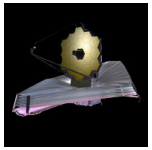

11301 - Cloudy with a Chance of Disequilibrium Chemistry: A Comprehensive View of Silicate Clouds in a Hot Jupiter with a MIRI/LRS Phase Curve

Cycle: 5, Proposal Category: GO

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OBSERVATIONS

Folder	***Observation***	***Label***	***Observing Template***	***Science Target***
MIRI LRS Phase Curve				
	1	HD 189733b Phase Curve	MIRI Low Resolution Spectroscopy	(1) HD-189733b

ABSTRACT

We propose to observe HD 189733b with MIRI LRS to obtain a full-orbit phase curve. Recent work suggests that hot Jupiters are extremely diverse exoplanet population even before considering the effect of clouds. The MIRI phase curve of WASP-43b showed evidence of nightside clouds and disequilibrium mixing influencing the chemistry of this planet. HD 189733b is likely to be in a different regime containing global cloud coverage as indicated by its MIRI LRS eclipse. However, global cloud coverage and species remains a mystery because HD 189733b has never had a spectroscopic phase curve.

By utlizing MIRI LRS we will obtain an unprecedentedly high SNR phase curve which can constrain the global cloud coverage and properties. Such an observation will provide a landmark dataset to which future climate models and observations of hot Jupiters will be benchmarked. Phase curves are the most effective tool for probing the multi-dimensional structure of exoplanet atmospheres and the only way to observe nightside emission. MIRI LRS offers the optimal spectral range for detecting cooler nightside emissions and distinguishing disequilibrium chemistry signatures, such as CH4 (7–8 and 8–9 μm) and NH3 (6–7 and 10–12 μm), as well as composition-specific cloud signatures, like silicate clouds at 9 μm. This observation will show where clouds form and dissipate, informing the planet’s energy balance and constraining slicate cloud specific species and particle sizes to ~0.05 μm. Comparing these observations with global circulation models (GCMs), phase-resolved spectra, eclipse maps, and transmission spectra will advance our understanding of hot Jupiter diversity and their formation pathways.

OBSERVING DESCRIPTION

We propose to observe HD 189733b using MIRI LRS for a full-orbit phase curve, starting just before an eclipse and ending after the second eclipse, following the suggestions and set-up from the (successful)
archival WASP-43b dataset.

HD 189733b has an orbital period of 2.21 days and is very bright (K = 5.54), to limit saturation we use 5 groups per integration with 222327 total integrations. To stay within the maximum frame limit, we divide the observation into 7 exposures, and ensure that no exposure breaks occur near any of the occultations. This setup provides an exposure time of 58.93 hours with 82.75% efficiency.

For target acquisition we use the F1500W filter with FAST readout mode, taking 1.27 seconds with 8 groups. We request that our observations allow for a safe padding before the first eclipse to mitigate the effects of the known ramp systematic. We further request constraints on the PA to minimize contamination on the spectrum of the target star from nearby stars.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	HD-189733b	RA: 20 00 43.7129 (300.1821371d)	Proper Motion RA: -3.208 mas/yr	
		Dec: +22 42 39.07 (22.71085d)	Proper Motion Dec: -250.32299990925821 mas/yr	
		Equinox: J2000	Parallax: 0.0505668"	
			Epoch of Position: 2000	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.
Category=Star
Description=[Exoplanet Systems, Exoplanets, K stars]

Observation

Proposal 11301, Observation 1: HD 189733b Phase Curve

Wed Aug 19 19:00:21 GMT 2026

Diagnostic Status: Warning

Observing Template: MIRI Low Resolution Spectroscopy

Diagnostics

(HD 189733b Phase Curve (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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Category=Star
Description=[Exoplanet Systems, Exoplanets, K stars]

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	Optional ETC ID
1	1 HD-189733b	F1500W	FAST	8	1	1	0.942	273161.1

Template

Subarray	Obtain Verification Image?
SLITLESSPRISM_IPS	true

Dithers

#	Dither Type	No. Spectral Steps	Spectral Step Offset	No. Spatial Steps	Spatial Step Offset
1	NONE				

Pointing Verification

#	PV Readout Pattern	PV Groups/Int	PV Integrations/Exp	PV Total Integrations	PV Exposures/Dith	PV Total Dithers	PV Total Exposure Time	Optional ETC ID	Filter
1	FASTR1	8	1	1	1	1	0.942		F1500W

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	Optional ETC ID
1	FASTR1	5	37533	300264	8	1	212153.59	273161.2

Special Requirements

Phase 0.2139 to 0.2233 with period 4.437150286 Days and zero-phase 2454632.19046 HJD
Aperture PA Range 4.83544897 to 40.83544897 Degrees (V3 0.0 to 36.0)
Aperture PA Range 91.83544897 to 220.83544897 Degrees (V3 87.0 to 216.0)
Aperture PA Range 271.83544897 to 328.83544897 Degrees (V3 267.0 to 324.0)
Time Series Observation
No Parallel Attachments