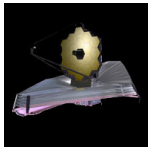

2021 - Into the next Dimension: 3-D Eclipse Maps of the Canonical Hot Jupiter HD 189733b

Cycle: 1, Proposal Category: GO

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. Brian Kilpatrick (PI)	**Space Telescope Science Institute**	**brian@planetkil.com**
Dr. Tiffany Kataria (CoI) (CoPI) (US Admin CoI) (Contact)	Jet Propulsion Laboratory	tiffany.kataria@jpl.nasa.gov
Dr. Nikole Lewis (CoI) (CoPI) (Contact)	Cornell University	nikole.lewis@cornell.edu

OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Eclipse1				
	1		MIRI Low Resolution Spectroscopy	(1) HD-189733B
	11		MIRI Low Resolution Spectroscopy	(1) HD-189733B
Eclipse2				
	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

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.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	HD-189733B	RA: 20 00 43.7093 (300.1821221d) Dec: +22 42 35.19 (22.70978d) Equinox: J2000	Proper Motion RA: -2.380559461785614E-4 sec of time/yr Proper Motion Dec: -0.25022499999067804 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Exoplanet Systems, Exoplanets]
Extended=NO

Observation

Proposal 2021, Observation 1

Thu Nov 17 17:01:36 GMT 2022

Diagnostic Status: Warning

Observing Template: MIRI Low Resolution Spectroscopy

Diagnostics

(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.

(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)	HD-189733B	RA: 20 00 43.7093 (300.1821221d) Dec: +22 42 35.19 (22.70978d) Equinox: J2000	Proper Motion RA: -2.380559461785614E-4 sec of time/yr Proper Motion Dec: -0.25022499999067804 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Exoplanet Systems, Exoplanets]
Extended=NO

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	1 HD-189733B	FND	FAST	98	1	1	15.586	63539

Template

Subarray	Obtain Verification Image?
SLITLESSPRISM	true

Dithers

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

Pointing Verification

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	FAST	98	1	1	15.586	63539

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	FASTR1	5	17035	17035	1	1	16255.319	

Special Requirements

Phase 0.4492917904395841 to 0.4680726087952938 with period 2.21857567 Days and zero-phase 2453955.525551 HJD
Aperture PA Range 70 to 150 Degrees (V3 65.16455103 to 145.16455103)
Aperture PA Range 196 to 264 Degrees (V3 191.16455103 to 259.16455103)
Time Series Observation
No Parallel

Observation

Proposal 2021, Observation 11

Thu Nov 17 17:01:36 GMT 2022

Diagnostic Status: Warning

Observing Template: MIRI Low Resolution Spectroscopy

Comments: Repeat of failed observation 1

Diagnostics

(Observation 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)	HD-189733B	RA: 20 00 43.7093 (300.1821221d) Dec: +22 42 35.19 (22.70978d) Equinox: J2000	Proper Motion RA: -2.380559461785614E-4 sec of time/yr Proper Motion Dec: -0.25022499999067804 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Exoplanet Systems, Exoplanets]
Extended=NO

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	1 HD-189733B	FND	FAST	98	1	1	15.586	63539

Template

Subarray	Obtain Verification Image?
SLITLESSPRISM	true

Dithers

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

Pointing Verification

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	FAST	98	1	1	15.586	63539

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	FASTR1	5	17035	17035	1	1	16255.319	

Special Requirements

Phase 0.4492917904395841 to 0.4680726087952938 with period 2.21857567 Days and zero-phase 2453955.525551 HJD
Aperture PA Range 70 to 150 Degrees (V3 65.16455103 to 145.16455103)
Aperture PA Range 196 to 264 Degrees (V3 191.16455103 to 259.16455103)
Time Series Observation
No Parallel

Observation

Proposal 2021, Observation 2

Thu Nov 17 17:01:36 GMT 2022

Diagnostic Status: Warning

Observing Template: MIRI Low Resolution Spectroscopy

Diagnostics

(Observation 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)	HD-189733B	RA: 20 00 43.7093 (300.1821221d) Dec: +22 42 35.19 (22.70978d) Equinox: J2000	Proper Motion RA: -2.380559461785614E-4 sec of time/yr Proper Motion Dec: -0.25022499999067804 arcsec/yr Epoch of Position: 2015.5	

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Exoplanet Systems, Exoplanets]
Extended=NO

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	1 HD-189733B	FND	FAST	98	1	1	15.586	63539

Template

Subarray	Obtain Verification Image?
SLITLESSPRISM	true

Dithers

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

Pointing Verification

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	FAST	98	1	1	15.586	63539

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	FASTR1	5	17035	17035	1	1	16255.319	

Special Requirements

Phase 0.4492917904395841 to 0.4680726087952938 with period 2.21857567 Days and zero-phase 2453955.525551 HJD
Aperture PA Range 70 to 150 Degrees (V3 65.16455103 to 145.16455103)
Aperture PA Range 196 to 264 Degrees (V3 191.16455103 to 259.16455103)
Time Series Observation
No Parallel