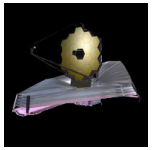

1935 - Unshrouding the Sub-Neptune Population: The Case of TOI-421b

Cycle: 1, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1	NIRISS	NIRISS Single-Object Slitless Spectroscopy	(3) TOI-421
	2	NIRSPEC	NIRSpec Bright Object Time Series	(3) TOI-421

ABSTRACT

Sub-Neptunes, while ubiquitous in our galaxy, remain of uncertain disposition. The radius distribution of such planets indicates they have rocky cores with tenuous primordial H2-rich atmospheres, but their bulk densities admit the possibility of ice-rich compositions. Only atmospheric investigations can break degeneracies in bulk composition and address the fundamental nature of the sub-Neptune population. However, observations of sub-Neptunes have repeatedly returned featureless or muted transmission spectra that have provided us with little information about their atmospheres. It is strongly suspected that photochemical haze is to blame for the muted spectra. Such hazes are predicted to form over a limited

temperature range — primarily below 850 K. The implication is that planets hotter than this cutoff temperature should be free of obscuring hazes and should present clear atmospheres that are ideal for atmospheric investigations. To that end, we propose to obtain the transmission spectrum of TOI-421b — the highest S/N sub-Neptune that is hot enough (Teq~1,000 K) to expect haze-free conditions. We will measure the transmission spectrum of this planet from 0.83 to 5 microns, allowing us to determine the abundances of multiple H/O/C-bearing molecules. Our results are expected to provide the first clear-atmosphere characterization of a sub-Neptune. We will robustly constrain the bulk composition of TOI-421b's atmosphere, test theories of aerosol formation, and provide valuable context for how to best use JWST for future investigations of the sub-Neptune population.

OBSERVING DESCRIPTION

We propose NIRISS+SOSS and NIRSpec+G395M transit observations of the planet TOI-421b. The period of the planet is 5.20 days, and the duration of the transit is 1.12 hours. We nominally plan for time equal to the transit duration both before and after the transit, with an extra 0.5 hour before to also account for detector burn in. The observation is scheduled to start between 0 and 1 hour plus the transit duration before the transit to give a large enough timing window so as to not incur the scheduling penalty.

The NIRISS observations have to use the SUBSTRIP96 subarray for this bright target.
The NIRSpec observations can use the full 2048 BOTS subarray.
The NIRSpec target acquisition has to be done on a nearby star because the target is too bright.

We used the ExoCTK website to optimize the number of groups per integration to keep the max fluence below 75% of saturation. We determined the number of integrations to give 3.85 hour visit durations.

The ephemeris will need to be updated once the TESS Sector 32 data are released.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(3)	TOI-421	RA: 05 27 24.8259 (81.8534413d) Dec: -14 16 37.05 (-14.27696d) Equinox: J2000	Proper Motion RA: -35.743 mas/yr Proper Motion Dec: 50.387 mas/yr Epoch of Position: 2000	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Star* *Description=[Exoplanet Systems, G dwarfs]*				
(4)	Gaia-DR3-2984582227215748224	RA: 05 27 23.7421 (81.8489254d) Dec: -14 16 12.21 (-14.27006d) Equinox: J2000	Proper Motion RA: -36.19 mas/yr Proper Motion Dec: 50.607 mas/yr Epoch of Position: 2000	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Star* *Description=[K stars]*				

Observation

Proposal 1935, Observation 1: NIRISS Mon Aug 14 19:01:01 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRISS Single-Object Slitless Spectroscopy

Diagnostics

(NIRISS (Obs 1)) Warning (Form): Exposure Duration exceeds the limit of 10000.0 seconds. Above this limit it is possible that a High Gain Antenna move may occur during the exposure.

(Exposure) Warning (Form): Exposure Duration exceeds the limit of 10000.0 seconds. Above this limit it is possible that a High Gain Antenna move may occur during the exposure.

(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(3)	TOI-421	RA: 05 27 24.8259 (81.8534413d)	Proper Motion RA: -35.743 mas/yr	
		Dec: -14 16 37.05 (-14.27696d)	Proper Motion Dec: 50.387 mas/yr	
		Equinox: J2000	Epoch of Position: 2000	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Exoplanet Systems, G dwarfs]

Acquisition

#	Target	Acquisition Mode	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	SOSSFAINT	F480M	NISRAPID	3	1	1	0.202	86209

Template

Subarray	Include F277W Exposure?
SUBSTRIP96	true

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	NISRAPID	3	1561	1	1561	13856.185	
2	NISRAPID	3	20	1	20	177.53	

Special Requirements

Phase 0.97848018 to 0.98657818 with period 5.197574 Days and zero-phase 2458441.282998 HJD
Aperture PA Range 27 to 59 Degrees (V3 26.43873283 to 58.43873283)
Aperture PA Range 308 to 321 Degrees (V3 307.43873283 to 320.43873283)
Time Series Observation
No Parallel Attachments

Observation

Proposal 1935, Observation 2: NIRSPEC Mon Aug 14 19:01:01 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Diagnostics

(NIRSPEC (Obs 2)) Warning (Form): Exposure Duration exceeds the limit of 10000.0 seconds. Above this limit it is possible that a High Gain Antenna move may occur during the exposure.

(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(3)	TOI-421	RA: 05 27 24.8259 (81.8534413d)	Proper Motion RA: -35.743 mas/yr	
		Dec: -14 16 37.05 (-14.27696d)	Proper Motion Dec: 50.387 mas/yr	
		Equinox: J2000	Epoch of Position: 2000	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Exoplanet Systems, G dwarfs]

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	4 Gaia-DR3-2984582227215748224	WATA	SUB32	F110W	NRSRAPID	3	1	1	0.08	63579.2

Template

Subarray
SUB2048

Spectral Elements

#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395M/F290LP	NRSRAPID	4	3058	1	1	3058	13854.208	

Special Requirements

Phase 0.97848018 to 0.98657818 with period 5.197574 Days and zero-phase 2458441.282998 HJD
Time Series Observation
No Parallel Attachments