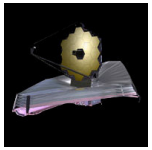

2347 - A Hell of a Phase Curve: Mapping the Surface and Atmosphere of a Lava Planet K2-141b

Cycle: 1, Proposal Category: GO

INVESTIGATORS

Name	*Institution*
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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
K2-141b				
	1	K2-141b (ph1)	MIRI Low Resolution Spectroscopy	(1) K2-141

ABSTRACT

The CoRoT, Kepler and K2 missions have revealed a new class of planet, so-called lava planets, which have bulk densities consistent with terrestrial composition, but dayside temperatures hot enough to melt—and vaporize—rock. Of these planets, the most promising candidate for atmospheric and surface characterization is K2-141b: it has a density of 8 g/cm^3, a dayside temperature measured by Spitzer to be 2125 K, and an orbital period of

6.7 hrs around a J=9 star. We propose to monitor K2-141b for three complete orbits of the planet with MIRI LRS for just under 21 hrs of time. These observations will allow us to measure the vertical atmospheric structure on the dayside of the planet via the 9 micron SiO feature, to determine the presence of an extended atmosphere via the planet's nightside temperature, and to search for rock clouds that might form as the supersonic winds blowing towards the nightside cool and condense. JWST is uniquely suited to detect SiO in emission spectra of lava planets and MIRI LRS is the only instrument able to probe low nightside planetary temperatures to place stringent constraints on the presence of a global atmosphere. The combination of the strong signal expected from K2-141b and the large contrast at long wavelengths, makes MIRI LRS observations of K2-141b the approach for testing theories of cloud formation in a fully condensable atmosphere, and testing atmospheric loss on the extreme scenario of a planet skimming its star's corona.

OBSERVING DESCRIPTION

We propose to observe K2-141b (J=9) with MIRI LRS continuously for 3 full-orbit phase curves bringing the total science time requested to around 20.5 hours and a total charged time just under 25 hours. We will use the F1500W filter with the FAST readout mode to perform target acquisition. With 4 groups per integration, this bring the total target acquisition time to a negligible 0.64 s. The MIRI LRS uses the FAST mode to read the SLITLESSPRISM subarray for its slitless time-series observations. We used pandexo to simulate JWST observations and to find the optimal maximum possible number of groups before saturation of the detector. Our proposed observations have the following configuration: N_group = 41 per integration with 7 seconds integrations for a total of 11359 integrations resulting in a total data volume of 36836 MB.

We request that our observations do not start within 30 minutes of a transit or eclipse, hence between orbital phases theta = [0.15-0.35] or [0.65-0.85]. Additionally, the K2-141 system includes a 7.7 days period outer planet, K2-141c. We request that our observations occur outside of the 1-hour transit and eclipse of K2-141c, which still leaves two 90 hours windows per orbital period of planet c.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	K2-141	RA: 23 23 40.0911 (350.9170462d) Dec: -01 11 21.06 (-1.18918d) Equinox: J2000	Proper Motion RA: 0.007746201713892242 sec of time/yr Proper Motion Dec: 0.025358000000000002 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, K stars]

Observation

Proposal 2347, Observation 1: K2-141b (ph1)

Mon Feb 27 15:03:06 GMT 2023

Diagnostic Status: Warning

Observing Template: MIRI Low Resolution Spectroscopy

Diagnostics

(K2-141b (ph1) (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.

(K2-141b (ph1) (Obs 1)) Warning (Form): Groups/Int cannot be 1, Groups/Int = 2 requires permission and Groups/Int of 3-4 is allowed but not recommended.

(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)	K2-141	RA: 23 23 40.0911 (350.9170462d) Dec: -01 11 21.06 (-1.18918d) Equinox: J2000	Proper Motion RA: 0.007746201713892242 sec of time/yr Proper Motion Dec: 0.025358000000000002 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, K stars]

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	1 K2-141	F1500W	FAST	4	1	1	0.636	61727.3

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	4	1	1	1	1	0.636		F1500W

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	FASTR1	41	3718	11154	3	1	74504.674	61727.3

Special Requirements

Phase 0.325 to 0.425 with period 1.1212976 Days and zero-phase 2457738.46540 HJD
Time Series Observation
No Parallel Attachments
No Parallel Attachments