



16998 - A comparative study of atmospheric escape in the brightest system of super-earths straddling the evaporation valley

Cycle: 30, Proposal Category: GO

(UV Initiative)

(Availability Mode: AVAILABLE)

INVESTIGATORS

<i>Name</i>	<i>Institution</i>
Prof. David Ehrenreich (PI) (ESA Member) (Contact)	University of Geneva, Department of Astronomy
Dr. Laetitia Delrez (CoI) (ESA Member)	Université de Liège
Dr. Malcolm Fridlund (CoI) (ESA Member)	Universiteit Leiden
Dr. Leonardo Dos Santos (CoI) (Contact)	Space Telescope Science Institute
Dr. Vincent Bourrier (CoI) (ESA Member) (Contact)	University of Geneva, Department of Astronomy
Prof. Monika Lendl (CoI) (ESA Member)	University of Geneva, Department of Astronomy
Prof. Yann Alibert (CoI) (ESA Member)	University of Bern
Dr. Isabella Pagano (CoI) (ESA Member)	INAF, Osservatorio Astrofisico di Catania
Dr. Luca Fossati (CoI) (ESA Member)	Space Research Institute, Austrian Academy of Sciences
Prof. Kevin Heng (CoI) (ESA Member)	University of Bern
Dr. Alexis Brandeker (CoI) (ESA Member)	Stockholm University
Dr. Alfred Vidal-Madjar (CoI) (ESA Member)	CNRS, Institut d'Astrophysique de Paris
Dr. Baptiste Lavie (CoI) (ESA Member)	University of Geneva, Department of Astronomy
Dr. Adrien Deline (CoI) (ESA Member) (Contact)	University of Geneva, Department of Astronomy
Dr. Alain Lecavelier des Etangs (CoI) (ESA Member)	CNRS, Institut d'Astrophysique de Paris

VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
03	(1) -NU.02-LUP	COS/FUV COS/NUV	5	24-Mar-2023 12:00:45.0	yes

5 Total Orbits Used

ABSTRACT

Photo-evaporation of planetary atmospheres plays a key role in the evolution of exoplanets, carving their whole population. However, direct observations of atmospheric escape are scarce and almost non-existent in the mass range of super-Earths and mini-Neptunes, while these planets are among the most impacted by the phenomenon. A huge step forward could be made by achieving a comparative study of several super-Earths, volatile-rich or not, in a single multi-planet system: such planets would indeed experience the same evolution of the stellar X and EUV flux that are driving atmospheric escape. The perfect system for such a study has just been identified: the nearby, solar-type, and naked-eye star ν^2 Lupi hosts transiting planets spanning a remarkably large range of insolation (~ 100 to $\sim 5x$ the insolation of Earth). TESS found the transits of the two inner planets and CHEOPS detected the transit of planet d, a volatile-rich super-Earth with an exceptional period of 107 day. These super-Earths straddle the radius gap of the "evaporation valley" and could have retained different fractions of gas and volatiles. Like for previously observed warm Neptunes, they could be enshrouded in huge comet-like exospheric clouds of escaping gas, which could have built up in the mild radiative environment. The system unique combination of proximity, brightness and favorable planet characteristics offers a fantastic opportunity to exploit HST ultraviolet capabilities to search for the hydrogen, oxygen and carbon escaping three planets in whole new mass and irradiation regimes. It is the ideal testbed for advancing both observations and theories of atmospheric evaporation of exoplanets.

OBSERVING DESCRIPTION

We are targetting transits of exoplanets in the Nu2 Lupi system at Lyman-alpha. Nu2 Lupi is a naked-eye star ($V=5.65$). We will observe it with COS/FUV/G130M using both segments B (incl. Lyman-alpha) and A. The Lyman-alpha airglow will be corrected using available airglow templates, as in programs GO14877 (Bourrier et al. 2018, A&A 615, A117) and GO14767 (Dos Santos et al. 2019, A&A 629, A47). We wish to use only one FP-POS setting per visit so we are not impacted by the restriction to FP-POS=3 or 4 that applies when using segment B. We have set FP-POS=3 through the whole program. Each visit will consist in 5 HST orbits, spent in a single, orbit-long exposure in time-tag mode. The first orbit in each visit additionally contains an acquisition performed with COS/NUV in imaging mode, using the Bright Object Aperture and MIRRORB.

The transit observations are time-critical: we aim at obtaining two transits (2x5 orbits) of planet b, three transits (3x5 orbits) of planet c, and three

Proposal 16998 (STScI Edit Number: 0, Created: Friday, March 24, 2023 at 11:00:45 AM Eastern Standard Time) - Overview

transits (3x5 orbits) of planet d. Planet b transits every ~11 days and there is a dozen windows available until March 2023. Planets c and d have longer periods and they are much more constraining in terms of planning: with its ~27-day period, there are only 4 windows available for transits of c between now and March 2023, with a first opportunity on 21 September 2021 (still in Cycle 28) and two beyond Cycle 29. Finally, planet d has an even longer period of ~107 days; there are 3 opportunities: one on 11 August 2021 (Cycle 28), one on 14 March 2022 (Cycle 29) and one on 29 Jan 2023 (Cycle 30). The proposal anticipated that one visit (5 orbits) would be carried over in Cycle 30; it might actually be up to three visits (15 orbits). Besides, the visits have slightly different phase constraints, set to cover different parts of the transits.

Proposal 16998 - Planet d (03) - A comparative study of atmospheric escape in the brightest system of super-earths straddling the eva...

Visit	<p>Proposal 16998, Planet d (03), implementation Fri Mar 24 16:00:46 GMT 2023</p> <p>Diagnostic Status: Warning</p> <p>Scientific Instruments: COS/FUV, COS/NUV</p> <p>Special Requirements: SCHED 100%; Period 107.1360 D AND ZERO-PHASE HJD2459331.18760</p>																		
	Diagnostics	<p>(Planet d (03)) Warning (Form): For the best data quality, it is generally required to use all four FP-POS positions when observing at a given COS cenwave. See the COS Instrument Handbook for exceptions that may apply to observations with G130M/1291 or G160M.</p>																	
Fixed Targets		<table border="1"> <thead> <tr> <th data-bbox="142 391 247 418">#</th> <th data-bbox="247 391 478 418">Name</th> <th data-bbox="478 391 909 418">Target Coordinates</th> <th data-bbox="909 391 1255 418">Targ. Coord. Corrections</th> <th data-bbox="1255 391 1602 418">Fluxes</th> <th data-bbox="1602 391 2007 418">Miscellaneous</th> </tr> </thead> <tbody> <tr> <td data-bbox="142 418 247 586">(1)</td> <td data-bbox="247 418 478 586"> -NU.02-LUP Alt Name1: HD136352 </td> <td data-bbox="478 418 909 586"> RA: 15 21 48.1511 (230.4506296d) Dec: -48 19 3.46 (-48.31763d) Equinox: J2000 </td> <td data-bbox="909 418 1255 586"> Proper Motion RA: -1624.047 mas/yr Proper Motion Dec: -276.024 mas/yr Parallax: 0.0680818" Epoch of Position: 2000 Radial Velocity: -68.780 km/sec </td> <td data-bbox="1255 418 1602 586">V=5.65</td> <td data-bbox="1602 418 2007 586">Reference Frame: ICRS</td> </tr> <tr> <td colspan="6" data-bbox="142 586 2007 669"> <p><i>Comments:</i> Category=STAR Description=[EXTRA-SOLAR PLANETARY SYSTEM, G V-IV] Extended=NO</p> </td> </tr> </tbody> </table>	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous	(1)	-NU.02-LUP Alt Name1: HD136352	RA: 15 21 48.1511 (230.4506296d) Dec: -48 19 3.46 (-48.31763d) Equinox: J2000	Proper Motion RA: -1624.047 mas/yr Proper Motion Dec: -276.024 mas/yr Parallax: 0.0680818" Epoch of Position: 2000 Radial Velocity: -68.780 km/sec	V=5.65	Reference Frame: ICRS	<p><i>Comments:</i> Category=STAR Description=[EXTRA-SOLAR PLANETARY SYSTEM, G V-IV] Extended=NO</p>				
	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous													
(1)	-NU.02-LUP Alt Name1: HD136352	RA: 15 21 48.1511 (230.4506296d) Dec: -48 19 3.46 (-48.31763d) Equinox: J2000	Proper Motion RA: -1624.047 mas/yr Proper Motion Dec: -276.024 mas/yr Parallax: 0.0680818" Epoch of Position: 2000 Radial Velocity: -68.780 km/sec	V=5.65	Reference Frame: ICRS														
<p><i>Comments:</i> Category=STAR Description=[EXTRA-SOLAR PLANETARY SYSTEM, G V-IV] Extended=NO</p>																			

Proposal 16998 - Planet d (03) - A comparative study of atmospheric escape in the brightest system of super-earths straddling the eva...

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
Exposures	1	(COS.ta.152 (1) -NU.02-LUP 2351)	COS/NUV, ACQ/IMAGE, BOA	MIRRORB		PHASE 0.0005 TO 0.0009		13 Secs (13 Secs) [==>]	[1]
	2	(COS.sp.174 (1) -NU.02-LUP 6796)	COS/FUV, TIME-TAG, PSA	G130M 1327 A	BUFFER-TIME=3400; FP-POS=3; FLASH=YES; SEGMENT=BOTH; LIFETIME-POS=L P3			2550 Secs (2184 Secs) [==>2184.0 Secs]	[1]
	3	(COS.sp.174 (1) -NU.02-LUP 6797)	COS/FUV, TIME-TAG, PSA	G130M 1327 A	BUFFER-TIME=3400; FP-POS=3; FLASH=YES; SEGMENT=BOTH; LIFETIME-POS=L P3			2829 Secs (2477 Secs) [==>2477.0 Secs]	[2]
	4	(COS.sp.174 (1) -NU.02-LUP 6797)	COS/FUV, TIME-TAG, PSA	G130M 1327 A	BUFFER-TIME=3400; FP-POS=3; FLASH=YES; SEGMENT=BOTH; LIFETIME-POS=L P3			2829 Secs (2477 Secs) [==>2477.0 Secs]	[3]
	5	(COS.sp.174 (1) -NU.02-LUP 6797)	COS/FUV, TIME-TAG, PSA	G130M 1327 A	BUFFER-TIME=3400; FP-POS=3; FLASH=YES; SEGMENT=BOTH; LIFETIME-POS=L P3			2829 Secs (2477 Secs) [==>2477.0 Secs]	[4]
	6	(COS.sp.174 (1) -NU.02-LUP 6797)	COS/FUV, TIME-TAG, PSA	G130M 1327 A	BUFFER-TIME=3400; FP-POS=3; FLASH=YES; SEGMENT=BOTH; LIFETIME-POS=L P3			2829 Secs (2477 Secs) [==>2477.0 Secs]	[5]



