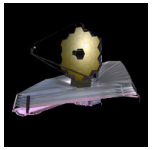

5863 - Shining a Spot-light on the Atmosphere of a Giant Planet around a Cool Star

Cycle: 3, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1	NIRISS TOI-3884b	NIRISS Single-Object Slitless Spectroscopy	(1) TOI-3884b
	2	NIRSpec TOI-3884b	NIRSpec Bright Object Time Series	(1) TOI-3884b
	3	NIRISS TOI-3884b	NIRISS Single-Object Slitless Spectroscopy	(1) TOI-3884b
	4	NIRSpec TOI-3884b	NIRSpec Bright Object Time Series	(1) TOI-3884b

ABSTRACT

We propose to observe two transits each with NIRSpec/G395M and NIRISS/SOSS of TOI 3884 b with two aims. (1) To characterize the atmosphere of the only known super-Neptune planet around a fully convective M dwarf. These transmission spectra will offer glimpses in the atmospheric metallicity and C/O ratio of M-dwarf giant planets to better understand their unlikely formation, and into the potential clouds and hazes that form on planets around a young, active star. This wide 0.6—5.1μm spectral range will be highly sensitive ($>$6σ) to the large predicted absorption features from \ch{CH4} and \ch{H2O}, and to species indicative of disequilibrium chemistry or photochemical processes: \ch{CO2}, \ch{NH3}, \ch{HCN}, or \ch{SO2}. (2) For the first time, take multiple precise measurements of the spectra of starspots on a cool M dwarf. Stellar inhomogeneities are a ubiquitous problem for planets around low-mass stars, and severely limit our inferences from high precision transmission spectra. TOI 3884 b eclipses a persistent complex of polar spots every transit. Therefore, we will tightly constrain the temperature, coverage, and spectral impact of occulted and unocculted star spots on a cool dwarf, directly comparing two gold-standard methods of constraining spot properties. We will observe TOI 3884's stellar contamination at work, empirically deriving the spectra of TOI 3884 and its spots, making this proposal directly synergistic to all M-dwarf planet observations made by JWST.

OBSERVING DESCRIPTION

We propose to observe four transits of TOI-3884b, two each with NIRISS/SOSS and two with NIRSpec/G395M. The science observations for each transit visit will include 4.2 hours of continuous spectra. This time includes 1 hour to absorb the time-constrained overhead charge and allow the detector to settle (which for this instruments has been shown to often require only 20-30 minutes), and 3.2 hours representing two complete transit durations, to provide equal in-transit and out-of-transit time baselines. For all transits, a "Phase" Special Requirement is included to make sure observations are centered on predicted times of transit.

For NIRISS/SOSS, target acquisition will be done using the target, with the SOSSFAINT setting and 19 groups/integration (reaching expected S/N of 237 and about 20% of saturation). We will also include the "Short First Exposure" to stabilize the pupil and filter wheel, and three integrations with the F277W to help disentangle the NIRISS orders in our analysis. For science exposures, we will use 10 groups/integration to achieve an integration time of about 1 minute and avoid saturating the detector. We used the Montreal NIRISS/SOSS contamination planning tool to assess the optimal Aperture Position Angles (APA) for the observation; it showed that TOI-3884 is observable in an APA range of [274.8, 300.1] with no contamination, so we implement this as a "PA Range" Special Requirement.

For NIRSpec/G395M, target acquisition might be done usng WATA with an offset, because the target itself is too bright. We select a nearby Gaia EDR3 star that is about G=17.2 magnitudes, and use the CLEAR filter to observe it for acquisition, reaching an expected S/N of about 30 on the acquisition star. We would like to discuss with an Instrument Specialist whether this offset pointing actually surpasses what we would expect with

using NONE as the acquisition option, but we budget for the offset acquisition just in case.

We will double and triple check all these settings if this program is awarded.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	TOI-3884b	RA: 12 06 17.2338 (181.5718075d) Dec: +12 30 25.31 (12.50703d) Equinox: J2000	Proper Motion RA: -186.04240974761944 mas/yr Proper Motion Dec: 26.38783553163484 mas/yr Parallax: 0.023015871532074378" Epoch of Position: 2016.0	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Star* *Description=[Exoplanets, M dwarfs]*				
(2)	NIRSpecAcquisitionStar	RA: 12 06 15.6153 (181.5650637d) Dec: +12 29 27.84 (12.49107d) Equinox: J2000	Proper Motion RA: -1.8359874079940004 mas/yr Proper Motion Dec: -2.974309221922878 mas/yr Epoch of Position: 2016.0	
Comments: Offset target acquisition *G =17.19* *RP = 16.59* *BP = 17.57* *Category=Star* *Description=[G stars]* *Extended=NO*				

Observation

Proposal 5863, Observation 1: NIRISS TOI-3884b

Wed Dec 18 16:00:25 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRISS Single-Object Slitless Spectroscopy

Diagnostics

(NIRISS TOI-3884b (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-3884b	RA: 12 06 17.2338 (181.5718075d) Dec: +12 30 25.31 (12.50703d) Equinox: J2000	Proper Motion RA: -186.04240974761944 mas/yr Proper Motion Dec: 26.38783553163484 mas/yr Parallax: 0.023015871532074378" Epoch of Position: 2016.0	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Exoplanets, M 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	19	1	1	0.93	176542

Template

Subarray	Include Short First Exposure and F277W Exposure?
SUBSTRIP256	true

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	NISRAPID	1	1	1	1	11.008	
2	NISRAPID	10	251	1	251	15174.074	176542
3	NISRAPID	10	10	1	10	604.545	176542

Special Requirements

Phase 0.968827354918769 to 0.9779957799426605 with period 4.54458889 Days and zero-phase 2459556.51661753 HJD
Aperture PA Range 296.6 to 300.8 Degrees (V3 296.03873283 to 300.23873283)
Time Series Observation
No Parallel Attachments

2 After 1 by 0.25 Days to 10 Days

Observation

Proposal 5863, Observation 2: NIRSpec TOI-3884b

Wed Dec 18 16:00:25 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Diagnostics

(NIRSpec TOI-3884b (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-3884b	RA: 12 06 17.2338 (181.5718075d) Dec: +12 30 25.31 (12.50703d) Equinox: J2000	Proper Motion RA: -186.04240974761944 mas/yr Proper Motion Dec: 26.38783553163484 mas/yr Parallax: 0.023015871532074378" Epoch of Position: 2016.0	

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

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	23	699	1	1	699	15146.268	176542

Special Requirements

Phase 0.968827354918769 to 0.9779957799426605 with period 4.54458889 Days and zero-phase 2459556.51661753 HJD
Time Series Observation
No Parallel Attachments

2 After 1 by 0.25 Days to 10 Days
3 After 2 by 0.25 Days to 10 Days

Observation

Proposal 5863, Observation 3: NIRISS TOI-3884b

Wed Dec 18 16:00:25 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRISS Single-Object Slitless Spectroscopy

Diagnostics

(NIRISS TOI-3884b (Obs 3)) 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 3:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

(Visit 3:1) Informational (Form): Visit schedulable, but most scheduling windows are when JWST is pointed in direction of greatest micrometeoroid impact risk. This is likely due to scheduling special requirements.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	TOI-3884b	RA: 12 06 17.2338 (181.5718075d) Dec: +12 30 25.31 (12.50703d) Equinox: J2000	Proper Motion RA: -186.04240974761944 mas/yr Proper Motion Dec: 26.38783553163484 mas/yr Parallax: 0.023015871532074378" Epoch of Position: 2016.0	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Exoplanets, M 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	19	1	1	0.93	176542

Template

Subarray	Include Short First Exposure and F277W Exposure?
SUBSTRIP256	true

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	NISRAPID	1	1	1	1	11.008	
2	NISRAPID	10	251	1	251	15174.074	176542
3	NISRAPID	10	10	1	10	604.545	176542

Special Requirements

Phase 0.976162126881991 to 0.9853305396196868 with period 4.54458889 Days and zero-phase 2459556.51661753 HJD
Aperture PA Range 296.6 to 300.8 Degrees (V3 296.03873283 to 300.23873283)
Time Series Observation
No Parallel Attachments

3 After 2 by 0.25 Days to 10 Days
4 After 3 by 0.25 Days to 10 Days

Observation

Proposal 5863, Observation 4: NIRSpec TOI-3884b

Wed Dec 18 16:00:25 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Diagnostics

(NIRSpec TOI-3884b (Obs 4)) 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 4:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

(Visit 4:1) Informational (Form): Visit schedulable, but most scheduling windows are when JWST is pointed in direction of greatest micrometeoroid impact risk. This is likely due to scheduling special requirements.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	TOI-3884b	RA: 12 06 17.2338 (181.5718075d) Dec: +12 30 25.31 (12.50703d) Equinox: J2000	Proper Motion RA: -186.04240974761944 mas/yr Proper Motion Dec: 26.38783553163484 mas/yr Parallax: 0.023015871532074378" Epoch of Position: 2016.0	

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

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	23	699	1	1	699	15146.268	176542

Special Requirements

Phase 0.976162126881991 to 0.9853305396196868 with period 4.54458889 Days and zero-phase 2459556.51661753 HJD
Time Series Observation
No Parallel Attachments

4 After 3 by 0.25 Days to 10 Days