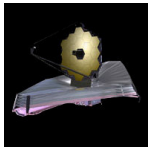

5967 - Exploring the desert: Thermal characterization of an exposed planetary core

Cycle: 3, Proposal Category: GO

INVESTIGATORS

Name	*Institution*
M. Pierre-Alexis Roy (PI) (CSA Member)	**Universite de Montreal**
Dr. Michael Radica (CoI)	University of Chicago
Louis-Philippe Coulombe (CoI) (CSA Member)	Universite de Montreal
Dr. Caroline Piaulet Ghorayeb (CoI)	University of Chicago
Prof. Bjorn Benneke (CoI) (CoPI) (US Admin CoI)	University of California - Los Angeles
Mr. Stefan Pelletier (CoI) (ESA Member)	University of Geneva, Department of Astronomy

OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1	Eclipse 1	NIRSpec Bright Object Time Series	(1) TOI-849
	2	Eclipse 2	NIRSpec Bright Object Time Series	(1) TOI-849
	3	Eclipse 3	NIRSpec Bright Object Time Series	(1) TOI-849
	11	Eclipse 1	NIRSpec Bright Object Time Series	(1) TOI-849

ABSTRACT

The recent discovery of a handful of ultra-dense and hot sub-Neptunes, found right in the middle of the hot-Neptune desert, offer us the unprecedented opportunity to perform direct spectroscopic characterization of primordial planetary cores. Indeed, these sub-Neptunes with large masses and extreme bulk densities are thought to be remnant and exposed version of the cores found at the center of giant planets like Jupiter, but they have never been observed in spectroscopy. We propose to characterize the thermal structure and composition of the highest-ESM ultra-dense sub-Neptune for JWST: TOI-849b. We will observe three secondary eclipses of the exoplanet with NIRSpec/G395H, which will enable us to precisely measure the dayside temperature, and heat redistribution efficiency, as well as infer the metallicity, and the C/O of the planet's envelope.

This will be achieved by obtaining an emission spectrum of the exoplanet, which will be precise enough to measure the water and carbon dioxyde contributions. Such measurements will allow us to spectroscopically confirm the metal-enriched, exposed core nature of the sub-Neptune, as well as to trace its formation history, as the C/O measured for this planet will directly be that of the exposed core, in contrast to standard C/O measurements which only access the upper layers of H-rich atmospheres. This program will thus represent a major step forward in the study of the diversity of sub-Neptunes, but also in the study of planet formation, as it will provide us with a direct view at a primordial planetary core.

OBSERVING DESCRIPTION

We will observe time-series spectroscopic observations of three eclipses of the ultra-dense sub-Neptune exoplanet TOI-849b. For all three visits, the observations will be performed with the NIRSpec instrument in BOTS mode using the G395H grism which will measure an emission spectrum of the planet in the near-infrared. The observations need to be continuous, and they are time critical, as they need to be obtained when the planet goes into secondary eclipse.

Proposal 5967 - Targets - Exploring the desert: Thermal characterization of an exposed planetary core

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	TOI-849	RA: 01 54 51.7938 (28.7158075d) Dec: -29 25 18.14 (-29.42171d) Equinox: J2000	Proper Motion RA: 73.26987387007122 mas/yr Proper Motion Dec: 20.485729141580702 mas/yr Parallax: 0.004434682252362974" Epoch of Position: 2016	

Comments: Using the GAIA DR3 values
Category=Star
Description=[G dwarfs]

Observation

Proposal 5967, Observation 1: Eclipse 1

Fri Aug 22 00:00:09 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Diagnostics

(Eclipse 1 (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-849	RA: 01 54 51.7938 (28.7158075d) Dec: -29 25 18.14 (-29.42171d) Equinox: J2000	Proper Motion RA: 73.26987387007122 mas/yr Proper Motion Dec: 20.485729141580702 mas/yr Parallax: 0.004434682252362974" Epoch of Position: 2016	

Comments: Using the GAIA DR3 values
Category=Star
Description=[G 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	33	631	1	1	631	19364.431	255582.2

Special Requirements

Phase 0.31929592274734364 to 0.37372486167886665 with period 0.76552414 Days and zero-phase 2458394.73768 HJD
Time Series Observation
No Parallel Attachments

Observation

Proposal 5967, Observation 2: Eclipse 2

Fri Aug 22 00:00:09 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Diagnostics

(Eclipse 2 (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-849	RA: 01 54 51.7938 (28.7158075d) Dec: -29 25 18.14 (-29.42171d) Equinox: J2000	Proper Motion RA: 73.26987387007122 mas/yr Proper Motion Dec: 20.485729141580702 mas/yr Parallax: 0.004434682252362974" Epoch of Position: 2016	

Comments: Using the GAIA DR3 values
Category=Star
Description=[G 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	33	631	1	1	631	19364.431	255582.2

Special Requirements

Phase 0.31929592274734364 to 0.37372486167886665 with period 0.76552414 Days and zero-phase 2458394.73768 HJD
Time Series Observation
No Parallel Attachments

Observation

Proposal 5967, Observation 3: Eclipse 3

Fri Aug 22 00:00:09 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Diagnostics

(Eclipse 3 (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.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	TOI-849	RA: 01 54 51.7938 (28.7158075d) Dec: -29 25 18.14 (-29.42171d) Equinox: J2000	Proper Motion RA: 73.26987387007122 mas/yr Proper Motion Dec: 20.485729141580702 mas/yr Parallax: 0.004434682252362974" Epoch of Position: 2016	

Comments: Using the GAIA DR3 values
Category=Star
Description=[G 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	33	631	1	1	631	19364.431	255582.2

Special Requirements

Phase 0.31929592274734364 to 0.37372486167886665 with period 0.76552414 Days and zero-phase 2458394.73768 HJD
Time Series Observation
No Parallel Attachments

Observation

Proposal 5967, Observation 11: Eclipse 1 Fri Aug 22 00:00:09 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Comments: Repeat of skipped obervation 1

Diagnostics

(Eclipse 1 (Obs 11)) 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 11:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	TOI-849	RA: 01 54 51.7938 (28.7158075d) Dec: -29 25 18.14 (-29.42171d) Equinox: J2000	Proper Motion RA: 73.26987387007122 mas/yr Proper Motion Dec: 20.485729141580702 mas/yr Parallax: 0.004434682252362974" Epoch of Position: 2016	

Comments: Using the GAIA DR3 values
Category=Star
Description=[G 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	33	631	1	1	631	19364.431	255582.2

Special Requirements

Phase 0.31929592274734364 to 0.37372486167886665 with period 0.76552414 Days and zero-phase 2458394.73768 HJD
Time Series Observation
No Parallel Attachments