4008 - The search for regolith on the airless exoplanet LHS 3844 b

Cycle: 2, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
LHS3844b NIRSpec BOTS				
	1	LHS3844b - G395H	NIRSpec Bright Object Time Series	(1) LHS3844

ABSTRACT

Airless bodies in our solar system are rough and covered with regolith, a layer of dust and fine-grained debris originating from crumbled rocks. We show that well-known and understood processes caused by roughness lead most notably to more emitted flux around the secondary eclipse due to "thermal beaming". We propose to observe one phase curve (= 15 hours) of the rocky exoplanet LHS 3844 b with NIRSpec G395H. Previously, Spitzer observations of the planet showed that it has no significant atmosphere and is most likely an airless bare rock. Its short orbital period and high observability make it a perfect target for phase curve observations. Our proposed program will lead to the first observation of an exoplanet's surface roughness and open a window to the geologic history of LHS 3844 b. Detection of a rough regolith surface implies that LHS 3844 b's surface must have been stable for geologic timescales and undergone space weathering processes (impacts by micrometeoroids, cosmic radiation, or solar wind) that crumbled the rocks into fine-grained regolith. On the other hand, a smooth surface would indicate resurfacing events such as widespread

volcanic activity or crustal reprocessing. In addition to the measurement of surface roughness, the phase curve observation will also lead to a precise measurement of the planet's phase-resolved spectrum. This will enable us to characterize the type of rock as a function of longitude, and also search for trace amounts of CO2 that were undetected by previous Spitzer observations.

OBSERVING DESCRIPTION

We propose to observe a phase curve of the exoplanet LHS 3844 b in the NIRSpec BOTS mode while using the G395H grating. The observations will include an additional 30 minutes to let the detector settle ("burn-in") and one hour of timing window, which we can use as an additional baseline. The phase curve observations should include 2 eclipses (which is common practice), so we added phase constraints to ensure that.

As LHS3844 is to bright to use it for Target Acquisition, we determined the closest 2MASS point source and use it instead.

We used Pandexo and the ETC to choose the setup: we will observe LHS 3844 with the SUB2048 subarray and the NRSRAPID readout pattern. By observing 15 Groups per Integration we will keep all pixels below 50% of saturation. The full phase curve will span 15.1 hours consisting out of 3769 Integrations.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	LHS3844	RA: 22 41 59.1203 (340.4963346d) Dec: -69 10 19.95 (-69.17221d) Equinox: J2000	Proper Motion RA: 334.41936695017966 mas/yr Proper Motion Dec: -726.9859085966832 mas/yr Parallax: 0.06721234716183032" Epoch of Position: 2016	
Comments: Values taken from the Gaia archive. 2MASS J22415815-6910089 Gaia DR3 6385548541499112448 From Simbad: Parallaxes (mas): 67.2123 [0.0187] A 2020yCat.1350....0G Fluxes (5) : B 17.3 [~] E ~ G 13.364960 [0.002834] C 2020yCat.1350....0G J 10.046 [0.023] C 2003yCat.2246....0C H 9.477 [0.023] C 2003yCat.2246....0C K 9.145 [0.023] C 2003yCat.2246....0C Category=Star Description=[Exoplanet Systems, M stars]				
(2)	LHS3844-TA	RA: 22 41 52.4444 (340.4685183d) Dec: -69 10 36.15 (-69.17671d) Equinox: J2000	Proper Motion RA: 5.9576895133589876 mas/yr Proper Motion Dec: -10.176256860402493 mas/yr Parallax: 0.00044184563056068393" Epoch of Position: 2016	
Comments: Values taken from the Gaia archive. This object is the closest point sorce to LHS3844 in the 2MASS All-Sky Point Source Catalog (PSC). 2MASS J22415241-6910359 Gaia DR3 6385548163541992576 Category=Unidentified Description=[Infrared sources, Visible sources]				

Proposal 4008 - Observation 1 - The search for regolith on the airless exoplanet LHS 3844 b

Observation

Proposal 4008, Observation 1: LHS3844b - G395H Thu May 11 13:08:10 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec Bright Object Time Series

Comments: When entering the period, zero-phase and phase constraints, we got the following error message: "A visit's scheduling duration may not be longer than the gap between PHASE ranges".
As suggested in the jwst-docs (https://jwst-docs.stsci.edu/jppom/special-requirements/timing-special-requirements#TimingSpecialRequirements-Phase) we doubled the orbital period and adjusted the phase constraints accordingly.

Original values:
PERIOD = 0.46292913
PHASE_START = 0.2515278418
PHASE_END = 0.3415344194

The updated values:
PERIOD = 0.92585826
PHASE_START = 0.3757639209
PHASE_END = 0.4207672097

Diagnostics

(LHS3844b - G395H (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

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(1)	LHS3844	RA: 22 41 59.1203 (340.4963346d) Dec: -69 10 19.95 (-69.17221d) Equinox: J2000	Proper Motion RA: 334.41936695017966 mas/yr Proper Motion Dec: -726.9859085966832 mas/yr Parallax: 0.06721234716183032" Epoch of Position: 2016	

Comments: Values taken from the Gaia archive.

2MASS J22415815-6910089
Gaia DR3 6385548541499112448

From Simbad:
Parallaxes (mas): 67.2123 [0.0187] A 2020yCat.1350....0G
Fluxes (5) :
B 17.3 [~] E ~
G 13.364960 [0.002834] C 2020yCat.1350....0G
J 10.046 [0.023] C 2003yCat.2246....0C
H 9.477 [0.023] C 2003yCat.2246....0C
K 9.145 [0.023] C 2003yCat.2246....0C
Category=Star
Description=[Exoplanet Systems, M stars]

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	2 LHS3844-TA	WATA	SUB32	F140X	NRSRAPID	3	1	1	0.08	145912

Template

Subarray
SUB2048

Proposal 4008 - Observation 1 - The search for regolith on the airless exoplanet LHS 3844 b

Spectral Elements

#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395H/F290LP	NRSRAPID	15	3769	1	1	3769	54471.397	145912

Special Requirements

Phase 0.3757639209 to 0.4207672097 with period 0.92585826 Days and zero-phase 2459085.39295 HJD
Time Series Observation
No Parallel Attachments