



5687 - Unlocking New Dimensions in Eclipse Mapping with KELT-8b

Cycle: 3, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Observation Folder				
	1		MIRI Low Resolution Spectroscopy	(1) KELT-8
	2		MIRI Low Resolution Spectroscopy	(1) KELT-8
	3		MIRI Low Resolution Spectroscopy	(2) KELT-8-BKG
	4		MIRI Low Resolution Spectroscopy	(2) KELT-8-BKG

ABSTRACT

Eclipse mapping is currently the only method capable of measuring 2D (latitude-longitude) profiles of exoplanet atmospheres. The method has been used to accurately map the longitudinal profiles of a handful of exoplanets, allowing us to characterise their atmospheric dynamics using key tracers such as the longitudinal offset of the hotspot (the hottest point on the planet) due to supersonic jets. However, no exoplanet has yet been adequately mapped in latitude because there is a limited parameter space in which we are capable of observing such signals. Latitudinal hotspot offsets can be induced by a marginal misalignment between the magnetic field of an exoplanet and its spin axis, with the scale of the offset related to the field

strength and angle of misalignment. Characterising this offset would thus allow us to probe these parameters for planetary-mass objects for the first time, which is only possible via eclipse mapping because it is the only method capable of mapping these objects in latitude as well as longitude.

KELT-8b's 1675 K equilibrium temperature make it ideally susceptible to a magnetically-induced latitudinal hotspot offset, and its 0.741 impact parameter and 45 minute ingress/egress duration make this offset optimally observable. We will use MIRI/LRS to observe two eclipses of KELT-8b, using a unique observing strategy designed to give the best constraints on both its longitudinal and latitudinal profile. This will allow us to construct the most informative eclipse map of an exoplanet to date, from which we will be able to extract a wealth of information, including the atmospheric dynamics, heat redistribution, wind speeds, and magnetic field geometry.

OBSERVING DESCRIPTION

We will observe two eclipses of KELT-8b using MIRI/LRS in Slitless Prism mode to obtain 5-12 micron light curves and spectra. The planet-star flux ratio peaks in the mid-infrared, therefore we will achieve the best signal-to-noise (SNR) in this bandpass. The LRS instrument gives us the highest white light curve precision, which is required to recover the small-scale eclipse mapping signals, and the highest cadence of 13.6773 s, which gives us good spatial scanning of the dayside atmosphere, making its use optimal over that of the MIRI photometric filters.

Each observation will have 85 groups per integration. The shorter observation will consist of two exposures, each comprising 948 integrations (totalling 1896), covering the eclipse duration of 3.466 hours, with 2.487 hours of pre-eclipse baseline and 1.250 hours of post-eclipse baseline to characterise the baseline stellar and planetary flux and instrumental ramp effects. This observation totals 25932.108 s (7.203 hours) of exposure time. The longer observation will also consist of two exposures, but comprising 1641 integrations each (totalling 3282), with the added time given to the 7.750 hours of pre-eclipse baseline in order to measure the phase signal associated with the longitudinal hotspot offset. This observation totals 44889.04 s (12.468 hours) of exposure time. Together, the two observations total 19.44 hours of science time, and 19.671 hours of exposure time when accounting for instrumental overheads. When also including observatory overheads, this results in a total charged time of 24.97 hours.

Each time series observation must occur during, and cover a full secondary eclipse event of KELT-8b, 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 the appropriate baseline. We additionally include a series of Aperture PA ranges to ensure that our observations are free of contamination from nearby stars. There are multiple opportunities in Cycle 3 to conduct the proposed observations.

We will perform target acquisition on our target star using the F560W filter and FAST readout pattern with 10 groups. Using the JWST Exposure

Time Calculator, we estimate that this will achieve an SNR of 379, which will be sufficient to acquire our target.

Proposal 5687 - Targets - Unlocking New Dimensions in Eclipse Mapping with KELT-8b

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	KELT-8	RA: 18 53 13.3242 (283.3055175d) Dec: +24 07 38.58 (24.12738d) Equinox: J2000	Proper Motion RA: -14.508 mas/yr Proper Motion Dec: -31.32799993181834 mas/yr Epoch of Position: 2000	
<p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=Star Description=[Exoplanet Systems] Extended=NO</p>				
(2)	KELT-8-BKG	RA: 18 53 13.3242 (283.3055175d) Dec: +24 07 38.58 (24.12738d) Equinox: J2000	Proper Motion RA: -14.508 mas/yr Proper Motion Dec: -31.32799993181834 mas/yr Epoch of Position: 2000	
<p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=Star Description=[Exoplanet Systems] Extended=NO</p>				

Fixed Targets

Proposal 5687 - Observation 1 - Unlocking New Dimensions in Eclipse Mapping with KELT-8b

Wed Jul 23 17:00:30 GMT 2025

Observation	<p>Proposal 5687, Observation 1</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: MIRI Low Resolution Spectroscopy</p> <p>Background Observations:[Observation 3]</p> <p><i>Comments: PA ranges are required to avoid nearby stars. These were determined using Aladin in the APT.</i></p> <p><i>Phase constraints calculated using ExoCTK for a 1hr window starting 4.22hr prior to center of eclipse.</i></p>									
	<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>									
Diagnosics										
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections			Miscellaneous			
	(1)	KELT-8	RA: 18 53 13.3242 (283.3055175d) Dec: +24 07 38.58 (24.12738d) Equinox: J2000	Proper Motion RA: -14.508 mas/yr Proper Motion Dec: -31.32799993181834 mas/yr Epoch of Position: 2000						
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Acquisition	#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID	
	1	SAME	F560W	FAST	10	1	1	1.59	169196	
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	#	PV Readout Pattern	PV Groups/Int	PV Integrations/Exp	PV Total Integrations	PV Exposures/Dith	PV Total Dithers	PV Total Exposure Time	PV ETC Wkbk.Calc ID	Filter
	1	FASTR1	10	1	1	1	1	1.59		F560W

Proposal 5687 - Observation 1 - Unlocking New Dimensions in Eclipse Mapping with KELT-8b

Spectral Elements	#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
Special Requirements	1	FASTR1	85	948	1896	2	1	25932.108	169196
	<p>Phase 0.446532536 to 0.459376438 with period 3.24406 Days and zero-phase 2459021.32978 HJD Aperture PA Range 99.83544897 to 108.83544897 Degrees (V3 95.0 to 104.0) Aperture PA Range 142.83544897 to 164.83544897 Degrees (V3 138.0 to 160.0) Aperture PA Range 295.83544897 to 350.83544897 Degrees (V3 291.0 to 346.0) Time Series Observation No Parallel Attachments</p> <p>Group Observations 1, 3, Non-interruptible</p>								

Proposal 5687 - Observation 2 - Unlocking New Dimensions in Eclipse Mapping with KELT-8b

Wed Jul 23 17:00:30 GMT 2025

Observation	<p>Proposal 5687, Observation 2</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: MIRI Low Resolution Spectroscopy</p> <p>Background Observations:[Observation 4]</p> <p><i>Comments: PA ranges are required to avoid nearby stars. These were determined using Aladin in the APT.</i></p> <p><i>Phase constraints calculated using ExoCTK for a 1hr window starting 9.48hr prior to center of eclipse, to capture the peak of the phase signal.</i></p>									
	<p>(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.</p> <p>(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.</p>									
Diagnosics										
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections			Miscellaneous			
	(1)	KELT-8	RA: 18 53 13.3242 (283.3055175d) Dec: +24 07 38.58 (24.12738d) Equinox: J2000	Proper Motion RA: -14.508 mas/yr Proper Motion Dec: -31.32799993181834 mas/yr Epoch of Position: 2000						
<p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i></p> <p><i>Category=Star</i></p> <p><i>Description=[Exoplanet Systems]</i></p> <p><i>Extended=NO</i></p>										
Acquisition	#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID	
	1	SAME	F560W	FAST	10	1	1	1.59	169196	
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	#	PV Readout Pattern	PV Groups/Int	PV Integrations/Exp	PV Total Integrations	PV Exposures/Dith	PV Total Dithers	PV Total Exposure Time	PV ETC Wkbk.Calc ID	Filter
	1	FASTR1	10	1	1	1	1	1.59		F560W

Proposal 5687 - Observation 2 - Unlocking New Dimensions in Eclipse Mapping with KELT-8b

Spectral Elements	#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
	Special Requirements	1	FASTR1	85	1641	3282	2	1	44889.04
<p>Phase 0.378898929 to 0.391742832 with period 3.24406 Days and zero-phase 2459021.32978 HJD Aperture PA Range 99.83544897 to 108.83544897 Degrees (V3 95.0 to 104.0) Aperture PA Range 142.83544897 to 164.83544897 Degrees (V3 138.0 to 160.0) Aperture PA Range 295.83544897 to 350.83544897 Degrees (V3 291.0 to 346.0) Time Series Observation No Parallel Attachments Sequence Observations 2, 4, Non-interruptible</p>									

Proposal 5687 - Observation 3 - Unlocking New Dimensions in Eclipse Mapping with KELT-8b

Wed Jul 23 17:00:30 GMT 2025

Observation	Proposal 5687, Observation 3 Diagnostic Status: Warning Observing Template: MIRI Low Resolution Spectroscopy Background Observation For: [Observation 1] <i>Comments: PA ranges are required to avoid nearby stars. These were determined using Aladin in the APT.</i> <i>Phase constraints calculated using ExoCTK for a 1hr window starting 4.22hr prior to center of eclipse.</i>																												
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	#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID																				
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Template	Subarray				Obtain Verification Image?																								
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	#	PV Readout Pattern	PV Groups/Int	PV Integrations/Exp	PV Total Integrations	PV Exposures/Dith	PV Total Dithers	PV Total Exposure Time	PV ETC Wkbk.Calc ID	Filter																			
1	FASTR1	10	1	1	1	1	1.59		F560W																				

Proposal 5687 - Observation 3 - Unlocking New Dimensions in Eclipse Mapping with KELT-8b

Spectral Elements	#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
	1	FASTR1	85	10	20	2	1	273.231	169196
Special Requirements	Aperture PA Range 99.83544897 to 108.83544897 Degrees (V3 95.0 to 104.0) Aperture PA Range 142.83544897 to 164.83544897 Degrees (V3 138.0 to 160.0) Aperture PA Range 295.83544897 to 350.83544897 Degrees (V3 291.0 to 346.0) Offset 10.0 arcsec, 0.0 arcsec Time Series Observation No Parallel Attachments								
	Group Observations 1, 3, Non-interruptible								

Proposal 5687 - Observation 4 - Unlocking New Dimensions in Eclipse Mapping with KELT-8b

Wed Jul 23 17:00:30 GMT 2025

Observation	<p>Proposal 5687, Observation 4</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: MIRI Low Resolution Spectroscopy</p> <p>Background Observation For: [Observation 2]</p> <p><i>Comments: PA ranges are required to avoid nearby stars. These were determined using Aladin in the APT.</i></p> <p><i>Phase constraints calculated using ExoCTK for a 1hr window starting 9.48hr prior to center of eclipse, to capture the peak of the phase signal.</i></p>									
Diagnostics	<p>(Visit 4:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.</p>									
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Acquisition	#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID	
	1	1 KELT-8	F560W	FAST	10	1	1	1.59	169196	
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	#	PV Readout Pattern	PV Groups/Int	PV Integrations/Exp	PV Total Integrations	PV Exposures/Dith	PV Total Dithers	PV Total Exposure Time	PV ETC Wkbk.Calc ID	Filter
	1	FASTR1	10	1	1	1	1	1.59		F560W

Proposal 5687 - Observation 4 - Unlocking New Dimensions in Eclipse Mapping with KELT-8b

Spectral Elements	#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
		1	FASTR1	85	10	10	1	1	136.615
Special Requirements	<p>Aperture PA Range 99.83544897 to 108.83544897 Degrees (V3 95.0 to 104.0) Aperture PA Range 142.83544897 to 164.83544897 Degrees (V3 138.0 to 160.0) Aperture PA Range 295.83544897 to 350.83544897 Degrees (V3 291.0 to 346.0) Offset 10.0 arcsec, 0.0 arcsec Time Series Observation No Parallel Attachments Sequence Observations 2, 4, Non-interruptible</p>								