# Exploring the variety of small planets with HARPS-N

Dr Annelies Mortier
Senior Kavli Institute Fellow

Kavli Institute
Cavendish Laboratory
University of Cambridge

angm2@cam.ac.uk

UNIVERSITY OF CAMBRIDGE

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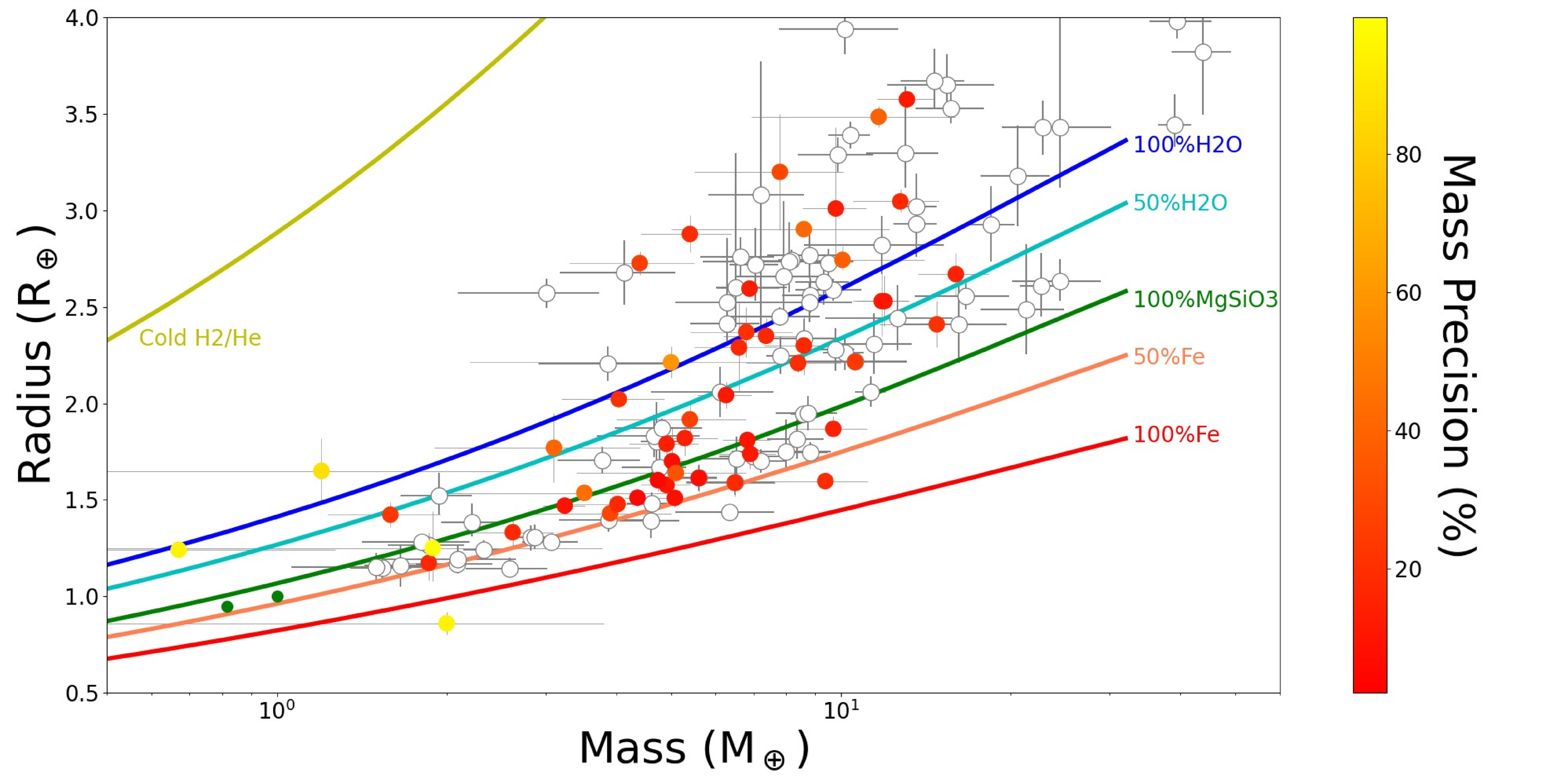
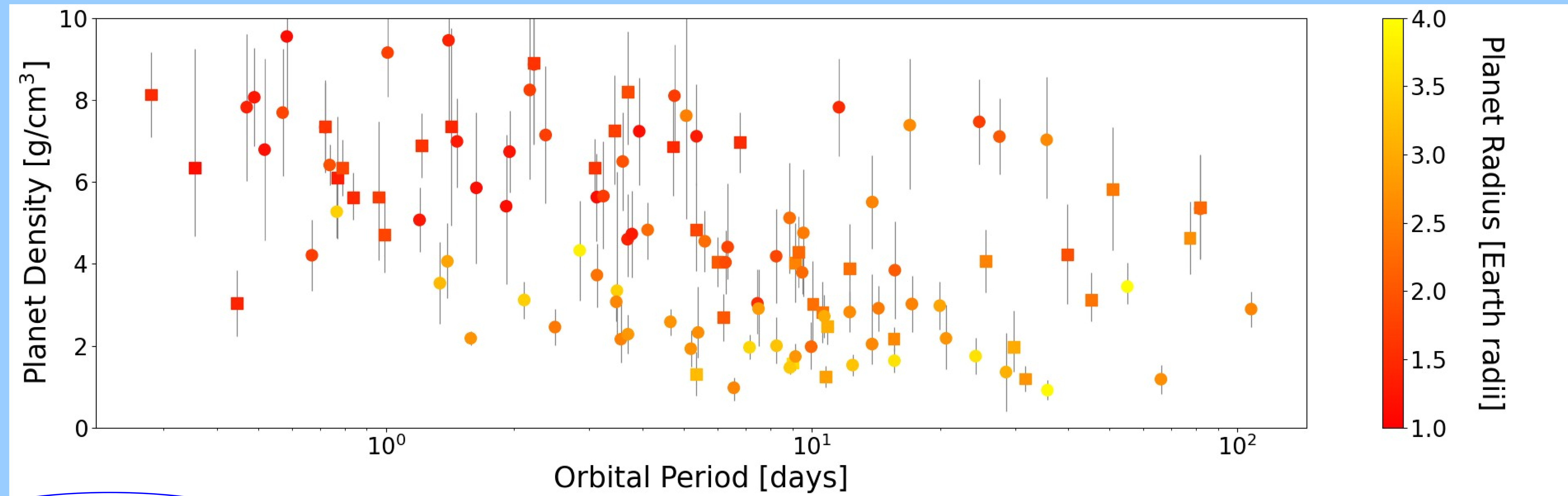



The high-resolution spectrograph HARPS-N has been hunting for planets for nine years. The **HARPS-N Collaboration** collects precise radial velocities (RVs) on **160 half-nights each year** via the Guaranteed Time Observation programme (GTO). The science goals are the follow-up of Kepler, K2, and TESS candidates and a Rocky Planet Search (Motalebi et al. 2015). Using these GTO observations, the HARPS-N Collaboration has already precisely characterised 50 small transiting exoplanets, of which **35 have a mass precision better than 25%**. The majority of the least precise measured masses are from additional planets in a multiplanetary system.

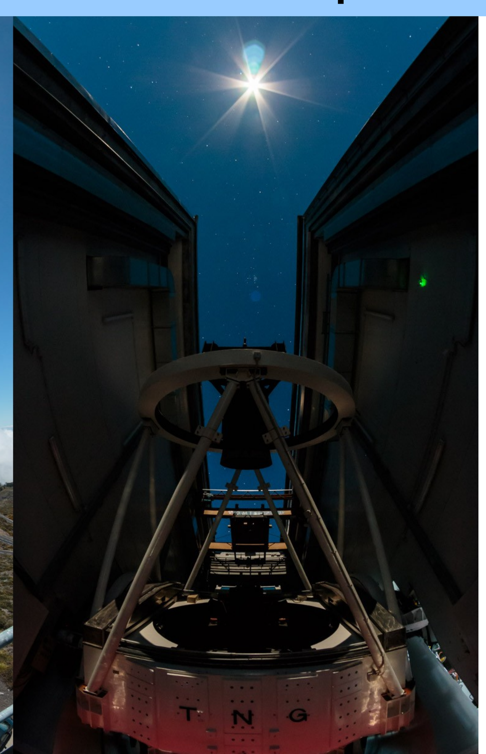


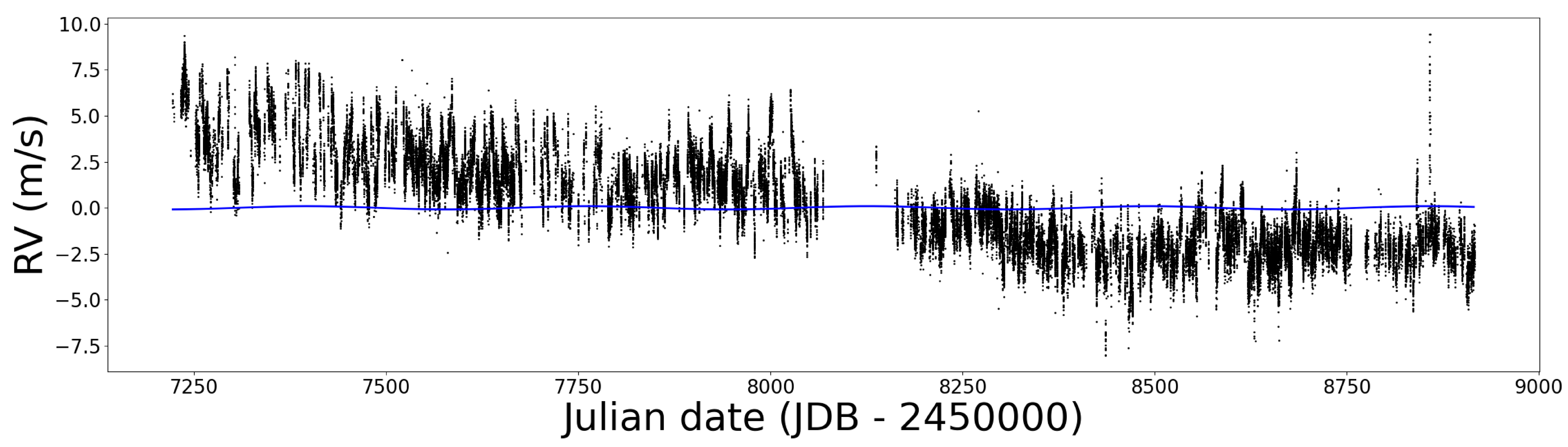

Roughly **40 % of all small planets** with precise radii and masses (better than 3 sigma) had their masses measured **using HARPS-N GTO observations.** The coloured dots in the mass-radius diagram represent values where HARPS-N GTO observations were used in measuring the planetary mass. White dots represent planets where the mass values were obtained using alternative programmes and/or spectrographs and where a precision of at least 33.3% on planetary mass is reported (data from exoplanet.eu).

Check out the talks by Alexandre Santerne (on HIP41378) and Xavier Dumusque (on our Solar data)

The panel above shows planet density versus orbital period for the small planets plotted in the mass-radius diagram. This diagram nicely shows the lack of low-density low-period planets, also known as the hot Neptune desert, created by the effect of photo-evaporation. The squares are the values from the HARPS-N Collaboration. Thanks to our long-term observations and many available consecutive nights, we are **able to precisely characterise ultra-short period planets as well as longer-period planets**. Among the best characterised long-period (P>50d) small planets is **K2-263b** (Mortier et al. 2018), **TOI-561e** (Lacedelli et al. 2021), **and Kepler-538b** (Mayo et al. 2019)**, all with a mass precision better than 23%**. These works prepare us well to characterise the intended long-period planets that will be detected by PLATO.

Distinguishing between a signal induced by stellar activity or a planet is the main challenge in RV data analysis for low-mass exoplanets. Even for transiting planets, where period and phase are known, stellar activity remains the main barrier in nailing down an accurate and precise planet mass. The HARPS-N Collaboration started **observing the Sun-as-a-star** in July 2015. In the figure below, the black dots are the Solar RVs, corrected for any effects of Solar System planets. The downwards slope represents the long-term variability of the Sun's magnetic field. The signature of the Earth's effect on the Sun is represented in blue. This dataset provides a unique test case to understand stellar variability in RVs and are crucial for upcoming experiments such as the Terra Hunting Experiment with HARPS3.






HARPS-N data in the diagrams on this poster was taken from the following works: Bonomo et al. 2014, 2019; Buchhave et al. 2016; Christiansen et al. 2017; Cloutier et al. 2020a,b,2021; Damasso et al. 2018, 2019; Dressing et al. 2015; Dubber et al. 2019; Dumusque et al. 2021; Frustagli et al. 2020; Gettel et al. 2016; Gillon et al. 2017; Haywood et al. 2018; Kosiarek et al. 2019; Lacedelli et al. 2021; Lopez-Morales et al. 2016; Malavolta et al. 2017, 2018; Mayo et al. 2019; Mortier et al. 2018, 2020; Pepe et al. 2013; Polanski et al. 2021; Rajpaul et al. 2017, 2021; Rice et al. 2019; Santerne et al. 2021; Vanderburg et al. 2015, 2017

Stay tuned for the Terra Hunting Experiment on HARPS3, the next Collaboration in the series of awesome and successful HARPS projects.