The GAPS Programme at TNG.

TOI-5076b: a warm sub-Neptune planet orbiting a thin-to-thick disk transition star in a wide binary system.

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1. Introduction

A bimodal distribution is observed in the radius distribution of sub-neptunian planets, with a local minimum around 1.5 $R_\oplus$ and 2 $R_\oplus$, known as the ***radius gap***.

- Planets below the gap are currently interpreted as stripped cores which lost their atmospheres by means of some physical processes like **photoevaporation** (Owen & Wu 2013) or **core-powered mass loss** (Ginzburg et al. 2018).
- Planets above the gap are thought to be able to retain their atmospheres or are water worlds (Zeng et al. 2019).

Increasing the sample of sub-Neptunes is important to clarify the origins of this class of exoplanets.

2. Observations and data

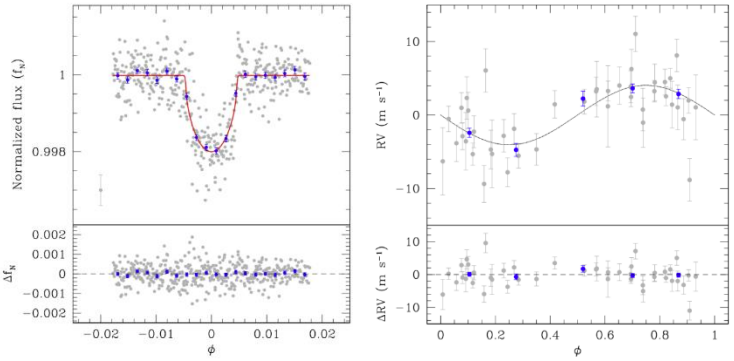
- TOI-5076 photometry was acquired by **TESS** satellite and analyzed with the DIAmante pipeline (Montalto et al. 2020); in total 4 transits were observed.
- The target was followed-up with the **HARPS-N** high resolution spectrograph. A total of 44 measurements were acquired in the context of the GAPS programme.

3. Host star

- The host star is a **metal rich K2V dwarf**, at about 82 pc from the Sun.
- It has a radius of $R_\star$=(0.78±0.01) $R_\odot$ and a mass of $M_\star$=(0.80±0.07) $M_\odot$.
- It forms a common proper motion pair with a M-dwarf companion star located at a projected separation of 2178 au.
- The chemical analysis of the host-star and the galactic space velocities indicate that TOI-5076 belongs to the old population of **thin-to-thick disk transition stars**.
- From the calculation of the log R'_{HK} indexes, the FWHMs of the CCF and the bisector spans, we conclude that stellar activity has a negligible impact on observed RVs.

4. Planetary parameters

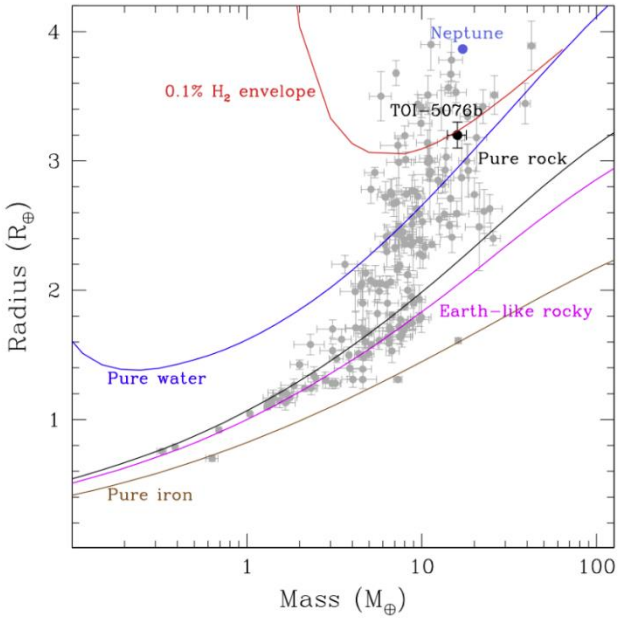
- Planetary parameters were obtained by performing a simultaneous fit of both spectroscopic and photometric data with the software *juliet* (Espinoza et al. 2019).
- We obtained that the transiting body is a **sub-Neptune planet** with a mass m_p = (16±2) $M_\oplus$ and a radius r_p = (3.2±0.1) $R_\oplus$ yielding a density ρ_p= (2.8±0.5) g cm^{-3}. Its orbital period is 23.445 days.



Grey points are our measurements, while blue points represent measurements rebinned respectively in twenty (left pic.) and five (right pic.) phase bins. Continuous lines represent our best fit models.

5. Planetary structure

- The density of TOI-5076b suggests the presence of a large fraction by volume of **volatiles overlying a massive core**.
- Assuming full heat redistribution and zero Bond albedo we estimated the planet's equilibrium temperature at T_{eq} = (615 ± 20) K.



In the image we have: pure iron (100% Fe, brown curve); Earth-like rocky (32.5% Fe+67.5% MgSiO3, magenta); pure rock (100% MgSiO3, black curve); pure water (100 % H2O, blue curve); 0.1% H2 envelope - (49.95% Earth-like rocky core + 49.95% H2O layer + 0.1% H2 envelope by mass), assuming 1 milli-bar surface pressure level and isothermal atmosphere at 700K (red curve).

6. Conclusions

- In this work, we report the confirmation of a new transiting warm sub-Neptune exoplanet TOI-5076b orbiting the star TOI-5076.
  - See the incoming paper *Montalto M., Greco N., Biazzo K. et al.* for further details.