectra even for fainter host stars. Between 2018 and 2023, the ESPRESSO consortium followed up some 50 stars hosting small transiting planet candidates from K2 and TESS, as part of the ESPRESSO Guaranteed Time Observations (GTO).

In this contribution, we will give a global overview of the 54 planets in 23 systems confirmed by this program, which range from super-Mercuries through super-Earths and water worlds to sub-Neptunes. These planets represent a significant addition to the precisely-characterized small planet population. We will highlight emerging trends in the overall population, such as:

- an insolation-dependent mass threshold between rocky and volatile rich planets;
- the clear emergence of a group of high-mass rocky "stripped core" planets at high insolation;
- an increasing planet mass with higher stellar metallicity.

We also compare planet masses to typical protoplanetary disks, finding these planets must form either early in the disk's lifetime, with high formation efficiency, or preferentially in massive disks. Finally, we will discuss the lessons learned from this program in terms of observing and analysis strategies. In the context of the upcoming PLATO mission, this is vital knowledge for the follow-up of the Earth-sized planet candidates that are PLATO's principal objective.