



3860 - Phase Curve Observations of TOI-561 b To Study Atmosphere-Interior Exchange

Cycle: 2, 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	toi561_phasecurve1	NIRSpec Bright Object Time Series	(1) TOI-561

ABSTRACT

Ultra-short period (USP) planets, with radii $< 2 R_{\text{Earth}}$ and periods < 1 day, are a rare but very valuable planet class that can provide a glimpse at the surface compositions of worlds outside our Solar System. Most USP planets appear ~uniform in their bulk densities, consistent with Earth-like compositions, and half of those with phase curve observations appear to be bare rocks. However, not all USP planets are consistent with the bare rock

picture, and whether such planets can host secondary atmospheres of evaporating silicates or outgassed volatiles – giving us a glimpse of what is below the surface – is still an open question. Here we propose to observe a spectroscopic phase curve of the lowest density USP planet yet detected, TOI-561 b, which orbits around an old, metal-poor thick disk star. Our JWST NIRSpec/G395H observations will constrain whether this planet has an atmosphere at all, and if so, the composition of that atmosphere as a function of depth, targeting key features of SiO, CO₂, CO, and H₂O. Only with JWST observations can the composition of this planet be resolved. Our findings will help elucidate the formation story of under-dense USP planets and connect small planet atmospheric to interior compositions, an important factor in studies of climate evolution of rocky exoplanets.

OBSERVING DESCRIPTION

We propose to observe TOI-561b (J=8.879) with NIRSpec/BOTS continuously for 4 full-orbit phase curves bringing the total science time requested to ~32 hours and a total charged time to ~44 hours. For target acquisition there were no feasible nearby TA stars, so we selected NONE and will rely on the JWST pointing accuracy and the accuracy of our target coordinates (it is in Gaia DR3).

For science observations, we will use the G395H grating, F290LP filter, and SUB2048 subarray (with NRSRPAID) readout to cover ~3-5 microns, with 6 groups per integration and 21228 integrations per exposure. We used PandExo to simulate JWST observations and the ExoCTK Groups and Integrations Calculator to calculate the optimal groups and integrations for our observation; we then modified the groups in the JWST ETC to avoid saturation.

This planet has an ultra-short period of 0.44 days, meaning there are numerous observation opportunities within each of several long JWST visibility windows throughout the year. We have set the phase constraints to allow for a range of 60 minutes for the JWST observation start window for ease of scheduling. We anticipate needing to discard a maximum of 0.75 hours of data at the start of the observation due to detector settling effects which result in a ramp-like increase in the flux measured, which would be unusable in our analysis. Thus we have set the phase constraints to start no later than 1.75 hours before the first eclipse, and also at least ~45 min post-eclipse baseline. We will cover 4 eclipses and 3 transits. Additionally, the TOI-561 system includes three other transiting planets with orbital periods of 10.77, 25.62, and 77.23 days. We request that our observations occur outside of the transits and eclipses of these other planets (which last 3.77, 4.85, and 6.96 hours, respectively)

Proposal 3860 - Targets - Phase Curve Observations of TOI-561 b To Study Atmosphere-Interior Exchange

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(1)	TOI-561	RA: 09 52 44.4364 (148.1851517d) Dec: +06 12 57.97 (6.21610d) Equinox: J2000	Proper Motion RA: -0.007276380963308157 sec of time/yr Proper Motion Dec: -0.06127900010142184 arcsec/yr Epoch of Position: 2015.5	
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> Category=Star Description=[Exoplanet Systems] Extended=NO					

Proposal 3860 - Observation 1 - Phase Curve Observations of TOI-561 b To Study Atmosphere-Interior Exchange

Thu May 11 12:03:26 GMT 2023

Observation	<p>Proposal 3860, Observation 1: toi561_phasecurve1</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRSpec Bright Object Time Series</p> <p><i>Comments: We followed the diagnostic browser recommendation to avoid an error due to scheduling duration, and divided our phase components by 4 and multiplied our orbital period by 4. There was not an available TA star in the visit splitting distance, so we are using TA Method = NONE per the recommendation from Nikolay Nikolov (INC0186235 in JWST Help Desk).</i></p>									
Diagnostics	<p>(toi561_phasecurve1 (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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	<p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i></p> <p>Category=Star Description=[Exoplanet Systems] Extended=NO</p>									
Template	TA Method					Subarray				
	NONE					SUB2048				
Spectral Elements	#	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	6	21228	1	1	21228	134468.341	138759.18
Special Requirements	<p>Phase 0.045376713 to 0.068702708875896 with period 1.786276 Days and zero-phase 2459317.7498 HJD</p> <p>Time Series Observation</p> <p>No Parallel Attachments</p>									