

PLATO – ARIEL SYNERGIES

In the GOP framework

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After a brainstorming with: V. Nascimbeni, L. Borsato, G. Bruno, L. Malavolta, G. Micela, M. Montalto, G. Piotto, R. Ragazzoni, G. Scandariato

Contest



2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
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PLATO



ARIEL



PLATO: Launch at end 2026; 4.5 yr nominal, consumables till 8.5 yr

ARIEL: Launch 2029 (mid?); 4 yr nominal + 2 yr extension






About planets

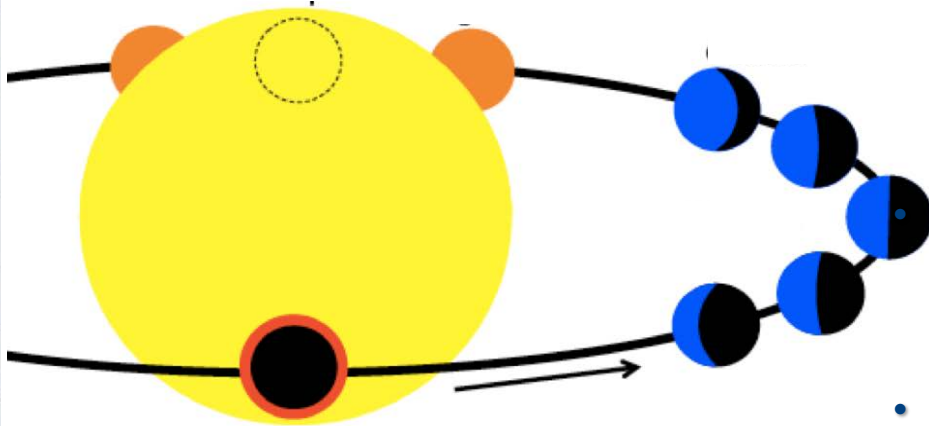
- Better ephemeris
- Better planet radius
 - this obviously influences the surface gravity and therefore the interpretation of the transmission spectra

BUT

- Typical planets that Ariel will investigate are HJ, WJ, some Neptune or super-Earth on stars of small radius.
- 
- There will be nothing that has not been done by TESS or with other facilities even from the ground.

Optical phase curves

- **Ariel** can make phase resolved spectroscopy for all Ariel eclipse targets.



- **PLATO** can provide, for many of the Ariel targets, some of the most accurate optical phase curves ever, on a different level than what TESS or CHEOPS can do today.

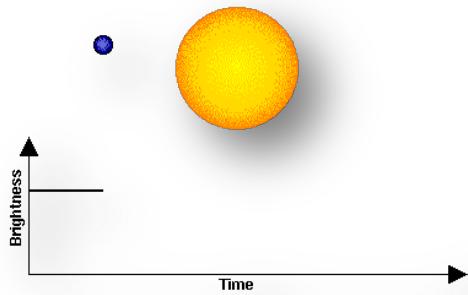
The typical HJ from $P \sim 3$ d falling on a LOPS field will be observed for approximately **~ 240 complete orbital phases** (!). \rightarrow a 15 times higher S / N.

- We are not talking about a huge number of targets,
 - In the areas covered by F-CAM we will have phase curves in two distinct optical bands, including occultations, therefore a measurement of the geometric albedo decoupled from the thermal emission of the planet can be obtained (however both bands are in the optical).
- Can this information be then integrated into the interpretation of the transmission / emission spectrum in NIR?

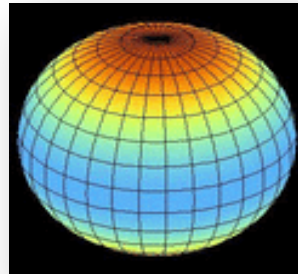
Stellar Parameters



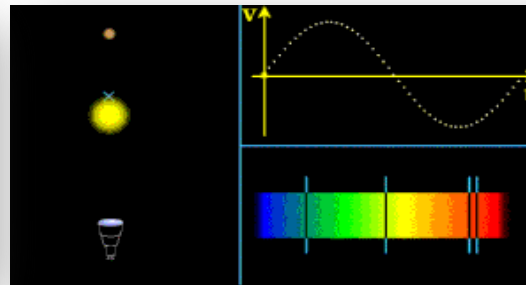
Transit Method



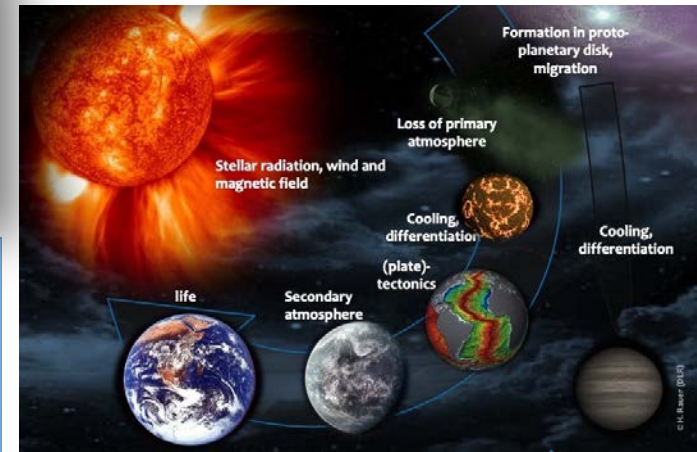
Asteroseismology



Radial velocity method



- R_p/R_*
- Orbital inclination
- Orbit parameters
- R_*
- M_*
- Stellar age
- $M_p/M_* \sin i$



Mean Densities, Age → Evolution of Planets & Planetary Systems, Habitability

Radius ~3% Mass ~10% Age ~10%

Does Ariel need masses?



- **Yes & No!!**

- A WG in Ariel has the task to secure masses for their targets by RV measurements
- Although RV follow-up of PLATO targets will be mainly devoted to systems with small planets, PLATO will make **asteroseismology** of all targets in the bright sample
- Improved stellar masses → improved planetary masses also for Ariel.



- Simulations made in the Ariel team (Di Maio et al) show that a minimum uncertainty **of 50% on the mass** is enough to retrieve the atmospheric parameters and the mean molecular weight that is at least within 2sigma of the true values (in the worst case scenario with Pclouds ~ 10-3 bar).

Does Ariel need ages?

- **Yes!!**
 - At least for solar-types ages provided by PLATO asteroseismology will put Ariel's detections on an accurate evolutionary scale,
 - This for comparative planetology is difficult to ignore ...



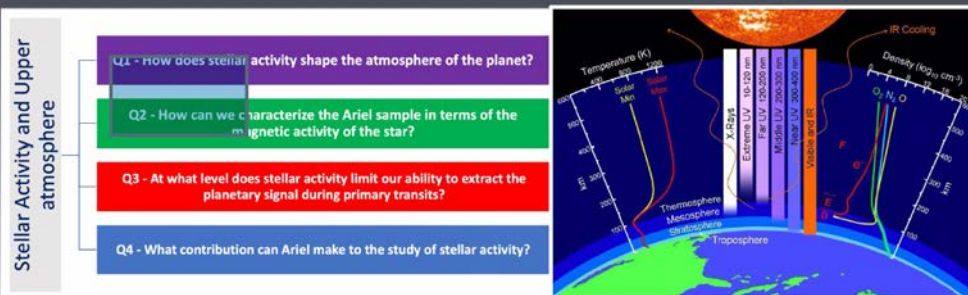
About Stellar Activity

Slide from Ariel meeting in Bologna last week

Stellar activity & upper atmosphere



NEW KEY QUESTIONS



Ariel @ Bologna Meeting 2022

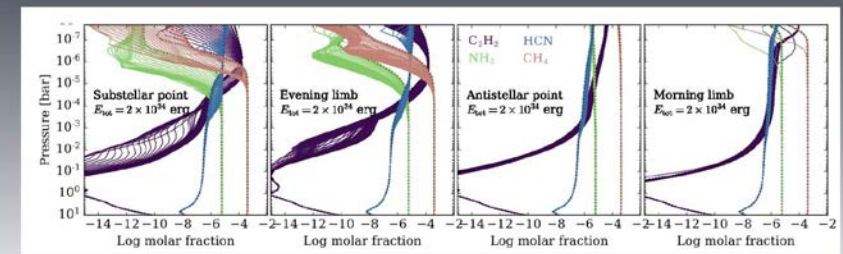
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Flares & atmospheric chemistry



WHAT ARE THE EFFECTS OF STELLAR FLARES?

Proposed experiment: select planets with similar basic parameters around quiescent M, active M and F



Konings et al. 2022; Louca et al. 2022; Ridgway et al. 2022; Venot et al. 2016

Ariel @ Bologna Meeting 2022

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Ariel can photometrically monitor its targets during spectroscopy, but PLATO data can say much more on the magnetic activity of the parent star.

PLATO can provide for all Ariel target in its fields info on:

- Rotational modulation (amplitude and period);
- Phase of the activity cycle
- Frequency of flares and CME

Granulation

- How granulation signal can affect the retrieval of atmospheric parameters is not well known → a dedicated team in Ariel Consortium will investigate it.
- PLATO with its uninterrupted long duration observations, and its sensitivity can study granulation from late type stars (K and M) much better than done up to current facilities.



Timing effects and internal structure

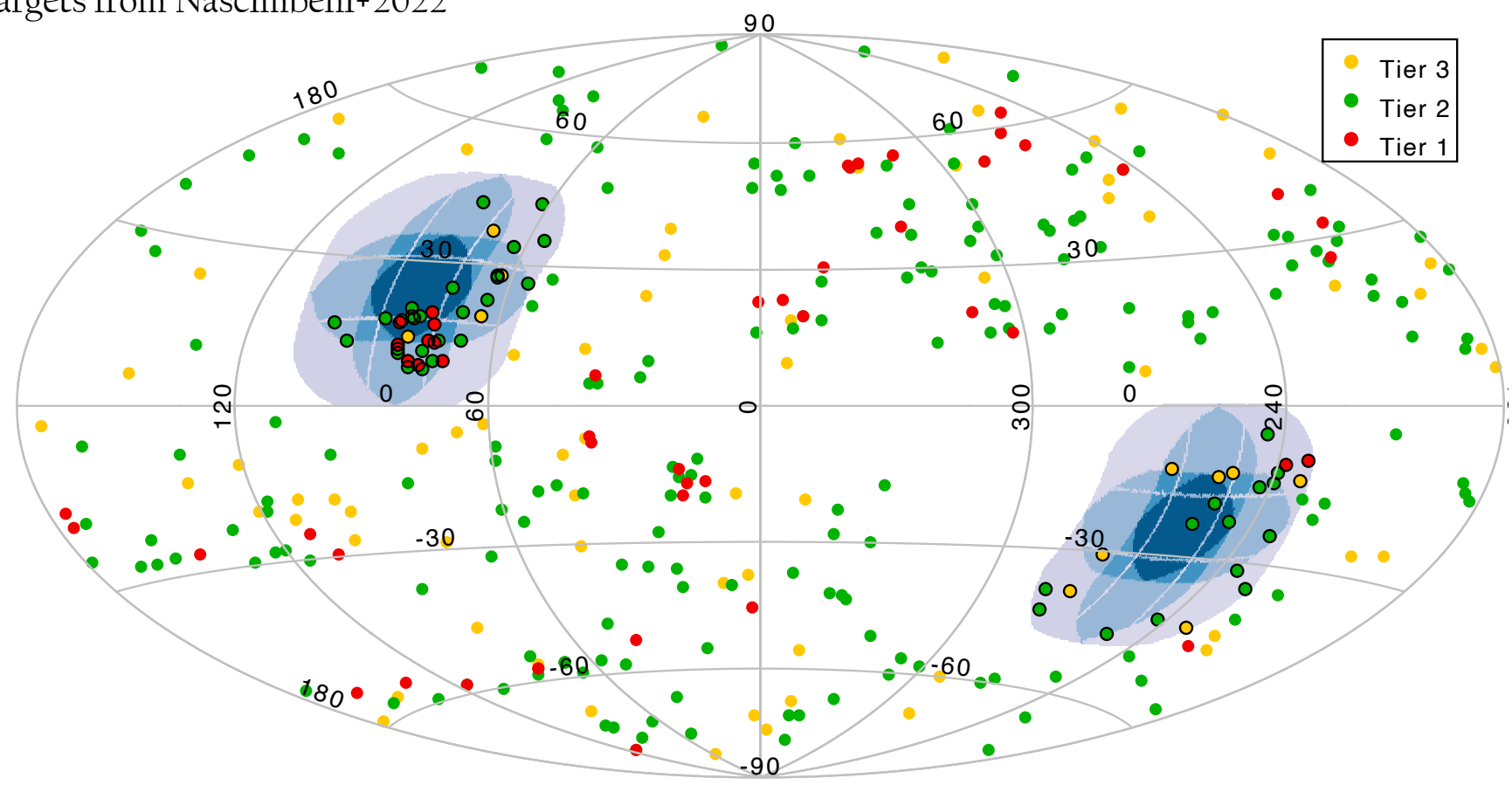


- Secular effects due to **tidal decay**, **apsidal precession** and light travel time effects (**LTTE**) from massive companions can be derived from the TESS -> (CHEOPS) -> PLATO -> (ARIEL) observations.
- The time baseline would allow $dP/dt < 1 \text{ ms / yr}$.
- The tidal decay of the **HJs**, in particular, allows to estimate the tidal quality factor and therefore to put some **constraints on the internal structure** (cf. Yee + 2020).
- The link between this information on internal structure and Ariel's interpretation of core science is not immediate to develop, however, there seems to be room for some synergy.

PLATO fields vs. Ariel targets



Ariel targets from Edwards+ 2019
PLATO targets from Nascimbeni+2022



V. Nascimbeni

Simultaneous Observations

- Several years both in space
- Contemporary observations will be unique!

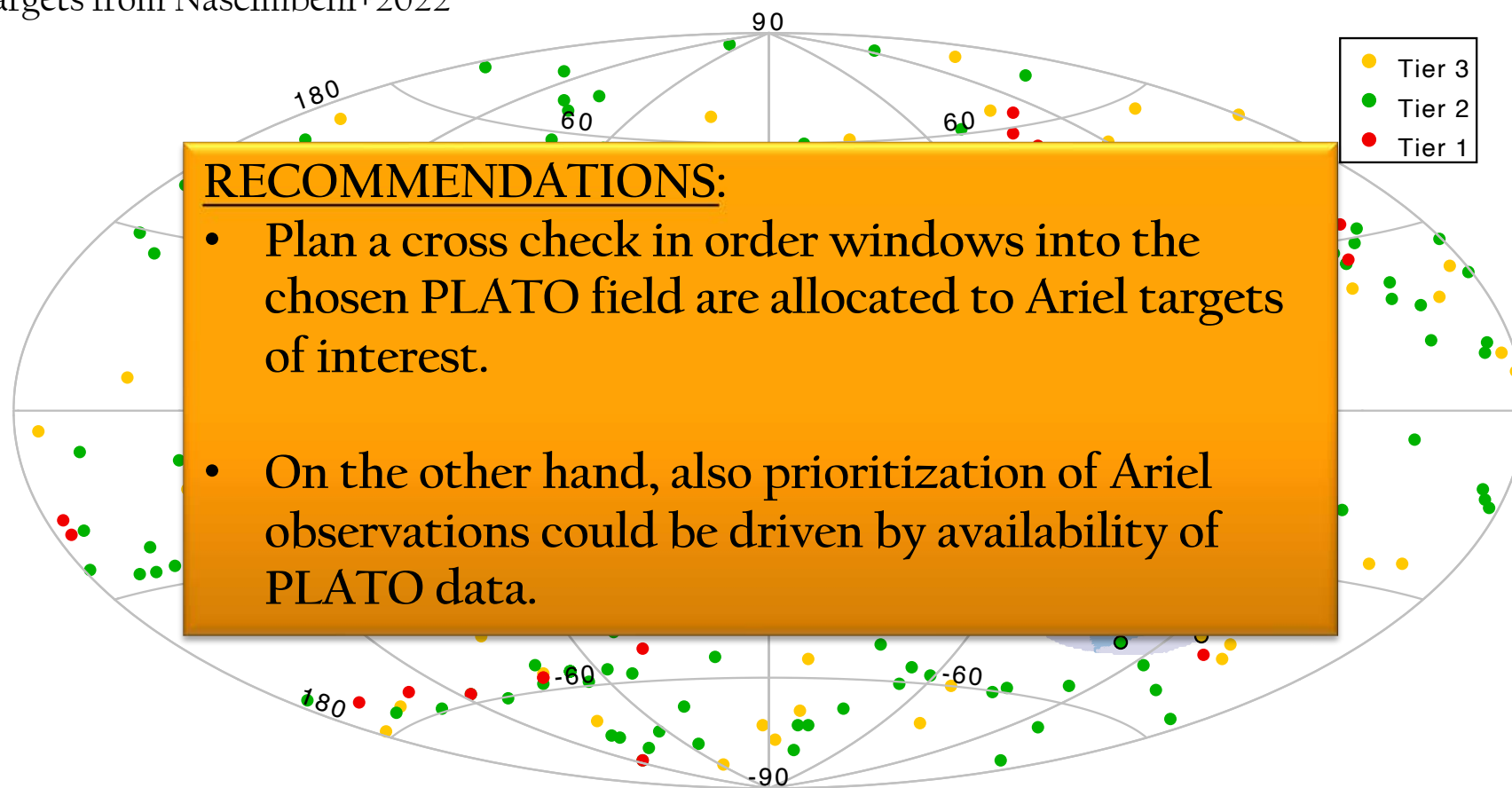


PLATO fields vs. Ariel targets



Ariel targets from Edwards+ 2019

PLATO targets from Nascimbeni+2022



SCOPRI UN NUOVO UNIVERSO



Ice cream planets everywhere!

Mini brioche filled with ice cream

Questions/Comments



- **Heike** comments that there will be a number of new targets identified by PLATO that will be valuable for Ariel; among these especially the warm jupiters/neptunes.
- **Isabella** suggests to set-up a team with the task to quantify how many new targets PLATO can give to Ariel.
- **Eike** comments about the relevance for Ariel of flares for the chemistry of the atmosphere; he says that there are hints from a small number of targets that small flares are not so numerous as the extrapolation of the cumulative distribution from high energy flares shows. He suggest that observing AD Leo can give a lot of info. **Isabella** explains that AD Leo cannot be observed with Cheops because of the contaminants in the fields. **Don** suggests this can be done with NGST.
- **Stephane** is interested to know about the GO time of Ariel. **Ana** highlights that the GO policy is written in the Ariel SMP (that is public)