



# 4105 - Not Your Normal Neptune: Exploring the Chemical Processes at Play in HAT-P-11b

Cycle: 2, Proposal Category: GO

## INVESTIGATORS

<i>Name</i>	<i>Institution</i>
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David Grant (CoI) (ESA Member)	University of Bristol
Daniel Valentine (CoI) (ESA Member)	University of Bristol
Matthew Lodge (CoI) (ESA Member)	University of Bristol
Dr. Nikole Lewis (CoI) (US Admin CoI)	Cornell University
Ryan J MacDonald (CoI)	University of Michigan
Dr. Jayesh Goyal (CoI)	National Institute of Science Education and Research, India
Dr. Julianne I. Moses (CoI)	Space Science Institute
Dr. Sarah E. Moran (CoI)	University of Arizona

## OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Observation Folder				
	1		NIRSpec Bright Object Time Series	(1) HAT-P-11
	2		NIRSpec Bright Object Time Series	(1) HAT-P-11

## ABSTRACT

Under equilibrium chemistry conditions, methane is expected to be the dominant carbon bearing species in Neptune-sized exoplanet atmospheres at temperatures below ~ 1000K for most C/O ratios and metallicities. However, observational searches for methane have thus far found only tentative

hints of its presence. In order to diagnose the source of the missing methane in extrasolar atmospheres, it is important to be able to tease apart the competing effects of high-metallicity equilibrium and low-metallicity disequilibrium chemical processes, both of which can reduce the molecule's expected abundance.

HAT-P-11b, the only Neptune-mass exoplanet with a sub-solar metallicity measurement, is one of the few exoplanets with potential evidence of methane. However, Spitzer observations show relatively flat transit depths in the IR where methane should have significant contributing opacity. Given its intriguingly low metallicity combined with its size and temperature, the ~800K HAT-P-11b is a prime target to examine and perhaps disentangle the chemical and dynamical processes occurring within atmospheres on the CO - CH<sub>4</sub> transition. We propose to obtain the 3-5 micron transmission spectrum of HAT-P-11b in order to definitively measure the C/O and [M/H] of the atmosphere and test the validity of current measurements, unraveling the mystery of the missing methane.

## **OBSERVING DESCRIPTION**

We will observe 2 primary transits of HAT-P-11b using the NIRSpec G395H grism in BOTS mode to obtain spectra from 2.87-5.27 microns.

Each single transit observation will consist of 3 groups per integration, with 5218 integrations covering the entire transit duration (2.36 hours), and additional pre- and post-transit baseline to characterise the baseline stellar flux and any instrumental ramp effects (5.23 hours total). When including instrumental and observatory overheads, this results in a total charge time of 14.22 hours.

Each time series observation must occur during, and cover a full transit event of HAT-P-11b, and therefore must begin within a specified phase window of the orbital period. We have specified a 1 hour window during which the observation can begin to allow for scheduling and adequate baseline

Given the brightness of the target star, we will perform target acquisition on a 2MASS source within the 70 arcsecond splitting distance. This strategy will use the WATA method with the SUB32 subarray and CLEAR filter with 3 groups.

Proposal 4105 - Targets - Not Your Normal Neptune: Exploring the Chemical Processes at Play in HAT-P-11b

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(1)	HAT-P-11	RA: 19 50 50.4423 (297.7101763d) Dec: +48 04 54.71 (48.08186d) Equinox: J2000	Proper Motion RA: 0.012583048033303935 sec of time/yr Proper Motion Dec: 0.232726 arcsec/yr Epoch of Position: 2015.5	
		<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=Star Description=[Exoplanets]			
(2)	19505049+4805017	RA: 19 50 50.4962 (297.7104008d) Dec: +48 05 1.78 (48.08383d) Equinox: J2000			
		<i>Comments: This object was generated by the targetselector and retrieved from the 2MASS database.</i> Category=Star Description=[K stars]			

Proposal 4105 - Observation 1 - Not Your Normal Neptune: Exploring the Chemical Processes at Play in HAT-P-11b

Thu May 11 15:07:04 GMT 2023

<b>Observation</b>	<p><b>Proposal 4105, Observation 1</b></p> <p><b>Diagnostic Status: Warning</b></p> <p>Observing Template: NIRSpec Bright Object Time Series</p>																																
<b>Diagnostics</b>	<p>(Observation 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.</p> <p>(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.</p>																																
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Proposal 4105 - Observation 2 - Not Your Normal Neptune: Exploring the Chemical Processes at Play in HAT-P-11b

Thu May 11 15:07:04 GMT 2023

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