



2159 - The first near-infrared spectroscopic phase-curve of a super-Earth

Cycle: 1, Proposal Category: GO

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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	K2-141 phase curve	NIRSpec Bright Object Time Series	(1) K2-141

ABSTRACT

The relatively rare sub-population of the so-called ultra-short period ($P < 1$ day) rocky planets offers a unique opportunity for atmospheric characterization studies. Given the large amount of stellar irradiation these planets are bombarded with, they are expected to have lost their primordial atmospheres giving rise to thin or thick (i.e., low or high pressure) outgassed, exotic Na, O or SiO-rich atmospheres. Characterizing the surfaces and/or atmospheres of these highly irradiated rocky worlds, thus, provides a window to explore exciting atmospheric and/or surface compositions which might be completely different to the ones observed in our Solar System. Motivated by these fascinating prospects, here we propose to constrain the atmosphere of the ultra-short period (6.9-hour; $T_{eq} = 2150$ K) transiting super-Earth K2-141b ($R_p = 1.51 R_{Earth}$; $M_p = 5.08 M_{Earth}$) through a spectroscopic phase-curve observation with the James Webb Space Telescope. Our program, which will allow us to directly detect the thermal emission of this exoplanet as a function of both orbital phase and wavelength, will provide precious insights into its atmospheric and/or geological properties, which will serve as a strong leverage for future studies and characterization efforts of highly-irradiated super-Earths.

OBSERVING DESCRIPTION

Our science observations are composed of a 11.92-hour long NIRSpec/BOTS Time Series Observation (TSO) exposure of 4317 integrations, having 10 groups per integration. These observations aim at obtaining the flux of an exoplanet through an entire orbital period around its host star, targeting in the process two secondary eclipses and one primary transit. The first 2.72 hours are expected to be spent as pre-eclipse baseline (which accounts also for uncertainties on the projected ephemerides for the exoplanet in the October-December 2022 range), followed by 0.47 hours spent going through mid-eclipse. Then, 6.73 hours (the orbital period of the exoplanet) will be spent sampling the phase-curve, and 0.47 extra hours will be spent sampling the end of the second secondary eclipse. Finally, 2 hours are added for both, post-eclipse baseline and to account for the phase-constraint 1-hour window. These observations will be obtained with the G395H grating, and the 2048 subarray with the NRSRAPID readout mode in order to obtain the entire wavelength range offered by the grating; these should use the S1600A1 slit.

The TSO exposure is preceded by a Target Acquisition exposure on the star 2MASS J23233859-0110575, which is 32 arcseconds away from our target and is sufficiently faint for the purpose of obtaining a WATA observing sequence with the NRSRAPID readout mode as well. With a single integration of 3 groups, the expected signal-to-noise ratio of this exposure is above 40, which is adequate for proper centroiding.

Updates on September, 2021:

- Ephemerides have been updated using a joint K2+Spitzer fit to the orbit of the exoplanet. The period is 6.7277985 and the time of secondary eclipse is 2457744.21168.

- In order to work around an APT bug, the phase-constraint was modified so that we only target one every 3 eclipses in the scheduler. In order for the observations to start 2.72 before mid-eclipse time, we set the phase-constraint range to be 0.8156-0.8652 which defines a 1-hour window for the event to start.

Proposal 2159 - Targets - The first near-infrared spectroscopic phase-curve of a super-Earth

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	K2-141	RA: 23 23 40.0950 (350.9170625d) Dec: -01 11 21.05 (-1.18918d) Equinox: J2000	Proper Motion RA: 116.32476036497832 mas/yr Proper Motion Dec: 25.21354227268836 mas/yr Parallax: 0.01613029393685726" Epoch of Position: 2016	
Fixed Targets	<i>Comments: Coordinates, proper motion and parallax updated using the Gaia DR3 data via https://gea.esac.esa.int/archive/ (Source ID: 2643952940813536768)</i> Category=Star Description=[K dwarfs, K stars] Extended=NO			
	(2)	23233859-0110575	RA: 23 23 38.6927 (350.9112196d) Dec: -01 10 57.94 (-1.18276d) Equinox: J2000	Proper Motion RA: 83.88302791173913 mas/yr Proper Motion Dec: -19.23111215172356 mas/yr Parallax: 0.0055644062638565625" Epoch of Position: 2016
<i>Comments: Data for the star was updated using Gaia DR3 via https://gea.esac.esa.int/archive/ (Source ID for this target is 2643953142676887808). This also confirms photometrically the star to be a 3200 K M-dwarf.</i> Category=Star Description=[M stars] Extended=NO				

Proposal 2159 - Observation 1 - The first near-infrared spectroscopic phase-curve of a super-Earth

Tue Jun 27 23:00:32 GMT 2023

Observation	<p>Proposal 2159, Observation 1: K2-141 phase curve</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRSpec Bright Object Time Series</p>																															
Diagnostics	<p>(K2-141 phase curve (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.</p> <p>(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.</p>																															
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Spectral Elements	<table border="1"> <thead> <tr> <th>#</th> <th>Grating/Filter</th> <th>Readout Pattern</th> <th>Groups/Int</th> <th>Integrations/Exp</th> <th>Exposures/Dith</th> <th>Total Dithers</th> <th>Total Integrations</th> <th>Total Exposure Time</th> <th>ETC Wkbk.Calc ID</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>G395H/F290LP</td> <td>NRSRAPID</td> <td>10</td> <td>4317</td> <td>1</td> <td>1</td> <td>4317</td> <td>42921.686</td> <td></td> </tr> </tbody> </table>										#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID	1	G395H/F290LP	NRSRAPID	10	4317	1	1	4317	42921.686			
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Special Requirements	<p>Phase 0.8156 to 0.8652 with period 20.1833955 Hours and zero-phase 2457744.21168 HJD</p> <p>Time Series Observation</p> <p>No Parallel Attachments</p>																															