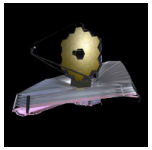

7255 - A Day In The Life of KELT-9b

Cycle: 4, Proposal Category: GO

INVESTIGATORS

Name	*Institution*
Dr. Kevin Stevenson (PI)	**The Johns Hopkins University Applied Physics Laboratory**
Dr. Joshua D. Lothringer (CoI) (CoPI)	Space Telescope Science Institute
Dr. Hayley Beltz (CoI)	University of Maryland
Dr. Ian Crossfield (CoI)	University of Kansas Center for Research, Inc.
Dr. Erin M May (CoI)	The Johns Hopkins University Applied Physics Laboratory
Dr. Kristin Showalter Sotzen (CoI)	The Johns Hopkins University Applied Physics Laboratory
Prof. David K. Sing (CoI)	The Johns Hopkins University
Junellie Gonzalez Quiles (CoI)	NASA Goddard Space Flight Center

OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
KELT-9b				
	1	Phase Curve pt1	NIRISS Single-Object Slitless Spectroscopy	(1) KELT-9
	2	Phase Curve pt2	NIRISS Single-Object Slitless Spectroscopy	(1) KELT-9

ABSTRACT

KELT-9b is, by far, the hottest known exoplanet. With a dayside temperature of ~4,500 K, most molecules have dissociated into their constituent atoms. Rather surprisingly, the dayside HST emission spectrum favors an anomalously high metallicity and excessive H-, TiO, VO, and/or FeH. While metal hydrides and H- are reasonable absorbers for KELT-9b within an equilibrium chemistry framework, the presence of TiO or VO cannot be explained without invoking totally unexpected disequilibrium processes, such as horizontal quenching from the planet's nightside. The alternative (and unsatisfying) solution is that the observed dayside features are due to the presence of an unknown absorber. Without a suitable explanation for this benchmark ultra-hot Jupiter, we propose for JWST to observe a full-orbit phase curve of KELT-9b.

Our program asks two overarching science questions that can be readily answered using NIRISS/SOSS spectroscopy: (1) Is the relatively efficient redistribution of heat on ultra-hot Jupiters due to hydrogen recombination? (2) Does the emission spectrum of KELT-9b show evidence of complex molecular abundances as a function of longitude? By combining information from all phases, we will provide robust constraints on the atmospheric metallicity and phase-resolved abundances of KELT-9b. The lessons learned from the hottest of hot Jupiters will shed light on the relative importance of various atmospheric processes and timescales within the atmospheres of the dozens of coolers planets with previous phase curve observations.

OBSERVING DESCRIPTION

This is a time-series observation of an ultra-hot Jupiter, KELT-9b, using NIRISS/SOSS. We require 52 hours (including overheads) to obtain a full-orbit phase curve. The observation is split into two exposures that have been linked as non-interruptable and in sequence. We use the SUBSTRIP96 subarray with 3 groups/integration in order to observe this bright target from 0.8 - 2.8 microns. Using the SUBSTRIP256 mode would sature the detector at the wavelengths needed for our science case. We used PandExo to demonstrate that we can achieve the necessary precision to achieve our science goals.

In the APT exposure setup, we include a short first exposure and an F277W exposure. The former is included in the event there is a slight shift in the pupil wheel position between the first and second exposure. The latter isolates the first-order spectrum in the region where the first and second orders overlap on the detector.

Proposal 7255 - Targets - A Day In The Life of KELT-9b

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	KELT-9	RA: 20 31 26.3534 (307.8598058d)	Proper Motion RA: 16.717 mas/yr	
		Dec: +39 56 19.77 (39.93882d)	Proper Motion Dec: 20.961 mas/yr	
		Equinox: J2000	Parallax: 0.0048258"	
			Epoch of Position: 2000	

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

Added parallax manually via SIMBAD:
https://simbad.u-strasbg.fr/simbad/sim-basic?Ident=kelt-9&submit=SIMBAD+search
Category=Star
Description=[A stars, Exoplanet Systems]
Extended=NO

Observation

Proposal 7255, Observation 1: Phase Curve pt1

Thu Jun 05 23:00:15 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRISS Single-Object Slitless Spectroscopy

Diagnostics

(Phase Curve pt1 (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.

(Phase Curve pt1 (Obs 1)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.

(Visit 1:1) Informational (Form): Visit schedulable, but most scheduling windows are when JWST is pointed in direction of greatest micrometeoroid impact risk. This is likely due to scheduling special requirements.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	KELT-9	RA: 20 31 26.3534 (307.8598058d) Dec: +39 56 19.77 (39.93882d) Equinox: J2000	Proper Motion RA: 16.717 mas/yr Proper Motion Dec: 20.961 mas/yr Parallax: 0.0048258" Epoch of Position: 2000	

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

Added parallax manually via SIMBAD:
https://simbad.u-strasbg.fr/simbad/sim-basic?Ident=kelt-9&submit=SIMBAD+search
Category=Star
Description=[A stars, Exoplanet Systems]
Extended=NO

Acquisition

#	Target	Acquisition Mode	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	1 KELT-9	SOSSFAINT	F480M	NISRAPID	3	1	1	0.202	168167

Template

Subarray	Include Short First Exposure and F277W Exposure?
SUBSTRIP96	true

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	NISRAPID	1	1	1	1	4.448	
2	NISRAPID	3	9130	1	9130	81042.262	168167
3	NISRAPID	3	10	1	10	88.765	168167

Special Requirements	Phase 0.182483 to 0.196550 with period 2.96223748 Days and zero-phase 2458955.970923 HJD Aperture PA Range 68 to 74 Degrees (V3 67.43873283 to 73.43873283) Aperture PA Range 195 to 200 Degrees (V3 194.43873283 to 199.43873283) Aperture PA Range 247 to 249 Degrees (V3 246.43873283 to 248.43873283) Time Series Observation No Parallel Attachments Sequence Observations 1, 2, Non-interruptible Same Aperture PA 1, 2

Observation

Proposal 7255, Observation 2: Phase Curve pt2 Thu Jun 05 23:00:15 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRISS Single-Object Slitless Spectroscopy

Diagnostics

(Phase Curve pt2 (Obs 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.

(Phase Curve pt2 (Obs 2)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	KELT-9	RA: 20 31 26.3534 (307.8598058d) Dec: +39 56 19.77 (39.93882d) Equinox: J2000	Proper Motion RA: 16.717 mas/yr Proper Motion Dec: 20.961 mas/yr Parallax: 0.0048258" Epoch of Position: 2000	

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

Added parallax manually via SIMBAD:
https://simbad.u-strasbg.fr/simbad/sim-basic?Ident=kelt-9&submit=SIMBAD+search
Category=Star
Description=[A stars, Exoplanet Systems]
Extended=NO

Acquisition

#	Target	Acquisition Mode	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	1 KELT-9	SOSSFAINT	F480M	NISRAPID	3	1	1	0.202	168167

Template

Subarray	Include Short First Exposure and F277W Exposure?
SUBSTRIP96	false

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	NISRAPID	3	8582	1	8582	76177.951	168167

Special Requirements	Time Series Observation No Parallel Attachments Sequence Observations 1, 2, Non-interruptible Same Aperture PA 1, 2