



3818 - To be or not to be in equilibrium: Probing disequilibrium chemistry on the warm sub-Neptune TOI-270 d

Cycle: 2, Proposal Category: GO

INVESTIGATORS

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Dr. Tansu Daylan (CoI)	Washington University in St. Louis

OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Observation Folder				
	2	G395H transit	NIRSpec Bright Object Time Series	(1) TOI-270

ABSTRACT

TOI-270 d is currently the most promising target for the atmospheric characterization of sub-Neptunes using transmission spectroscopy, because its expected signal-to-noise ratio is outstandingly high and because an atmospheric signal was recently found using HST WFC3, increasing the prospects of a H/He-dominated, cloud-free atmosphere producing strong signals. In Cycle 2, it will be targeted using NIRISS SOSS as part of a GTO program and we propose to extend the wavelength coverage by observing a transit of TOI-270 d using NIRSpec G395H. The additional data will cover the strongest absorption bands of CH₄ and CO accessible to JWST, key molecules to constraining the role of disequilibrium chemistry in TOI-270 d's atmosphere and its possible interior structure. In the warm temperature of TOI-270 d ($T_{\text{eq}} = 350$ K), carbon should be predominantly present in CH₄, whereas CO is expected to be the most dominant carbon-bearing molecule at higher temperatures (> 700 K). However, chemical reaction times increase as temperatures decrease so that disequilibrium processes caused by, e.g., horizontal winds, vertical mixing and stellar radiation are likely to become important, increasing the CO abundance against chemical equilibrium. Indeed, the depletion of CH₄ in a few warm (< 700 K) planets observed using JWST and Spitzer have delivered tentative evidence for disequilibrium chemistry in their atmospheres. Our transit observations employing NIRSpec G395H will put tight constraints on the CH₄ and CO abundances in TOI-270 d's atmosphere, effectively probing the role of disequilibrium chemistry which the NIRISS SOSS observations alone fail to do.

OBSERVING DESCRIPTION

We will observe a primary transits for the sub-Neptune TOI-270d, using NIRSpec with the G395H grism. We will use the Bright Object Time Series (BOTS) mode optimized for transiting exoplanet observations, using the 1.6"x1.6" square aperture with no dithering. Since TOI-270 is too bright for WATA, we have selected a fainter nearby star for offset acquisition (using GAIA DR2).

The transit observation consists of a single exposure lasting 5.31 hours. The total charged time for the program is 7.23 hours. Based on HST, Spitzer and JWST experience, each exposure is phase-constrained to begin at least half a transit duration before transit ingress and to end at least half a transit duration after egress. This will allow the stellar baseline flux to be calibrated at the beginning and end of each exposure to track any instrumental drift. The phase windows are both 61 minutes wide.

We determined an optimal detector readout pattern and groups per integration using the officially-supported ExoCTK platform (<https://exoctk.stsci.edu>). Signal-to-noise ratios for the transmission spectra of both targets were calculated using PandExo (<https://exoctk.stsci.edu/pandexo>).

Proposal 3818 - Targets - To be or not to be in equilibrium: Probing disequilibrium chemistry on the warm sub-Neptune TOI-270 d

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(1)	TOI-270	RA: 04 33 39.8593 (68.4160804d) Dec: -51 57 26.62 (-51.95739d) Equinox: J2000	Proper Motion RA: 0.008987950332541737 sec of time/yr Proper Motion Dec: -0.2698030000374274 arcsec/yr Epoch of Position: 2015.5	
<p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i></p> <p><i>TOI-270 is also known as L 231-32.</i></p> <p><i>Category=Star</i></p> <p><i>Description=[M dwarfs]</i></p>					
(2)	ACQUISITION	RA: 04 33 41.0962 (68.4212342d) Dec: -51 57 55.50 (-51.96542d) Equinox: J2000	Proper Motion RA: 8.92055325510114 mas/yr Proper Motion Dec: 5.288707895457872 mas/yr Epoch of Position: 2015.5		
<p><i>Comments:</i></p> <p><i>Category=Star</i></p> <p><i>Description=[M stars]</i></p>					

Proposal 3818 - Observation 2 - To be or not to be in equilibrium: Probing disequilibrium chemistry on the warm sub-Neptune TOI-270 d

Thu May 11 05:01:24 GMT 2023

Observation	<p>Proposal 3818, Observation 2: G395H transit</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRSpec Bright Object Time Series</p>																															
Diagnostics	<p>(G395H transit (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.</p> <p>(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.</p>																															
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Template	<p>Subarray</p> <p>SUB2048</p>																															
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Special Requirements

Time Series Observation
No Parallel Attachments