Updates from the planetary mass determination

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INAF – ASTRONOMICAL OBSERVATORY OF PALERMO

ARIEL-IT SCIENCE MEETING

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Knowing the planetary mass

Mass known with a precision better than 50% should allow to guide retrieval analysis successfully, while a precision of 20% is recommended for an in-depth characterisation of the atmosphere

(Batalha et al. 2019)

Prior information of the planetary mass helps in **breaking the degeneracy** between the planet mass and the mean molecular weight of species.

$$H = \frac{k_b T (R_0 + z)^2}{\mu M_p G}$$

Mass determination WG

- COORDINATORS: G. Micela, L. Buchhave
- GOALS:
  - Determination of the planetary mass of the Ariel targets for a proper atmospheric characterization
    - Estimate the RV effort
    - Need and feasibility of RV campaigns
    - Identification of suitable spectrographs

Summary of the previous work

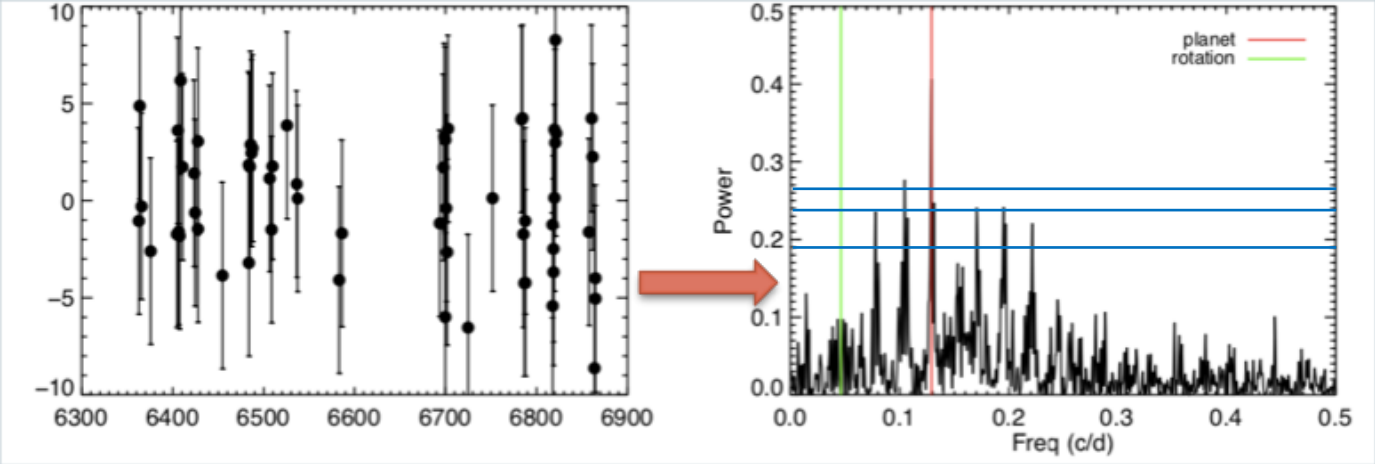
We simulated radial velocities (RV) time series for each potential target of ARIEL to quantify the number of RV data points to measure its planetary mass with a well defined precision:

- To quantify the **observing time** required to perform a spectroscopic follow-up
- To propose an observing **strategy** for dedicated RV campaigns
- To help the **selection** of the ARIEL Reference Sample

Part of the work is described in the ARIEL Red Book (arxiv) and in Demangeon et al. 2021 ExpAst (subm.)

Summary of the previous work

1. Injection of a planetary signal in the simulated RVs
2. Recovery of the signal by using GLS periodogram
   I. The main GLS peak must be centered at the orbital period within the errors
   II. The amplitude of the recovered signal must be equal to the injected K within errors



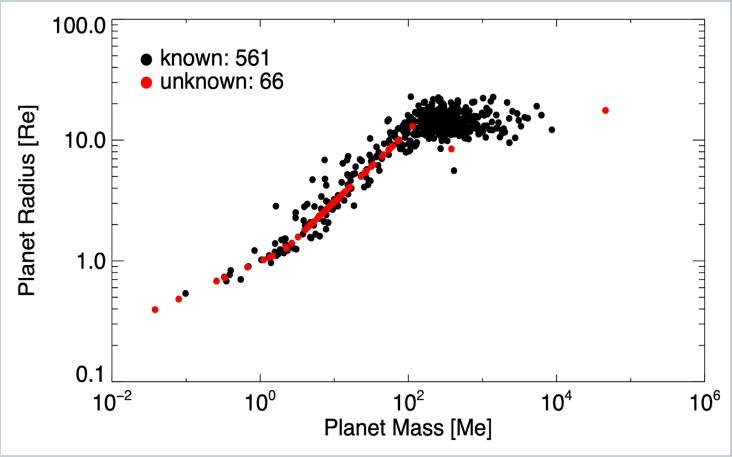
The new Candidate Reference Sample

Previous work based on the CRS2020 (Edwards et al. 2019)

- **1920** targets in the ARIEL Candidate Reference Sample
- **1538** TESS planets as derived by Barclay et al. 2018

New CRS by Edwards et al. 2022!

- **561** targets
- **68** TOIs
- **66** with no information on the mass
- **473** mass better than 50%
- **359** mass better than 20%



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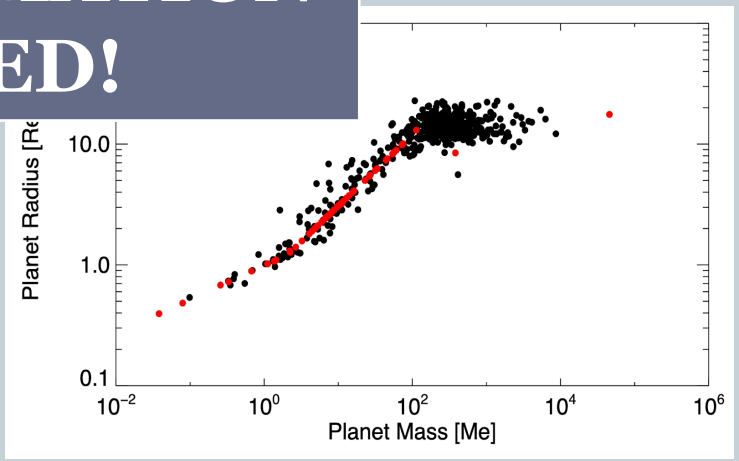
MORE INFORMATION REQUIRED!



Which planets?

Changeat + 2020: simulations to evaluate the impact of the mass uncertainty on the retrival of the atmosphere:

- of super-Earth around M dwarf
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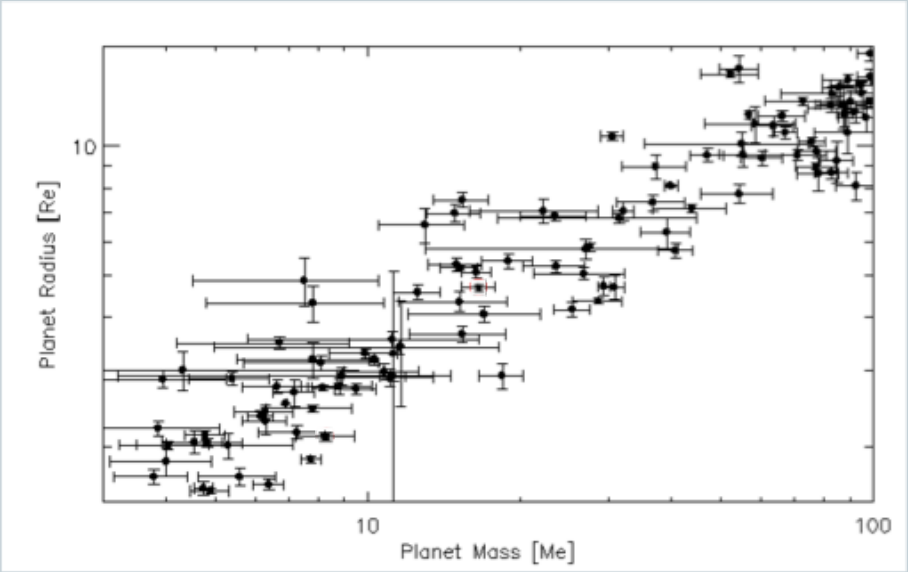

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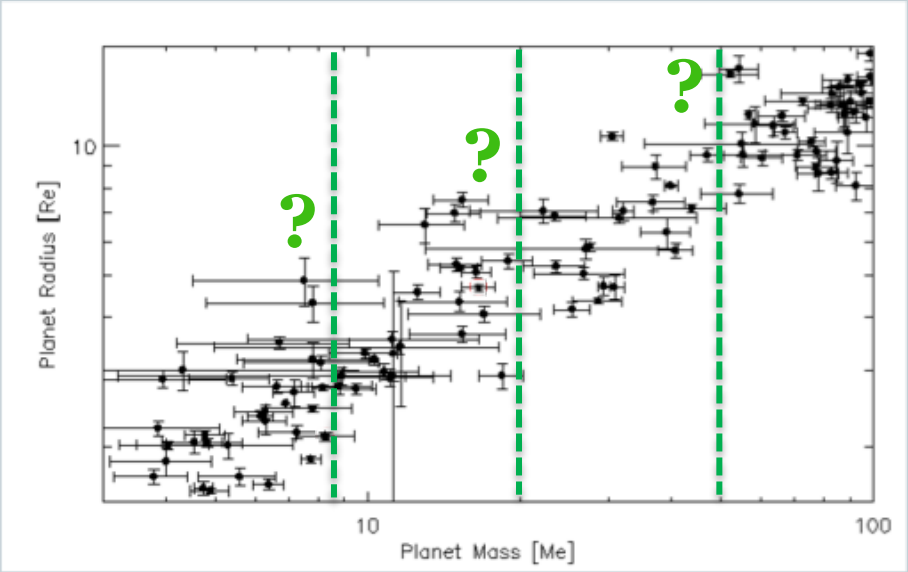


Tau-REx simulations

New simulations are currently ongoing to extend the parameter space:

- To explore the Neptunian regime
- To define the required precision in the planetary mass for a proper retrieval
- To evaluate if other parameters can play a role

See the talk by C. Di Maio

GAPS3?

- We proposed to include the Ariel planetary mass determination for the new GAPS large program
- GAPS: Italian collaboration to search and characterize exoplanets with HARPS-N/GIANO-B/ GIARPS at TNG

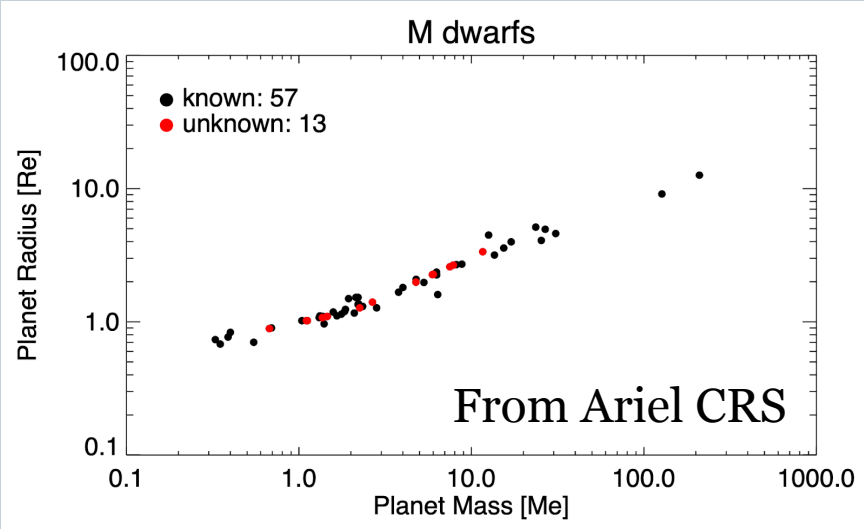
GAPS3?

- A range of planetary radii must be specified for the selected sample in order to define a specific science case
- Neptune-like planets seems to be the most interesting both for GAPS and Ariel (see the talk by A. Sozzetti)
- Perspectives to join the effort with the HARPS-N GTO

Some tests with Spirou

- Collaboration started with the Spirou Legacy Survey (SLS, Spirou@CFHT large program, 150 nights/yr)
- Some of the M-dwarfs in the ARIEL target list are currently included in the SLS
- Expected RV precision:

  ~8 m/s for Hmag ~ 10
- Contact point: F. Kiefer



Perspectives

- New simulations will help us to define which planets really need a dedicated RV follow-up and what is the required precision in the knowledge of the planetary mass
- Perspectives for RV follow-up for a number of Ariel targets (Spirou and HARPS-N)