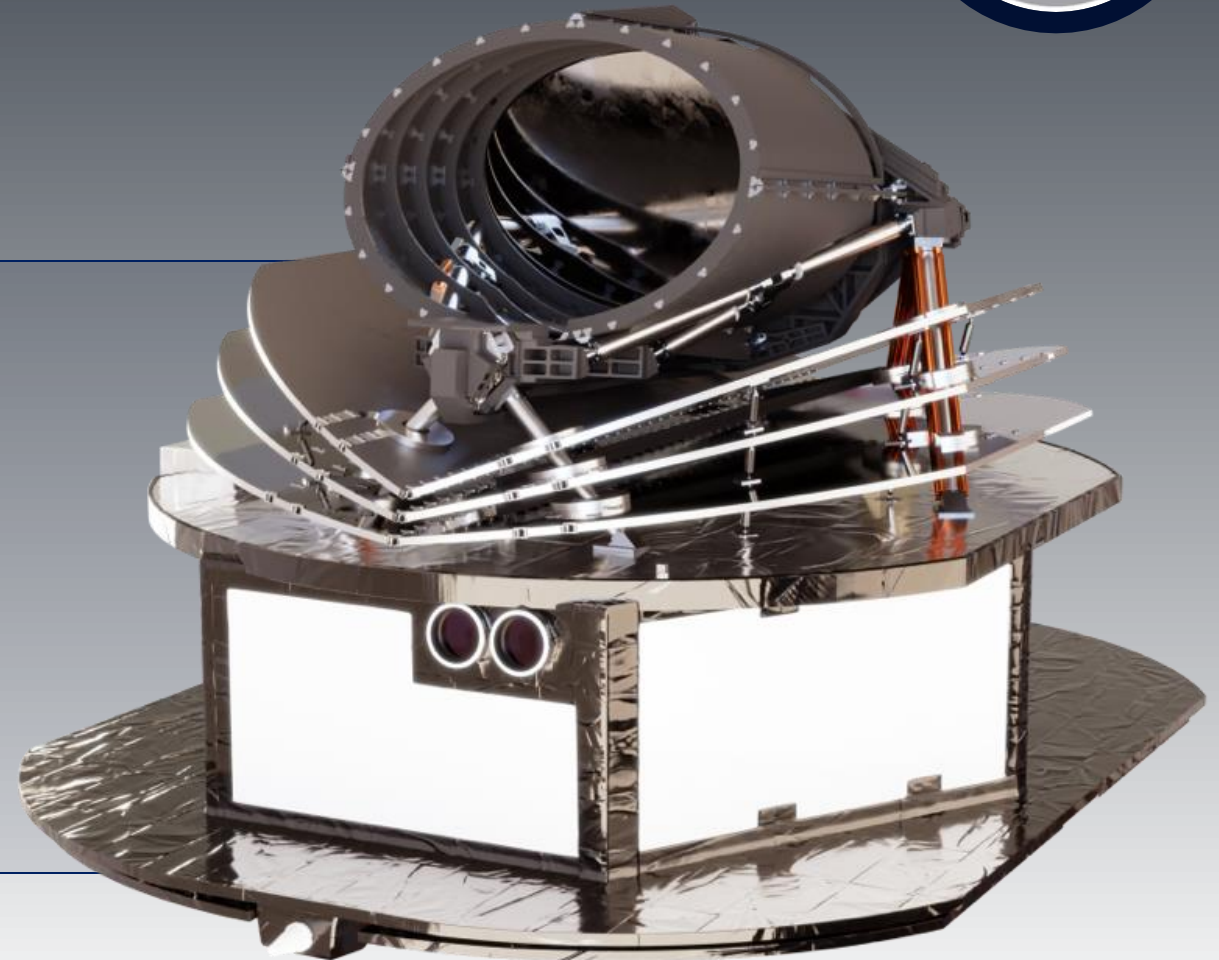




ARIEL

SCIENCE & COMMUNITY ENGAGEMENT

GIOVANNA TINETTI (UCL) AND THE ARIEL TEAM



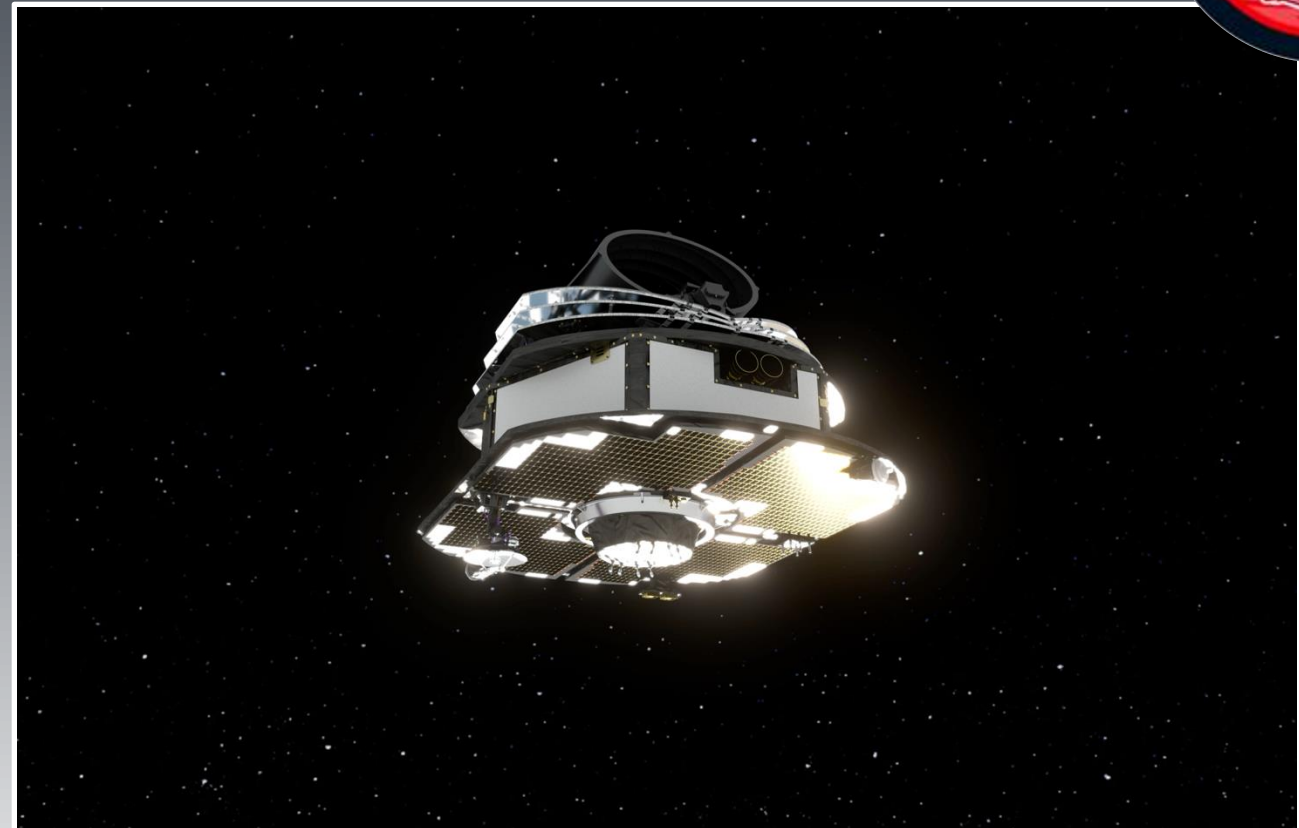
Ariel



- Adopted as ESA M4 in Nov. 2020
- PDR passed in 2023
- Launch to L2 in 2029

- 1 m-class telescope
- Simultaneous coverage 0.5-7.8 μm

- ~1000 exoplanets observed
- Rocky + gaseous; 300-3000K; stars A-M



Ariel Definition Study Report – Tinetti et al. 2021, arXiv:2104.04824



Ariel payload consortium



600+ SCIENTISTS AND ENGINEERS FROM 16 ESA COUNTRIES + NASA, JAXA, AND CSA



A mission is more than flying hardware.... there are people

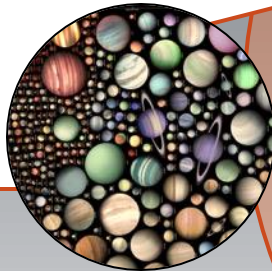


Ariel 4-Tier approach



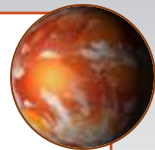
INDIVIDUAL PLANETS & POPULATION ANALYSIS

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



TIER 4

- Phase-curves
- Tailored observations



SURVEY – TIER 1

DEEP SURVEY – TIER 2

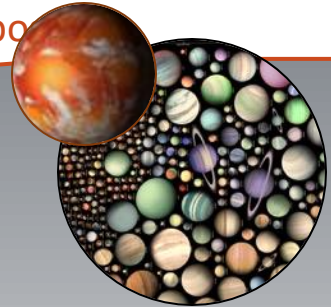
BENCHMARK – TIER 3

~ 50-100

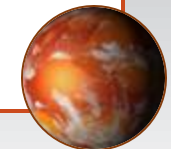
~ 500

~ 1000 PLANETS

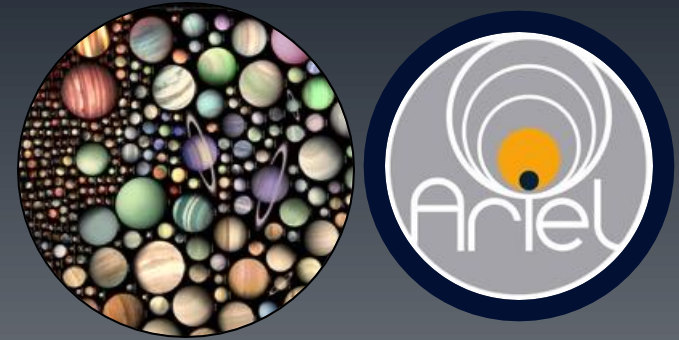
- Main atmospheric composition
- Trace gases
- Thermal structure
- Cloud characterization
- Elemental composition



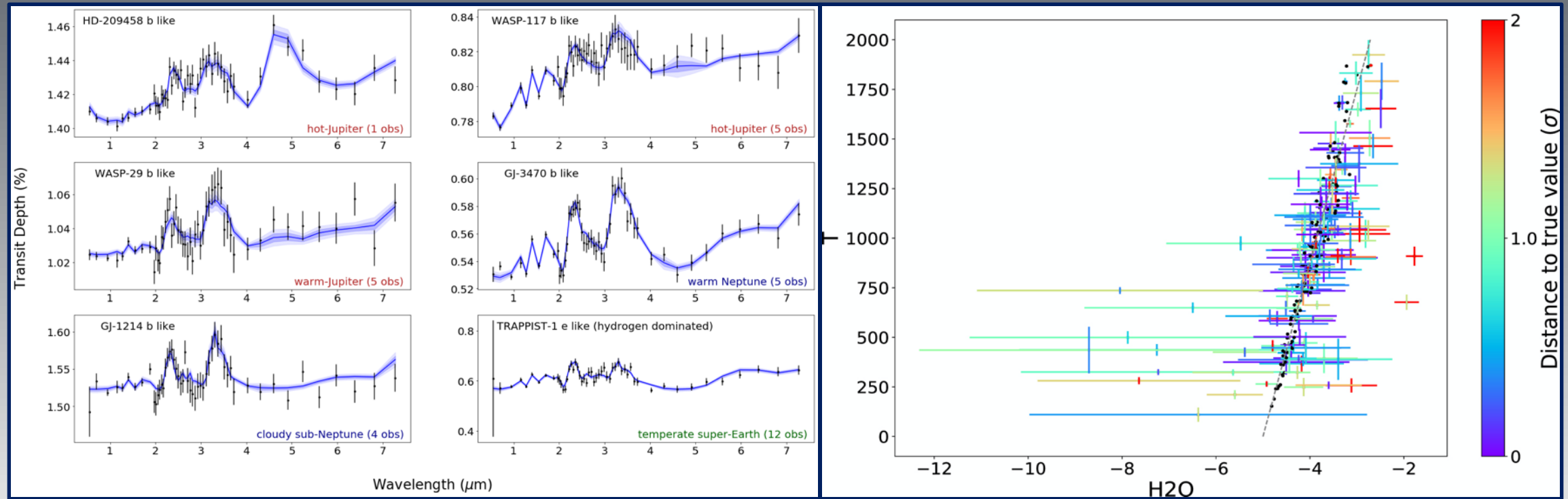
- Atmospheric circulation
- Spatial & temporal variability



Chemical survey



SEARCHING FOR CHEMICAL AND CLOUD TRANSITIONS (TIER 1 AND TIER 2)

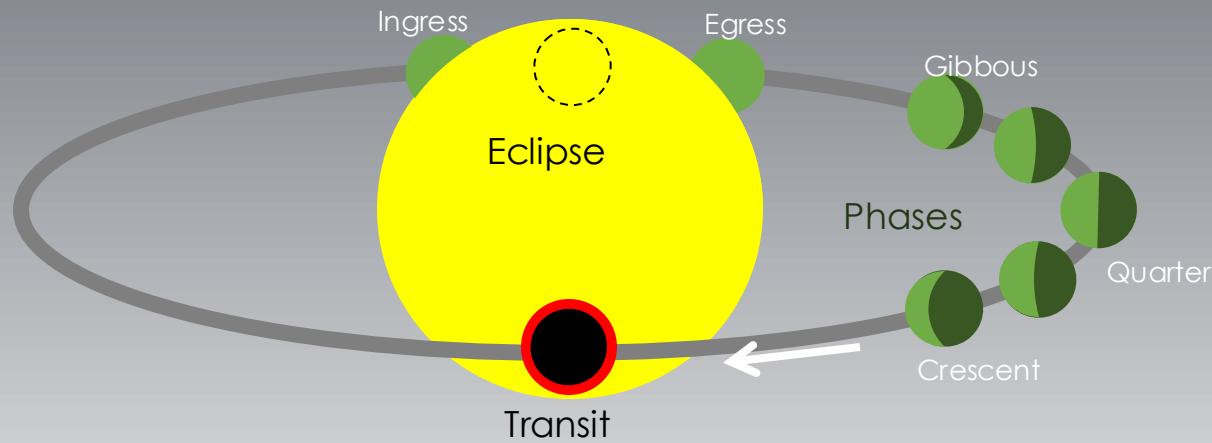


Changeat et al. 2020; see also Mugnai et al 2022, Bocchieri et al., 2024; Ma et al. in prep.

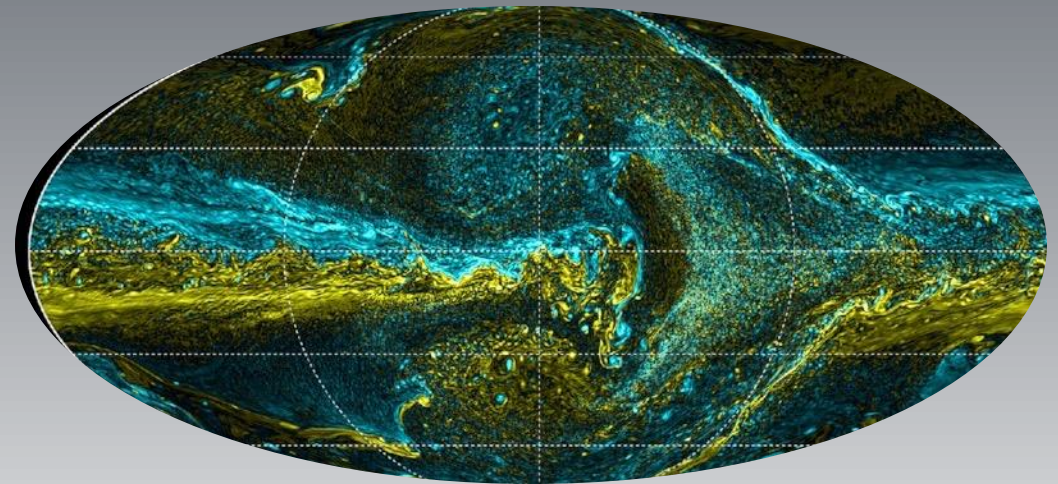
Planets are 3D complex objects



VARIABILITY IN SPACE AND TIME: PHASE-CURVES & REPEATED OBSERVATIONS (TIER 3 AND TIER 4)



Cowan (2014)



Skinner & Cho, 2022

Ariel Databases



A NEW PAPER AND DATABASE ABOUT SPECTROSCOPIC, CHEMICAL AND CLOUD DATA FOR ARIEL

RAS Techniques and Instruments



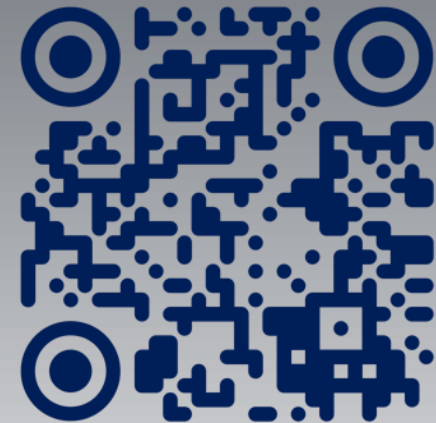
RASTAI 3, 636–690 (2024)

Advance Access publication 2024 September 19

<https://doi.org/10.1093/rasti/rzae039>

Data availability and requirements relevant for the *Ariel* space mission and other exoplanet atmosphere applications

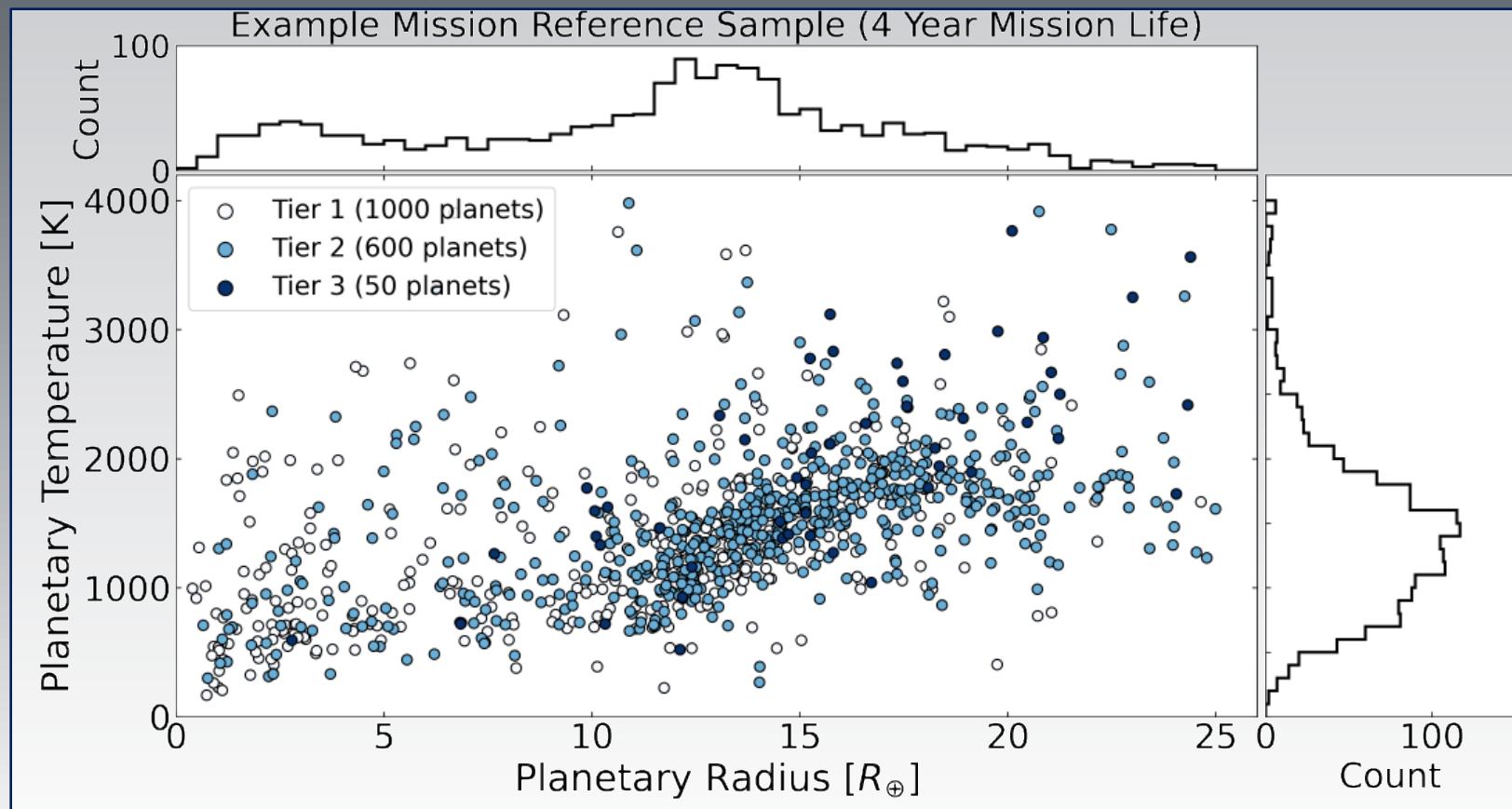
Katy L. Chubb^{1,2★}, Séverine Robert,³ Clara Sousa-Silva,^{4,5★} Sergei N. Yurchenko^{6★},
Nicole F. Allard⁷, Vincent Boudon,⁸ Jeanna Buldyreva,⁹ Benjamin Bultel,¹⁰ Athena Coustenis,¹¹
Aleksandra Foltynowicz,¹² Iouli E. Gordon¹³, Robert J. Hargreaves¹³, Christiane Helling,^{14,15}
Christian Hill,¹⁶ Helgi Rafn Hrodmarsson,¹⁷ Tijs Karman,¹⁸ Helena Lecoq-Molinos,^{14,15,19}
Alessandra Migliorini²⁰, Michaël Rey,²¹ Cyril Richard,⁸ Ibrahim Sadiek,²² Frédéric Schmidt,¹⁰
Andrei Sokolov,⁶ Stefania Stefani,²⁰ Jonathan Tennyson⁶, Olivia Venot¹⁷, Sam O. M. Wright,⁶
Rosa Arenales-Lope,²³ Joanna K. Barstow²⁴, Andrea Bocchieri,²⁵ Nathalie Carrasco,²⁶
Dwaipayan Dubey,²³ Oleg Egorov,²⁷ Antonio García Muñoz,²⁸ Ehsan (Sam) Gharib-Nezhad,²⁹
Leonardos Gkouvelis,²³ Fabian Grübel,²³ Patrick Gerard Joseph Irwin³⁰, Antonín Knížek,³¹
David A. Lewis,¹⁴ Matt G. Lodge¹, Sushuang Ma,⁶ Zita Martins,³² Karan Molaverdikhani²³,
Giuseppe Morello,³³ Andrei Nikitin,²⁷ Emilie Panek,³⁴ Miriam Rengel,³⁵ Giovanna Rinaldi,²⁰
Jack W. Skinner,^{36,37} Giovanna Tinetti,⁶ Tim A. van Kempen,³⁸ Jingxuan Yang³⁰
and Tiziano Zingales^{39,40}



Ariel target candidates (MCS)



ARIEL MISSION CANDIDATES SAMPLE (MCS) AVAILABLE ON GITHUB



Edwards et al. 2022

Focus on Ariel targets: stars



TARGETS MONITORING IS BEING PRIORITISED TO MAXIMISE THE SCIENCE RETURN OF ARIEL

From: Science Mission Office hubblereview@stsci.edu
Subject: HST Cycle 32 Phase I Notification Snapshot Letter
Date: 8 July 2024 at 18:05

To: Dr. Sudeshna Boro Saikia sudeshna.boro.saikia@univie.ac.at
Cc: HST17794@stsci.edu, Giovanna Tinetti g.tinetti@ucl.ac.uk, Manuel Guedel manuel.guedel@univie.ac.at, Kristina Kislyakova kristina.kislyakova@univie.ac.at, Simon Schleich simon.schleich@univie.ac.at, Gwenael Van Looveren gwenael.van.looveren@univie.ac.at, Franz Kerschbaum franz.kerschbaum@univie.ac.at, Andrea Bocchieri andrea.bocchieri@uniroma1.it, Lorenzo Mugnai lorenzo.mugnai@uniroma1.it, Yamila Miguel ymiguel@strw.leidenuniv.nl, Aline Vidotto vidotto@strw.leidenuniv.nl, Jiri Zak jirizak1@seznam.cz, Donna Rodgers-Lee dlee@cp.dias.ie, Theresa Lueftinger theresa.rank-lueftinger@esa.int, Ignazio Pillitteri ignazio.pillitteri@inaf.it, Sarah Casewell slc25@leicester.ac.uk, Billy Edwards b.edwards@sron.nl, Krisztian Vida vidakris@konkoly.hu, Luca Fossati luca.fossati@oead.ac.at, Stefano Bellotti sbellotti@irap.omp.eu, Olivia Venot olivia.venot@lisa.ipsl.fr, Antonio Maggio antonio.maggio@inaf.it, Antonio Garcia Munoz antonio.garciamunoz@cea.fr, Carol Rodriguez crodriguez@stsci.edu

SO

⚠ Caution: External sender

Sudeshna Boro Saikia
University of Vienna

AUT

Jul 08, 2024

Dear Dr. Boro Saikia,

We are pleased to inform you that your Hubble Space Telescope Cycle 32 proposal

Title: FUV flux of nearby exoplanet host stars in the Ariel target list
ID: 17794

has been approved for Hubble Space Telescope Cycle 32 and Cycle 33 Snapshot observations, following detailed consideration by the Cycle 32 Peer Review Panels and final review by the STScI Director.

The allocations approved for your program in Phase I are:

137

Snapshot Targets in Cycle 32



A&A, 688, A193 (2024)

Ariel stellar characterisation

II. Chemical abundances of carbon, nitrogen, and oxygen for 181 planet-host FGK dwarf stars★☆☆

✉ R. da Silva^{1,2}, ✉ C. Danielski^{3,4}, ✉ E. Delgado Mena⁵, ✉ L. Magrini³, ✉ D. Turrini⁶, ✉ K. Biazzo¹, ✉ M. Tsantaki³, ✉ M. Rainer⁷, ✉ K. G. Helminiak⁸, ✉ S. Benatti⁹, ✉ V. Adibekyan⁵, ✉ N. Sanna³, ✉ S. Sousa⁵, ✉ G. Casali^{10,11,12} and ✉ M. Van der Swaelmen³



A&A 663, A161 (2022)

Ariel stellar characterisation

I. Homogeneous stellar parameters of 187 FGK planet host stars: Description and validation of the method★

✉ L. Magrini¹, ✉ C. Danielski^{2,3}, ✉ D. Bossini⁴, ✉ M. Rainer^{1,5}, ✉ D. Turrini⁶, ✉ S. Benatti⁷, ✉ A. Bruccalassi¹, ✉ M. Tsantaki¹, ✉ E. Delgado Mena^{4,8}, ✉ N. Sanna¹, ✉ K. Biazzo⁹, ✉ T. L. Campante^{4,8}, ✉ M. Van der Swaelmen¹, ✉ S. G. Sousa⁴, ✉ K. G. Helminiak¹⁰, ✉ A. W. Neitzel^{4,8}, ✉ V. Adibekyan⁴, ✉ G. Bruno¹¹ and ✉ G. Casali^{12,13}

Spectropolarimetric characterisation of exoplanet host stars in preparation of the *Ariel* mission

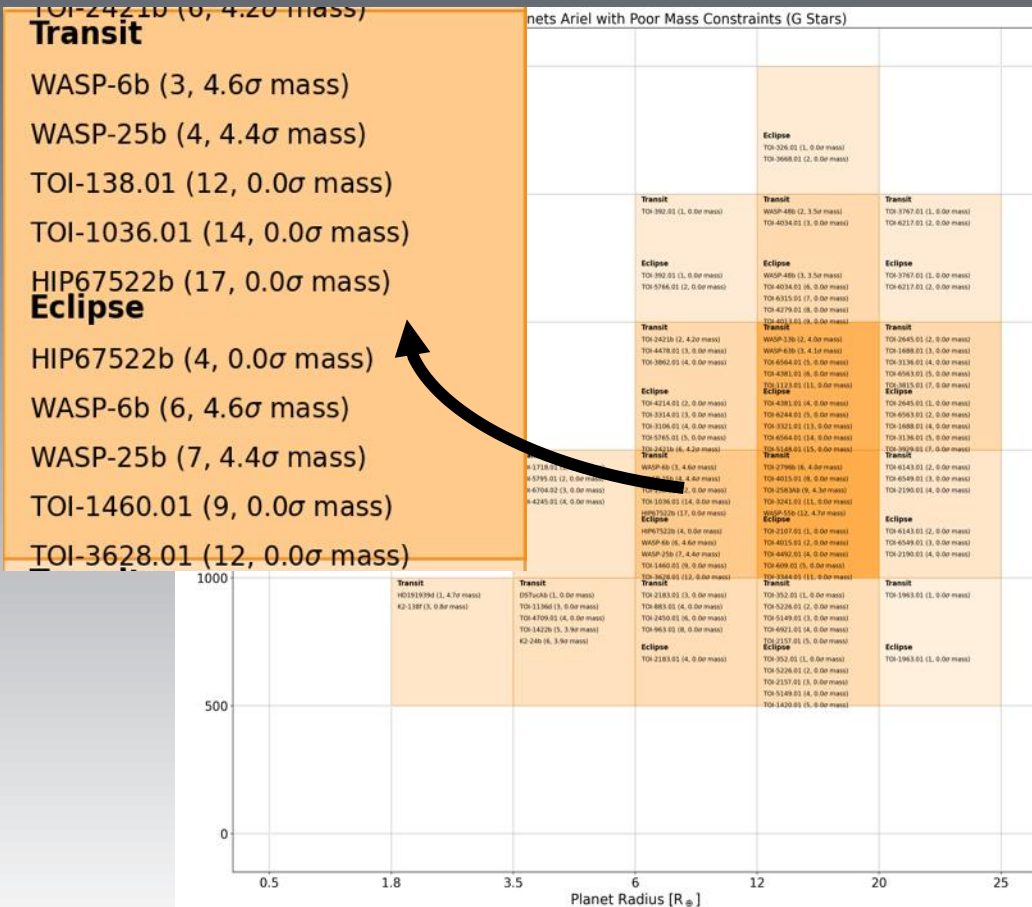
Magnetic environment of HD 63433

✉ S. Bellotti^{1,2}, ✉ D. Evensberger¹, ✉ A. A. Vidotto¹, ✉ A. Lavail², ✉ T. Lüftinger³, ✉ G. A. J. Hussain³, ✉ J. Morin⁴, ✉ P. Petit², ✉ S. Boro Saikia⁵, ✉ C. Danielski⁶, and ✉ G. Micela⁷



Focus on Ariel targets: masses

TARGETS MONITORING IS BEING PRIORITISED TO MAXIMISE THE SCIENCE RETURN OF ARIEL



D.21 U.S. Contributions to Ariel Preparatory Science

Number: NNH24ZDA001N-USCAPS | Directorate: Science Mission Directorate | Type: NASA Research Announcement | Status: Open

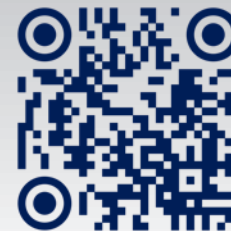
Label	Date	Option
Release	Feb 14, 2024	
USCAPS24 Mandatory NOIs Due	Dec 12, 2024	Create

Documents
Announcement Documents (7)

- [Important ROSES-24 Update October 11, 2024](#)
- [ROSES-2024 Summary of Solicitation as clarified October 15, 2024 \(.PDF\)](#)
- [Table 1 ROSES-24 Proposal Checklist \(also included in Summary of Solicitation document\) updated October 11, 2024 \(.PDF\)](#)
- [DUE DATES: Table 2 lists and links to all program elements in due date order as amended \(.HTML\)](#)
- [DUE DATES: Table 3 lists and links to all program elements in appendix order as amended \(.HTML\)](#)
- [D.1 Astrophysics Research Program Overview \(.pdf\)](#)
- [D.21 U.S. Contributions to Ariel Preparatory Science text released October 15, 2024 \(.pdf\)](#)

Other Documents (2)

-
-



NASA support to Ariel preparatory science is game-changing

ExoClock: target ephemerides+



1 400+ PARTICIPANTS FROM 50+ COUNTRIES (77% AMATEURS) 😊

THE ASTROPHYSICAL JOURNAL
SUPPLEMENT SERIES

OPEN ACCESS

2096 Total downloads

ExoClock Project. II. A Large-scale Integrated Study with 180 Updated Exoplanet Ephemerides

A. Kokori¹ , A. Tsiaras^{1,2} , B. Edwards^{1,3} , M. Rocchetto¹, G. Tinetti¹ , L. Bewersdorff⁴, Y. Jongen⁵, G. Lekkas⁶, G. Pantelidou⁷, E. Poultoirtzidis⁷ [+ Show full author list](#)

Published 2022 February 9 · © 2022. The Author(s). Published by the American Astronomical Society.






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ExoClock Project. III. 450 New Exoplanet Ephemerides from Ground and Space Observations

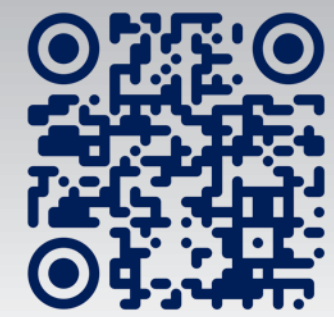
A. Kokori¹, A. Tsiaras^{1,2} , B. Edwards^{1,3} , A. Jones^{4,5}, G. Pantelidou⁶, G. Tinetti¹ , L. Bewersdorff⁴, A. Iliadou⁶, Y. Jongen^{4,7}, G. Lekkas⁸ [+ Show full author list](#)

Published 2023 February 14 · © 2023. The Author(s). Published by the American Astronomical Society.

[The Astrophysical Journal Supplement Series, Volume 265, Number 1](#)

Citation A. Kokori et al 2023 ApJS 265 4
DOI 10.3847/1538-4365/jac9da4

	vs ExoClock II (180 planets)	vs initial (450 planets)
Significantly improved	0.0%	31.8%
Drifting	1.1%	12.7%
Improved	29.4%	40.9%
No change	65.5%	10.4%
TTVs	3.9%	4.2%



Ariel target candidates



CATALOGUE AVAILABLE SOON THROUGH A NEW INTERACTIVE, WELL MAINTAINED WEBSITE

Ariel Target Candidate List

I

Search targets...

Tier Radius Temperature

HAT-P-19 b 1 2

Hot
Jupiter

🔍 👍 →

HAT-P-68 b 1

Hot
Jupiter

🔍 👍 →

HAT-P-40 b 1 2 3

Very Hot
Massive Jupiter

🔍 👍 →

HAT-P-18 b 1 2 3

HAT-P-26 b 1



HATS-18 b 1

localhost:3000/ariel/targets

Ariel target candidates



CATALOGUE AVAILABLE SOON THROUGH A NEW INTERACTIVE, WELL MAINTAINED WEBSITE

HD 209458 b  

Stellar Properties

Mass (Msun)	Radius (Rsun)
1.15	1.16

Distance from Earth (pc)

48.3016

Temperature (K)


6117

Planet Properties

Radius (Rjup)	Mass (Mjup)
1.38	0.714

Temperature (K)	Semi Major Axis (AU)
1459	0.04747

Albedo	Transit Duration (hour)
0.1	3.072

 Queued

Mugnai et al, 2022

Ariel Data Challenges



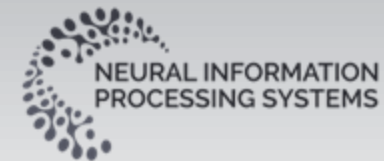
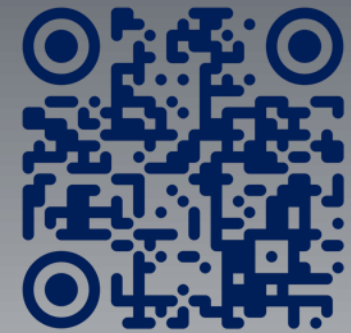
ADC 2024: 23,000+ SUBMISSIONS, \$50,000 PRIZE SPONSORED BY KAGGLE

NeurIPS - Ariel Data Challenge 2024 Late Submission ...

Overview Data Code Models Discussion Leaderboard Rules

Prize Winners

#	△	Team	Members	Score	Entries	Last	Solution
1	-1	c-number + daiwakun		0.7420624	42	2mo	
2	-1	Jeroen Cottaar		0.7408695	166	2mo	
3	—	Space Coders		0.7224522	167	2mo	
4	—	greySnow		0.7139354	84	2mo	
5	-3	Youri + Pascal		0.6961717	233	2mo	
6	-1	Through the thorns to the star		0.6934644	222	2mo	



A mission is more than flying hardware.... There is XAI 😊

Ariel Data Policy



A VERY OPEN APPROACH: FOUNDATION OF GOOD RIGOROUS SCIENCE AND REPRODUCIBILITY

Science Demonstration Phase

Data will be released immediately after processing and quality control

Nominal Science Operations Phase

- Tier 1 data public immediately after quality control is completed;
- Tier 2, 3 data public 6 months after quality control is completed;
- Tier 4 data public 1 year after quality control is completed.

Complementary Science data

- 5%-10% time available for other science, allocated through ESA calls
- Proprietary to the proposers for 6 months

Strong commitment to open-source software, Explainable AI



Conclusions



- Ariel has been conceived to deliver a chemical survey of ~ 1000 exoplanets, probing uniformly the gamut of planet and stellar parameters
- Input from the community is strongly encouraged through open data policy, regular open workshops, target candidates available through interactive websites, open-source tools and Data Challenges.
- NASA call for US contribution to Ariel -> David Ciardi's talk
- Ariel Open Conference being planned for spring 2026: stay tuned!
- Thank you for your time and for inviting me to your meeting