

# 2021 - Into the next Dimension: 3-D Eclipse Maps of the Canonical Hot Jupiter HD 189733b

Cycle: 1, Proposal Category: GO

### **INVESTIGATORS**

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#### **OBSERVATIONS**

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Folder	Observation Label		Observing Template	Science Target
Eclipse	1			
	1		MIRI Low Resolution Spectroscopy	(1) HD-189733B
	11		MIRI Low Resolution Spectroscopy	(1) HD-189733B
Eclipse?	2		· · · · · · · · · · · · · · · · · · ·	
	2		MIRI Low Resolution Spectroscopy	(1) HD-189733B

## **ABSTRACT**

Eclipse mapping is an observational technique that measures an exoplanet's thermal structure as a function of both latitude and longitude yielding two dimensional maps of the planetary dayside. Multiwavelength eclipse maps propel these observations into the next dimension and provide an unprecedented view of a planet's three-dimensional dynamics, thermal structure, chemistry, and energetics. Here we propose to produce spectroscopic eclipse maps of the canonical hot Jupiter, HD 189733b, from 6 to 12 microns with MIRI LRS. These observations will measure the geographic distribution of dayside emission over these wavelengths, thereby constraining the global circulation patterns and relevant atmospheric timescales in HD 189733b with latitude, longitude and altitude. When combined with previous Spitzer/IRAC mid-IR photometric phase curves and

JWST Proposal 2021 (Created: Thursday, November 17, 2022 at 12:01:36 PM Eastern Standard Time) - Overview eclipse maps, our proposed MIRI spectroscopic eclipse maps will paint the most detailed and complete picture to date of weather in a hot Jupiter atmosphere, refining general circulation models that aim to predict their climate.

## **OBSERVING DESCRIPTION**

Here we propose to observe the transiting Hot Jupiter HD~189733b during secondary eclipse with the MIRI LRS instrument for two separate eclipse observations. HD 189733b orbits a bright star (K=5.05) at a period of 2.22 days and has a duration of transit of 1.8 hours. Each eclipse observation will span approximately five hours of observing time for a total of ten hours (not including overheads). We will utilize MIRI in FAST read mode with NGroups = 5 such that there are ample number of groups. This strategy yields times per integration (including reset) of 0.95 seconds with a 66.7\% efficiency. Utilizing five groups results in the saturating of 14 pixels at the short wavelengths. We are willing to accept that saturation in order to lengthen the exoposure time and increase SNR at the longer wavelengths. The pixels that are saturated should be recoverable by only considering unsaturated groups, however, even if they are not recoverable it would have a negligible impact on our overall science goal.

Simulated light curves based on brightness models from GCM outputs of HD 189733b show maximum deviations in ingress/egress (compared to a uniform brightness model) of 200 ppm. We aim to achieve a secure 5 sigma detection of this deviation. We find that by observing two eclipses and binning spectrally in intervals of 30 pixels we can achieve or exceed the required precision per minute to detect and characterize the deviations in ingress and egress across a broad range of wavelengths. This approach would produce seven eclipse maps representing each of the seven spectral bins meeting the threshold. An additional map at the long end of the bandpass could be produced by combining the longest two spectral bins yielding as many as eight total eclipse maps.

## Proposal 2021 - Targets - Into the next Dimension: 3-D Eclipse Maps of the Canonical Hot Jupiter HD 189733b

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Proposal 2021 - Observation 1 - Into the next Dimension: 3-D Eclipse Maps of the Canonical Hot Jupiter HD 189733b

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Proposal 2021 - Observation 11 - Into the next Dimension: 3-D Eclipse Maps of the Canonical Hot Jupiter HD 189733b

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Proposal 2021 - Observation 2 - Into the next Dimension: 3-D Eclipse Maps of the Canonical Hot Jupiter HD 189733b

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