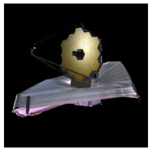

4102 - Hydrogen-rich sub-Neptune or exposed Neptune mantle? Confirming the nature of the most favorable sub-Neptune for JWST emission spectroscopy

Cycle: 2, Proposal Category: GO

INVESTIGATORS

Name	*Institution*
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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
TOI-824b NIRSpec BOTS				
	1	TOI-824b-G395H-eclipse1	NIRSpec Bright Object Time Series	(1) TOI-824
	2	TOI-824b-G395H-eclipse1	NIRSpec Bright Object Time Series	(1) TOI-824

ABSTRACT

Sub-Neptunes, despite being the most common outcome of planet formation, are still shrouded in mystery. Despite a decade of HST transmission observations of sub-Neptunes, it is still unclear whether sub-Neptunes form as rocky cores in hydrogen-rich envelopes and lose their envelopes to become super-Earths, or if these planets form independently as ice-rich bodies that host large amounts of water and volatiles. Recently, TOI-824b has been highlighted as a key target to tackle these questions, and as the most favorable target for emission spectroscopy with JWST. Recent Spitzer eclipse observations of the planet suggested that TOI-824b could be an exposed Neptune mantle, a planet with a volatile-rich envelope and little to no hydrogen.

We propose to confirm the nature of the keystone hot sub-Neptune TOI-824b through two eclipse observations of the planet using NIRSpec/G395H. With a 1250K equilibrium temperature and a measured hotter dayside temperature, TOI-824b is *by far* the most favorable sub-Neptune for emission spectroscopy with JWST. This program will allow us to robustly confirm the results from the Spitzer survey by measuring the dayside temperature and atmosphere metallicity. We will also constrain the carbon-to-oxygen ratio of TOI-824b using the carbon dioxyde and water abundances provided by the emission spectrum. Together, the metallicity and C/O measurements will reveal the nature of TOI-824b as either a hydrogen-rich planet or an exposed mantle. This result will represent a major step forward in understanding the composition and formation of the ubiquitous sub-Neptunes.

OBSERVING DESCRIPTION

Our observations are composed of time-series spectroscopic observations of two eclipses of the sub-Neptune exoplanet TOI-824b. For both eclipses, the observations will be performed with NIRSpec in BOTS mode using the G395H grism which will provide an emission spectrum of the planet in the near-infrared. Both observations must be completed in one continuous sequence, and are time-critical since the system must be observed as the exoplanet goes beyond the star TOI-824.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	TOI-824	RA: 14 48 39.7097 (222.1654571d) Dec: -57 35 20.00 (-57.58889d) Equinox: J2000	Proper Motion RA: -51.77027854762312 mas/yr Proper Motion Dec: -152.4140201103581 mas/yr Parallax: 0.015652877358583474" Epoch of Position: 2016	

Comments:
Category=Star
Description=[K dwarfs, K stars]

Observation

Proposal 4102, Observation 1: TOI-824b-G395H-eclipse1 Mon Jun 10 18:01:44 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Diagnostics

(TOI-824b-G395H-eclipse1 (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.

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

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	TOI-824	RA: 14 48 39.7097 (222.1654571d) Dec: -57 35 20.00 (-57.58889d) Equinox: J2000	Proper Motion RA: -51.77027854762312 mas/yr Proper Motion Dec: -152.4140201103581 mas/yr Parallax: 0.015652877358583474" Epoch of Position: 2016	

Comments:
Category=Star
Description=[K dwarfs, K stars]

Template

TA Method	Subarray
NONE	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	5	3257	1	1	3257	17693.587	202887.2

Special Requirements

Phase 0.41315249295633766 to 0.44306442743532204 with period 1.392975 Days and zero-phase 2458983.66859 HJD
Time Series Observation
No Parallel Attachments

Observation

Proposal 4102, Observation 2: TOI-824b-G395H-eclipse1 Mon Jun 10 18:01:44 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Diagnostics

(TOI-824b-G395H-eclipse1 (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
(1)	TOI-824	RA: 14 48 39.7097 (222.1654571d) Dec: -57 35 20.00 (-57.58889d) Equinox: J2000	Proper Motion RA: -51.77027854762312 mas/yr Proper Motion Dec: -152.4140201103581 mas/yr Parallax: 0.015652877358583474" Epoch of Position: 2016	

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Spectral Elements

#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
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