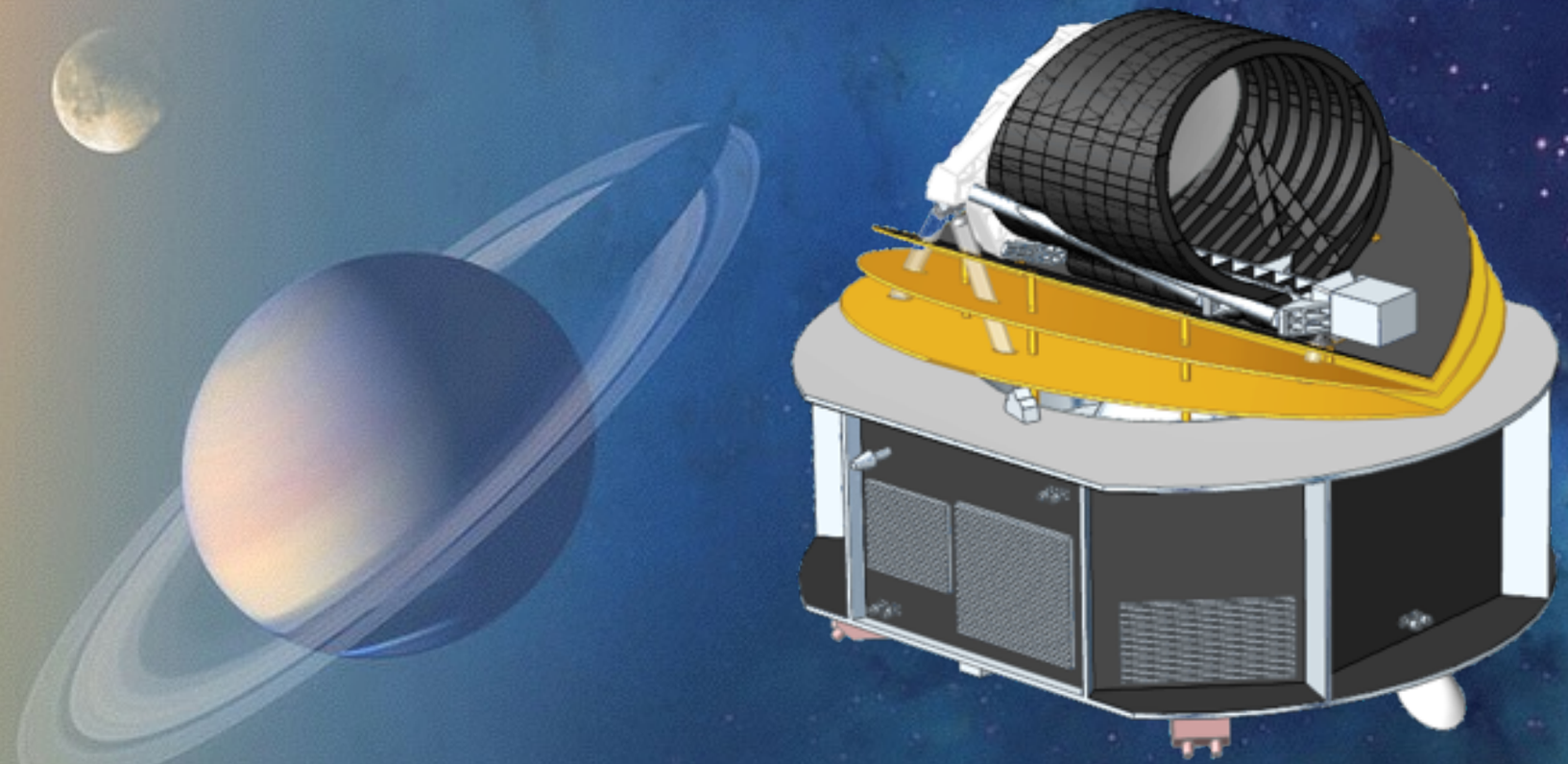
Connecting planetary atmospheres and host star properties

Vincent Coudé du Foresto (LESIA – Paris Obs.)
for the ARIEL consortium



PLANETS ARE UBIQUITOUS

Our Galaxy is made of gas, stars & planets

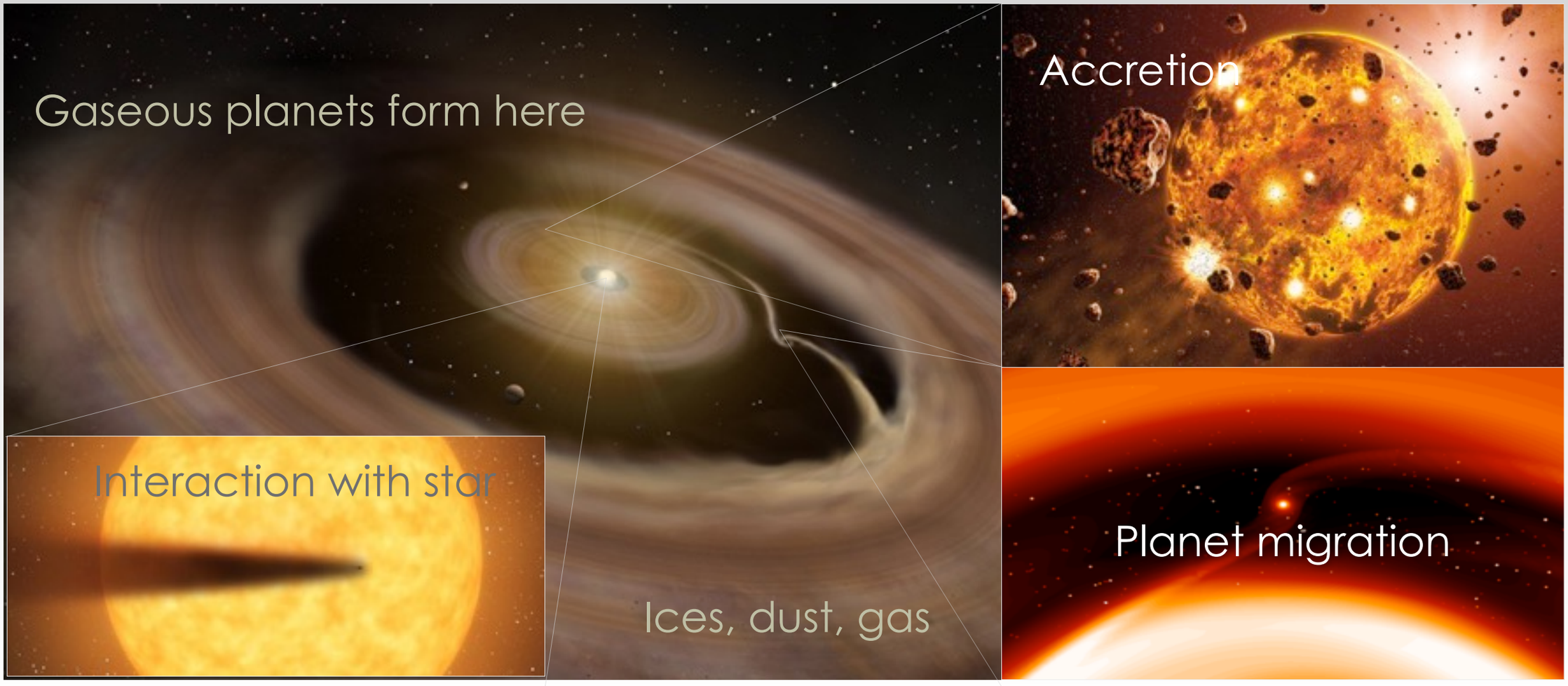
There are at least as many planets as stars

(Cassan et al. 2012, Batalha et al. 2014)

PLANETS ARE DIVERSE

PLANETARY DIVERSITY: WHY?

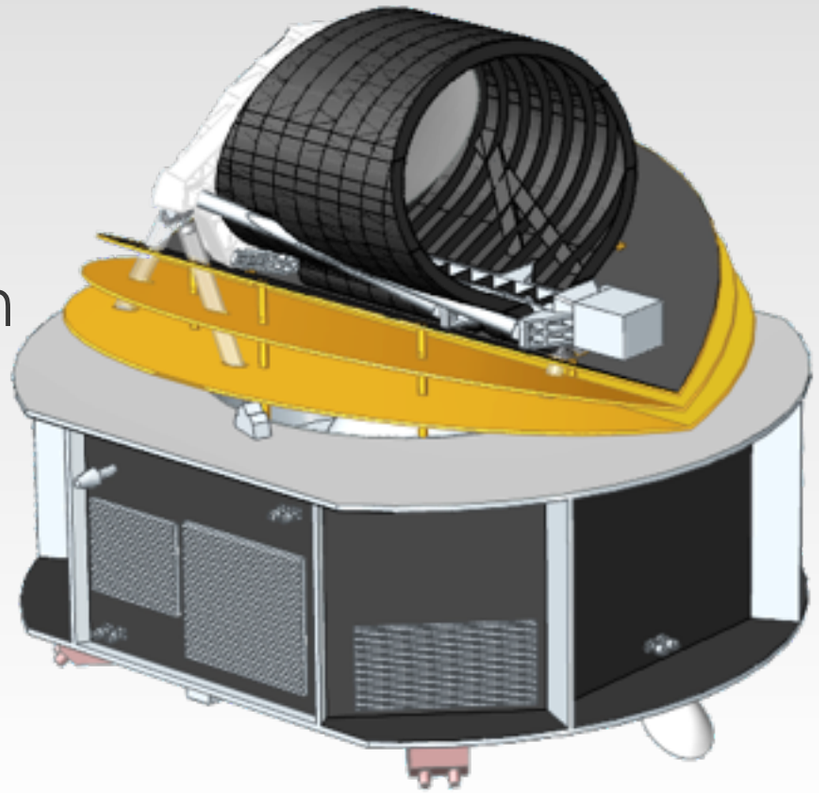
FORMATION & EVOLUTION PROCESSES? MIGRATION? INTERACTION WITH STAR?



ARIEL – KEY FACTS

ATMOSPHERIC REMOTE SENSING INFRARED LARGE SURVEY

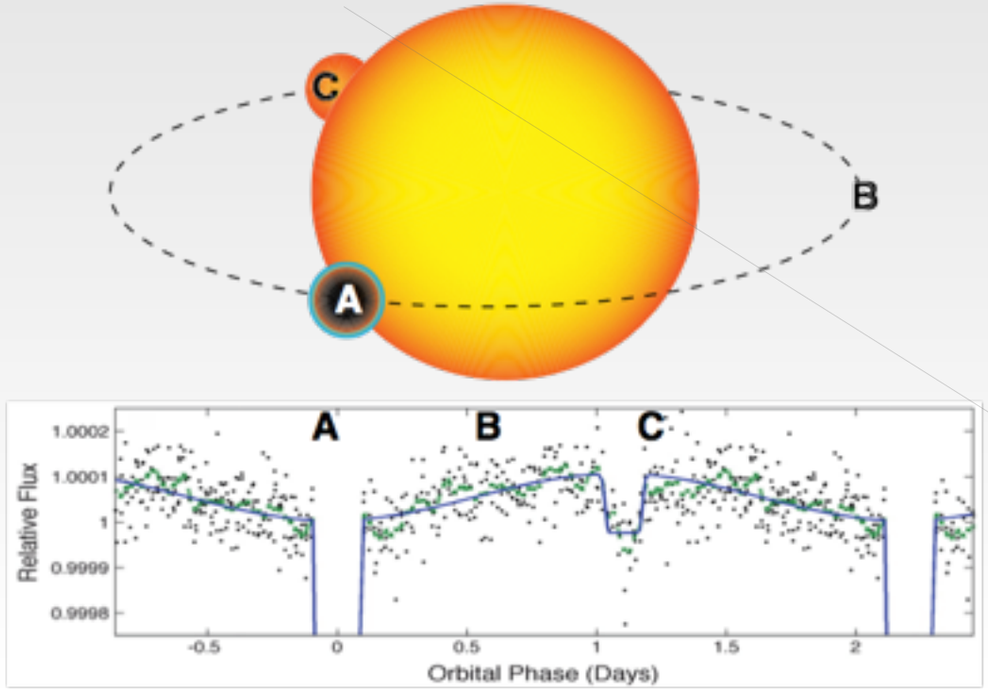
- 1-m class telescope, spectroscopy from VIS to IR (R = 30 – 200)
- ~1000 exoplanets observed (rocky + gaseous)
- Simultaneous coverage 0.5-7.8 micron
- Payload consortium: 11 ESA countries
- Finalist for M4 slot (2026 launch)
- Satellite in orbit around L2
- 4 years nominal lifetime (6 year goal)

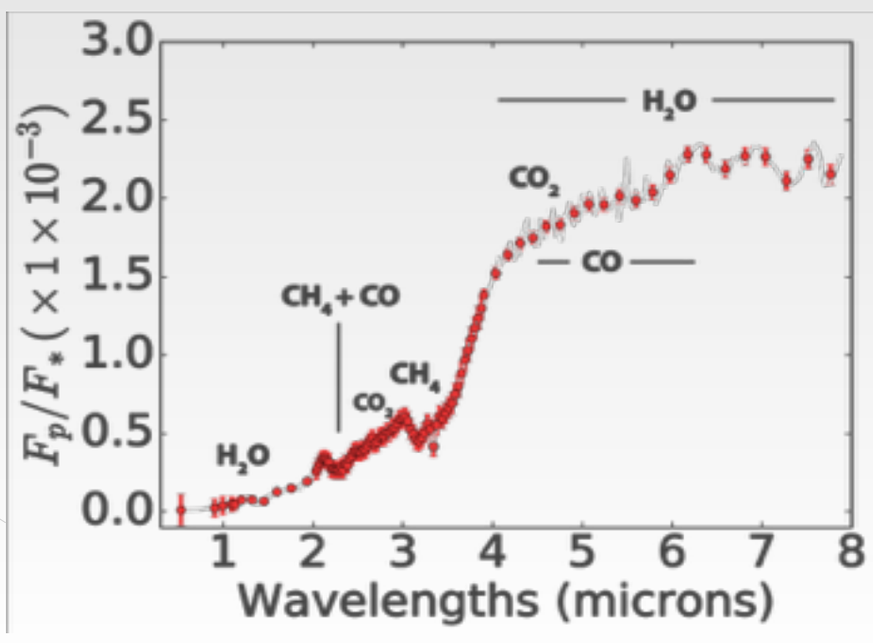


TRANSIT, ECLIPSE, PHASE-CURVE SPECTROSCOPY

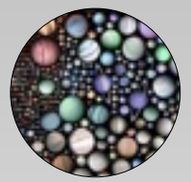
AIMING AT 10 PPM STELLAR FLUX AT MULTIPLE WAVELENGTHS

Through stable instrument, external calibration & proven postprocessing analysis



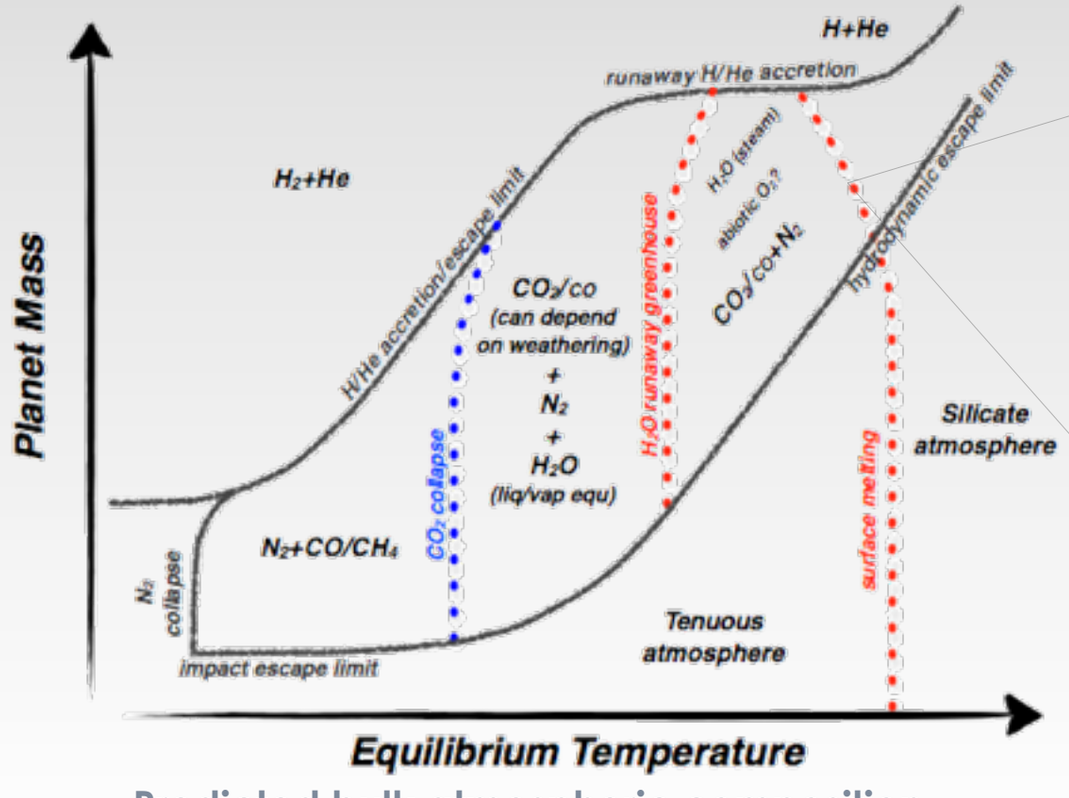


CHEMICAL DIVERSITY



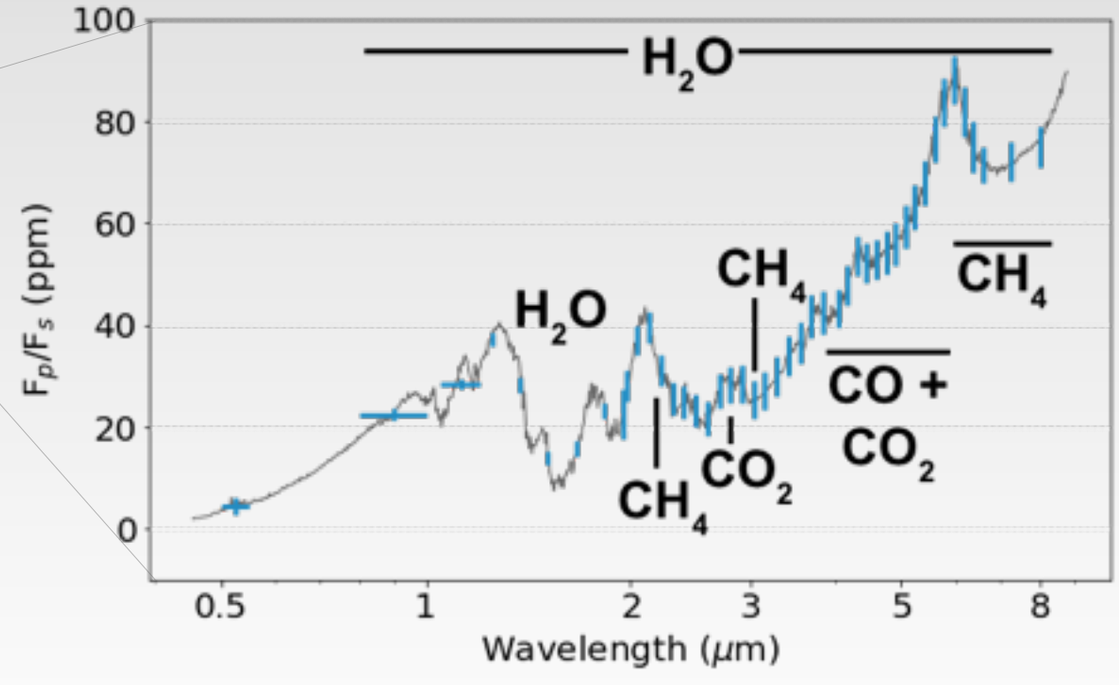
CORRELATION WITH ANY OTHER KEY PARAMETERS?

Is this plot true? Where are the transitions?



Predicted bulk atmospheric composition
(Forget & Leconte, 2013)

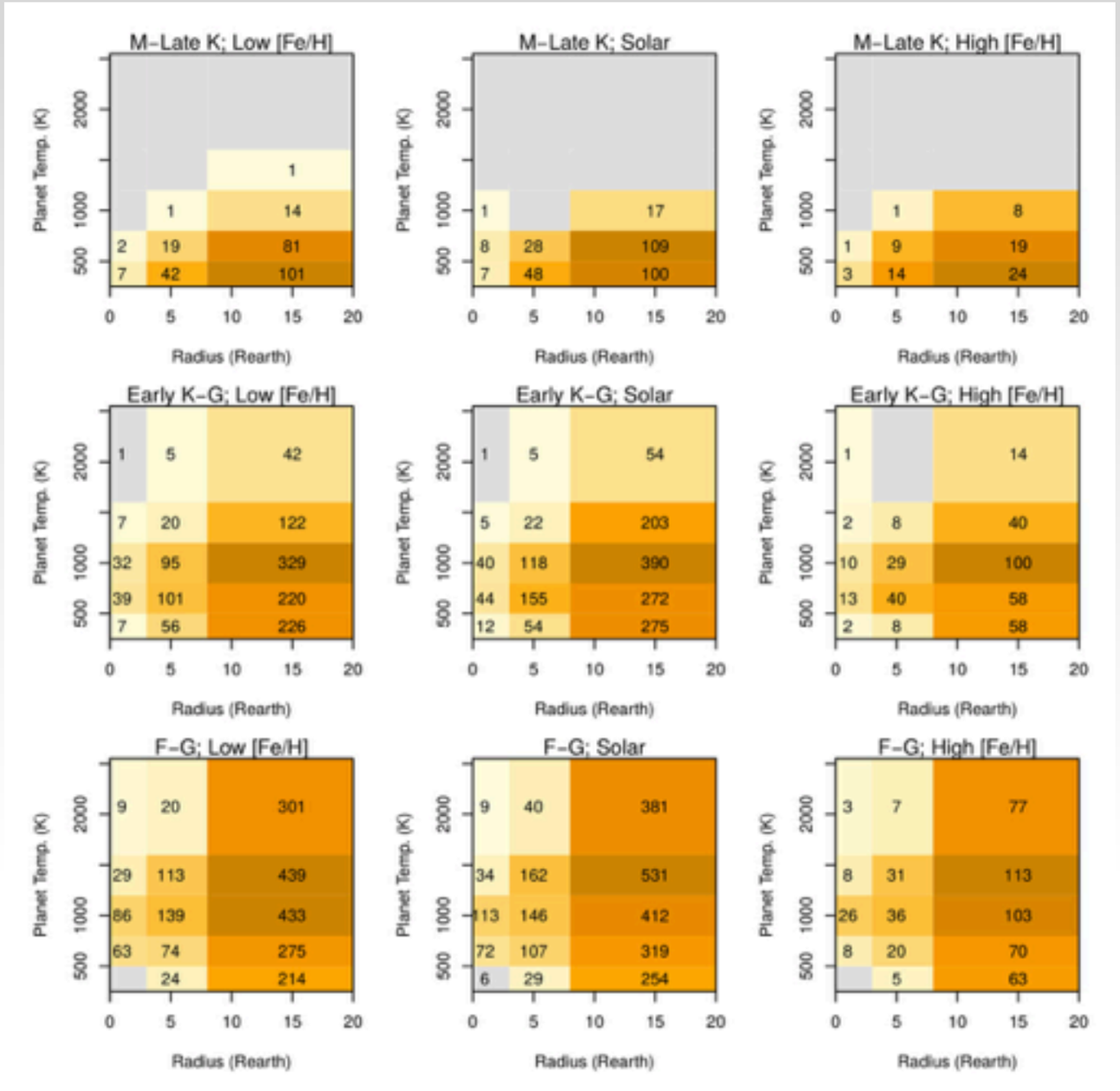
ARIEL observations x many planets



=> LEADING TO A "H-R DIAGRAM" FOR EXOPLANETS ?

NEED FOR A STATISCALLY SIGNIFICANT SAMPLE OF PLANETS

SELECTED OUT OF PLANETS AVAILABLE FOR CHEMICAL OBSERVATIONS



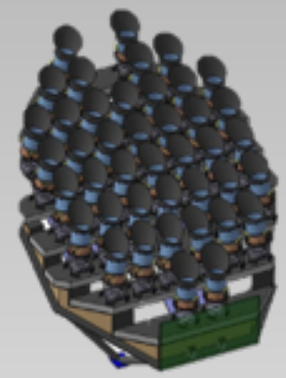
Parameter space to be paved:

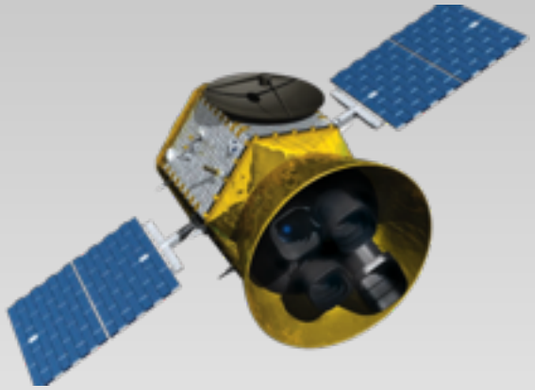
- Planet size,
- Temperature,
- Density;
- Stellar type,
- Metallicity

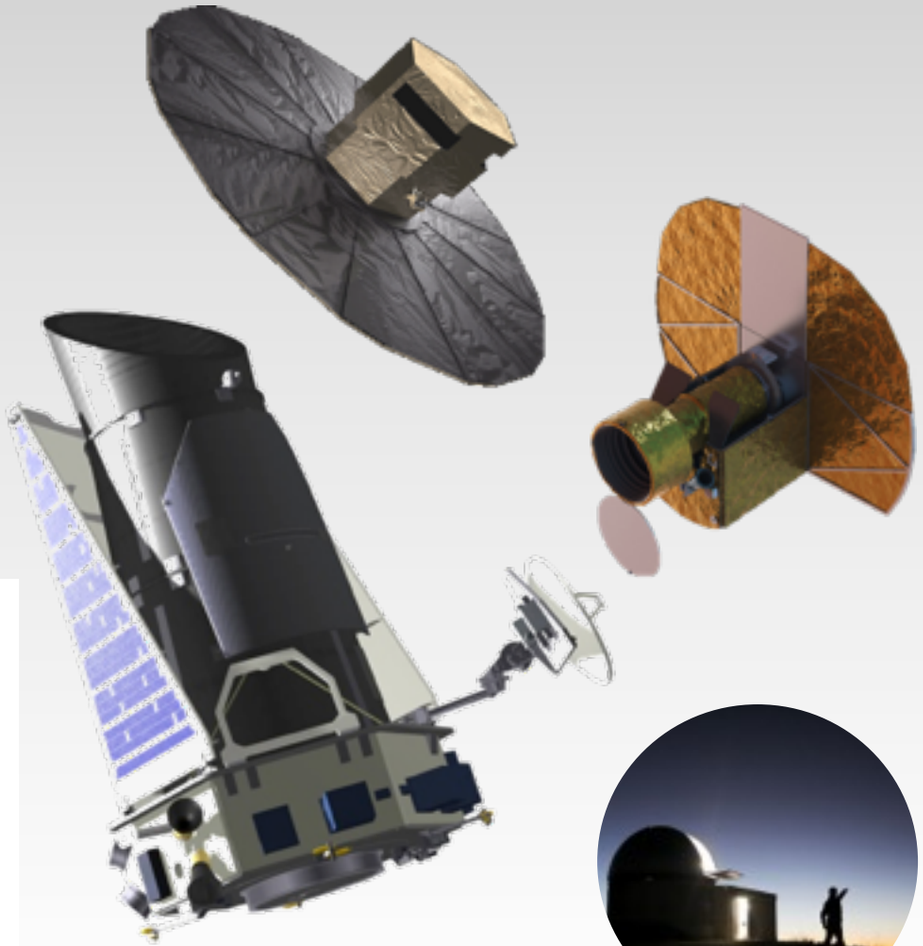
The sample should have ~ 1k planets

Zingales et al., 2017

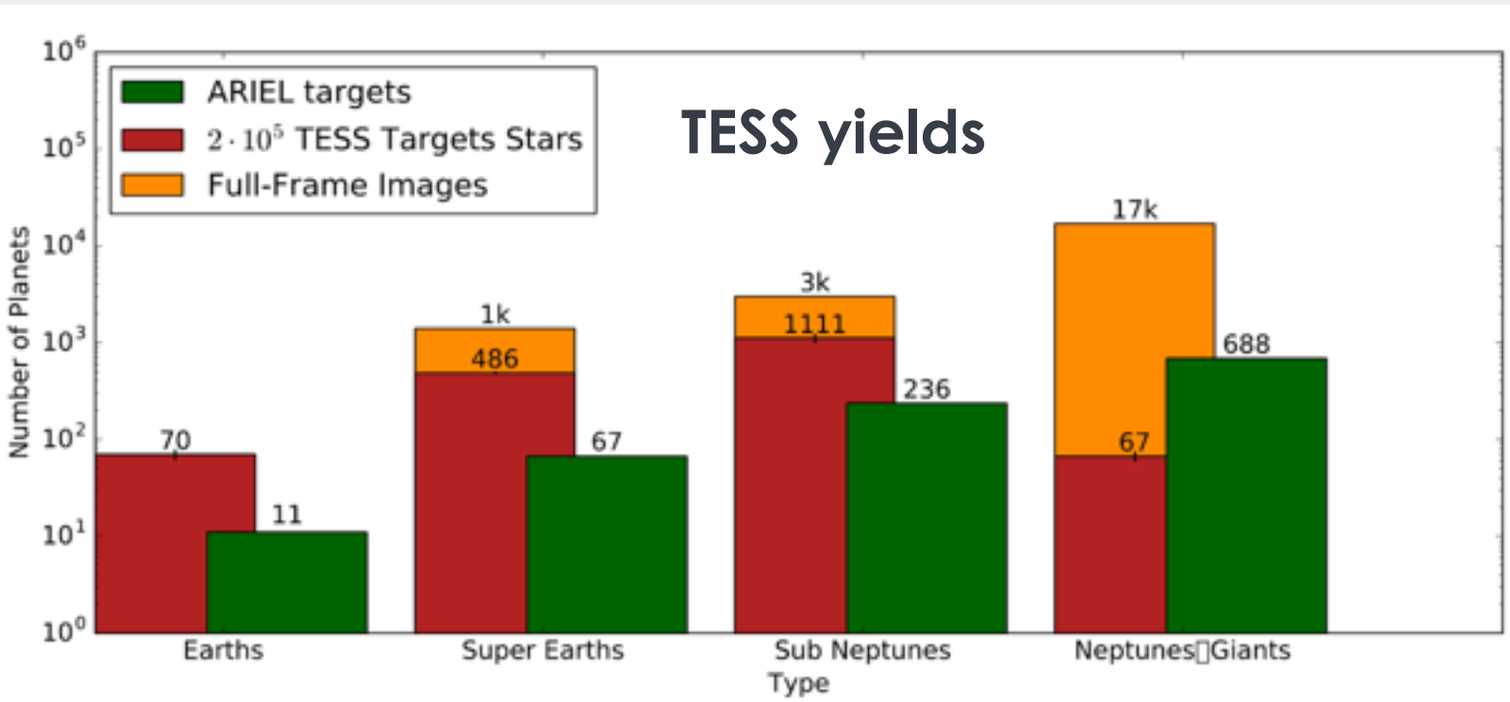
POSSIBLE TARGETS FOR ARIEL







- ~200 planets known today
- In 2026 :
  - ~2000 more targets known mostly from ground-based surveys
  - ~8000 including TESS and PLATO planets



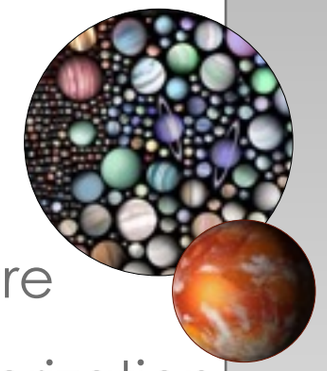
Sullivan et al., 2015

3-TIER MISSION

SINGLE PLANETS & POPULATION ANALYSIS

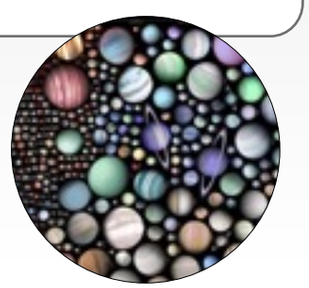
60% mission

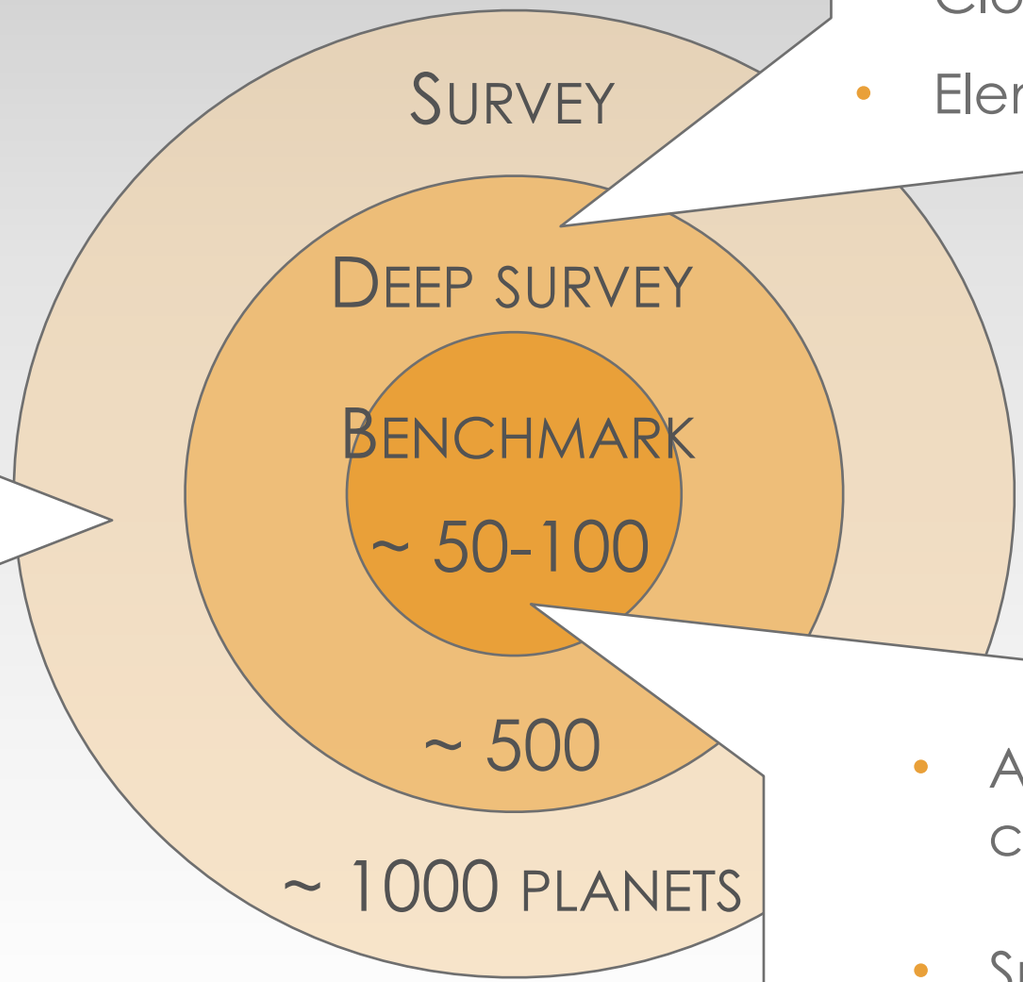
- Main atmospheric component
- Trace gases
- Thermal structure
- Cloud characterization
- Elemental composition



30% mission

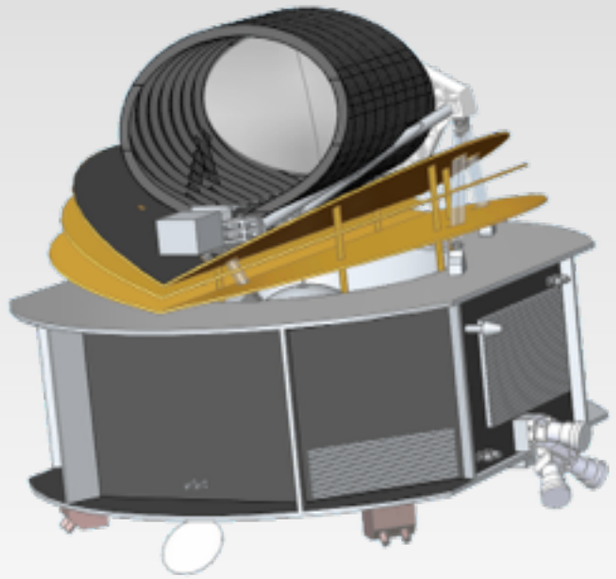
- What fraction of planets have clouds?
- Have small planets still retained H/He?
- Colour-colour diagrams
- Refinement of orbital/ planet parameters in IR





- Atmospheric circulation
- Spatial & temporal variability

10% mission

CONCLUSION

- ARIEL will enable us to understand why planets in our galaxy are so diverse and how they evolve
- ARIEL will do so by delivering the first chemical survey of ~ 1000 exoplanets, paving uniformly the gamut of planet and stellar parameters
- ARIEL will do for atmospheric characterization what Kepler has done for planetary demographics