Exploring the transition between ice & gas giants through ground-based transit surveys and radial velocity measurements

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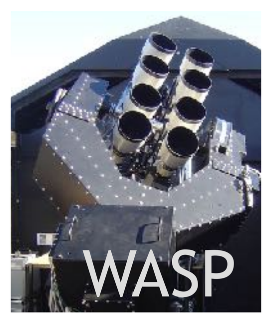
Observations

NGTS & WASP-south

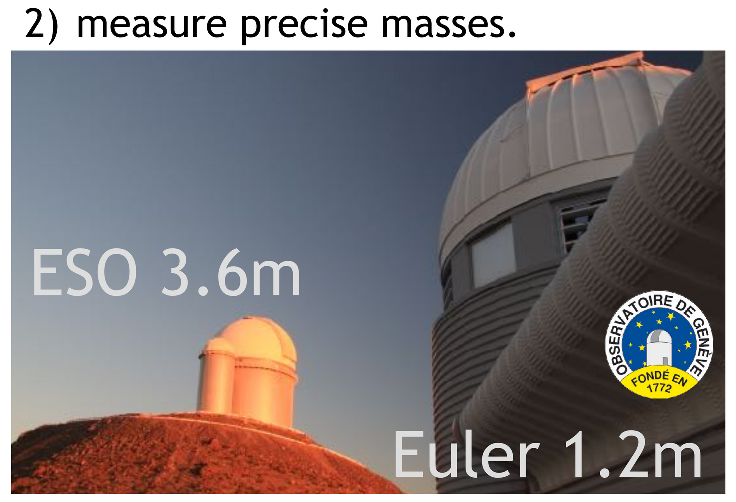
Intermediate sized exoplanets candidates orbiting relatively bright stars are targeted by the ground based transit surveys NGTS (Wheatley et al. 2018) and WASP-south (Pollacco et al. 2006). The latter is now focusing on shallow transits of bright stars after the installation of new 85 mm lenses. See posters #61 by L. Raynard and #86 by P. Eigmüller for information on NGTS-2b and the NGTS project.



RV follow up

The high resolution spectrographs CORALIE (an the Swiss 1.2m Euler telescope in La Silla) and HARPS (at the 3.6m ESO telescope, also in La Silla, Chile) are used to

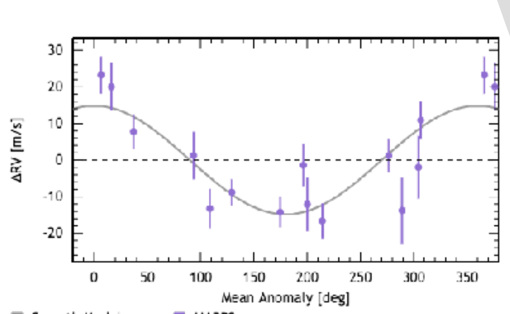
1) check for false positives, such as background eclipsing binaries and
2) measure precise masses.



Hundreds of exoplanet candidates produced by WASP and NGTS has been vetted and characterised over the last 10 years.

For P101, the current semester, 21 nights on CORALIE and 6.1 nights on HARPS has been has been allocated to this crucial follow-up process.

Fig 1: HARPS RV data for our smallest NGTS candidate, showing a RV amplitude of ~15 m/s. Our typical error bars are 5-6 m/s and limited by photon noise.



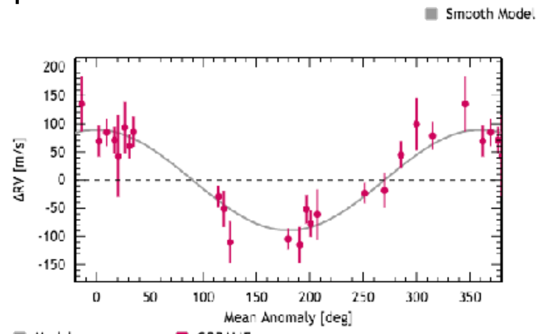


Fig 2: CORALIE RV data for a low density Jupiter- like WASP candidate. The grey line is a fit of a circular orbit, using the period and epoch from the WASP photometry, with RV amplitude 89 m/s.

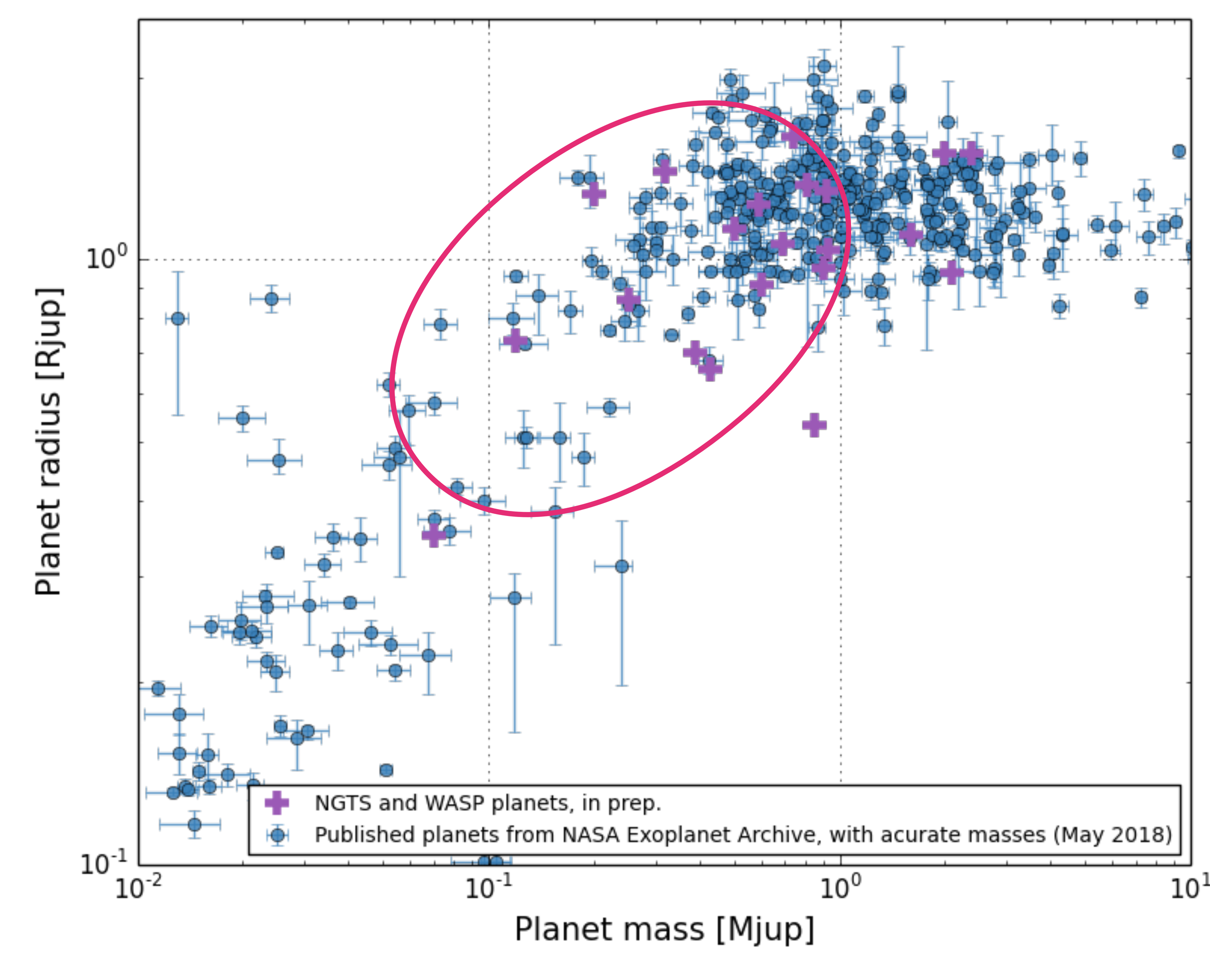
Transition between ice- and gas giants

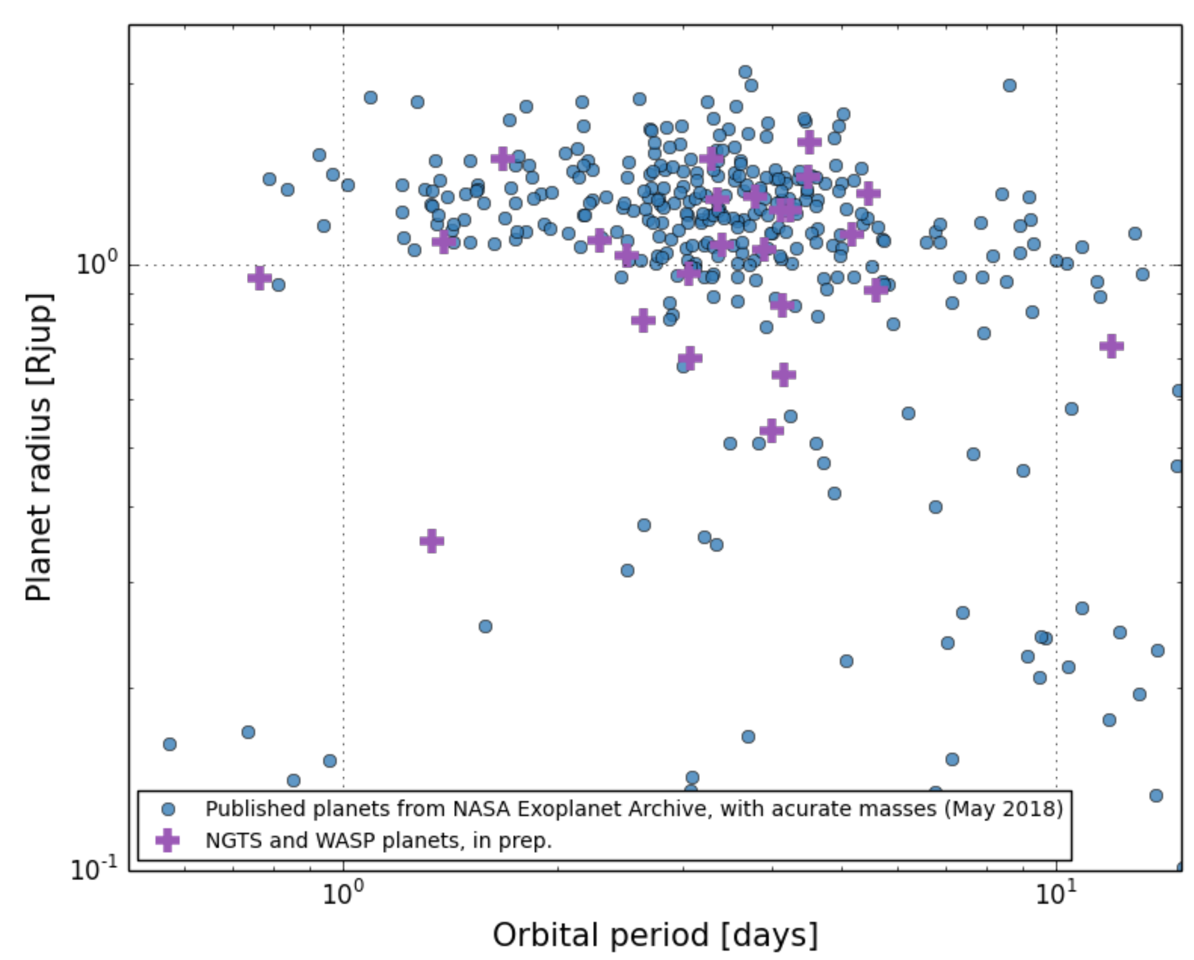
Constraining the transition between Neptune-like *ice giants* and the more massive Saturn- and Jupiter-like *gas giants*, is a key ingredient in constraining possible planet formation scenarios.

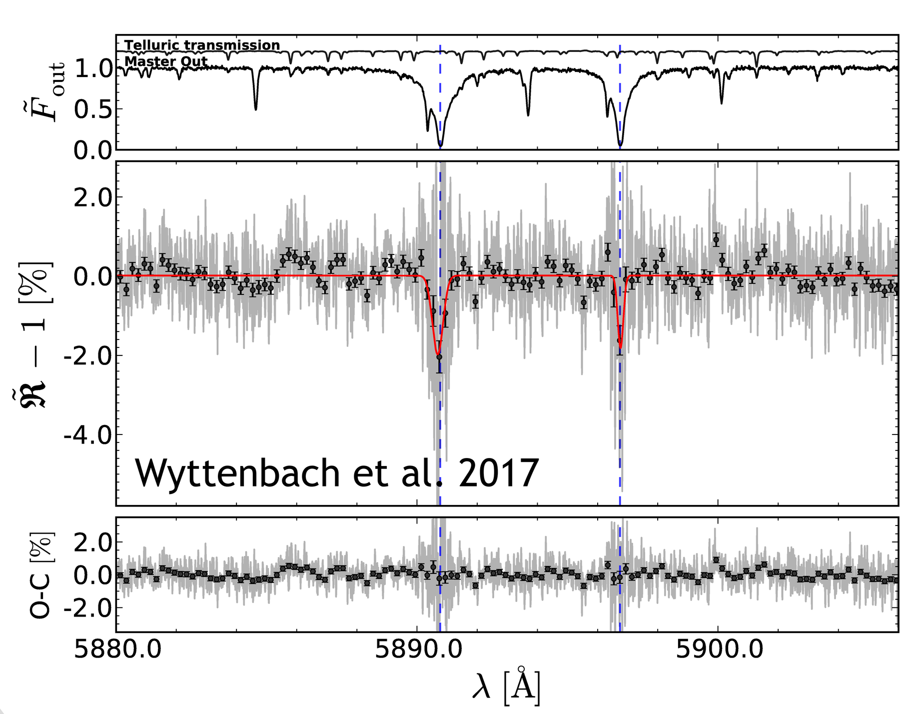
Only a few planets in this intermediate-mass transition space has precise masses and it is therefor important to detect and characterise more of these objects.

This is illustrated in **Fig. 3** on the right, which shows the current exoplanet population as of May 2018 from NASA Exoplanet Archive, with masses with at least 20 % precision. Over plotted in purple are new NGTS and WASP exoplanet candidates, all in prep. Many of these targets fall within the transition between Saturns and Neptunes and will help answer the question why ice giants do not evolve to become gas giants.

Disclaimer: the results for the new NGTS and WASP planets shown in purple in Fig. 3 & 4 are pre-global modelling and could be subject to minor corrections.







Neptune desert

The Neptune desert (Szabó & Kiss 2011, Mazeh et al 2016) is constituted by a dearth of short period Neptunian planets. Many explanations has been put forward to explain this phenomenon; in particular the upper boundary can be seen a limit beyond which neptunian planets cannot exist when they migrate inwards (e.g. Tian 2015). The lower limit can explained by three-stage in situ planet formation via core accretion, which naturally yields the final planetary mass as a function of distance to the host star (Lee et al. 2014, Helled et al. 2014).

Fig 4 on the left shows the same planets as presented in Fig 3, showing the lack of short period Neptune like planets. We have one planet falling within the border of the desert, which could help constraining it even further.

Atmospheric characterisation

Transiting exoplanets offer unique opportunities for in-depth characterisation, as they are the only planets for which we can study both bulk and atmospheric compositions.

This allows us to link the interior structure with volatile content to further constrain formation pathways. Exploring the properties of intermediate size exoplanets as function of host star properties, orbital period and insolation is necessary to get a complete picture of planet population.

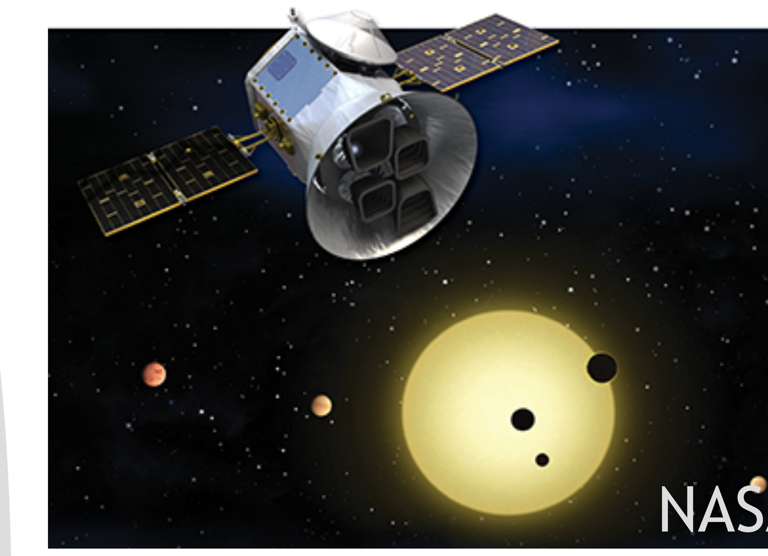
Having the precise masses of bloated Saturns and Neptunes is crucial for accurate atmospheric characterisation (see e.g. Barstow et al. 2013), especially in the era of ESPRESSO, NIRPS and SPIROU and subsequently JWST and ELTs.

Fig.5 to the left shows the current state of the art for high resolution transmission spectroscopy, here the sodium Na I D doublet as observed with HARPS for WASP-49b (Wyttenbach et al. 2017).

Getting ready for TESS

Starting December 2018, TESS will provide numerous exoplanet candidates transiting bright hosts stars and we will expand our characterisation of ice and gas giants. According to Barclay et al. (2018) TESS will detect a total of ~4500 planets of which >4000 will be intermediate or giant planets.

The Swiss Euler telescope in La Silla has committed 100 nights to vetting of TESS objects of interest. Furthermore, in particular CORALIE will be instrumental in the follow-up of potential thousands exoplanet candidates with an extra emphasis on long period giants and intermediate mass objects.



We also plan to continue our program on HARPS, slowly transitioning from ground based- to space based exoplanet surveys.

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PlanetS National Centre of Competence in Research
FNSNF Swiss National Science Foundation