



# 11302 - Sunsets on Tatooine: Characterising the First Circumbinary Planet

## Atmosphere

Cycle: 5, Proposal Category: GO

### INVESTIGATORS

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Dr. Matthew Standing (CoI) (ESA Member)	European Space Agency - ESTEC
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Dr. Benjamin Rackham (CoI)	Massachusetts Institute of Technology
Prof. Julien de Wit (CoI) (US Admin CoI)	Massachusetts Institute of Technology
Tristan Guillot (CoI) (ESA Member)	Observatoire de la Cote d'Azur

### OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Observation Folder				
	1	Transit Across Primary Star	NIRSpec Bright Object Time Series	(1) TOI-1338
	2	Transit Across Secondary Star	NIRSpec Bright Object Time Series	(1) TOI-1338
	3	Secondary Eclipse	NIRSpec Bright Object Time Series	(1) TOI-1338

## **ABSTRACT**

Circumbinary exoplanet systems have a uniquely compelling geometry. As the planets orbit two stars at once, the central binary disrupts the protoplanetary disc during formation, preventing planets from forming in-situ. This means that one of the big questions about planet formation - migration or in-situ formation - is completely eliminated for circumbinary planets. This makes them the most exciting laboratories to search for formation footprints in their atmospheres, and study the effects of binarity on planet composition.

The atmosphere of a circumbinary planet has never been detected because it has never yet been feasible. This proposal aims to carry out an atmospheric reconnaissance investigation of the only circumbinary planet currently transiting a bright enough host, with the only telescope capable of detecting its atmosphere. We propose to observe TOI-1338b, a 'super-puff' circumbinary planet on a 95 day orbit. We will obtain two full transits, one across the primary star and one across the secondary star, as well as a secondary eclipse of the central binary. This secondary eclipse is observed as close as possible to the transit epoch to enable us to precisely measure the flux contribution of the secondary star, and determine its imprint on the planet's transmission spectrum. Cycle 5 has a unique opportunity to fully observe all three events in under 50 hours, and this will not occur again until the 2030s.

This pioneering program will allow us to characterise the first circumbinary atmosphere. We will constrain molecular abundances, measure its metallicity, and potentially detect ammonia in a transiting exoplanet atmosphere for the first time.

## **OBSERVING DESCRIPTION**

We will use NIRSpec in Bright Object Time Series (BOTS) Mode with the S1600A1 1.6"×1.6" slit to obtain 40 hours of observation of our target TOI-1338. This is divided across three observations, with one visit each. TOI-1338 is a relatively bright,  $K_{mag}=10.6$ , target dominated by the spectrum of the F8 primary star, therefore to minimise saturation of the detector at short wavelengths we will use the SUB512 subarray in NRSRAPID mode obtaining 3 groups per integration. We will observe a transit across the primary star, a transit across the secondary star, and a secondary eclipse of the binary. For the primary transit observation, this results in a total of 79,298 integrations which we split into two exposures each consisting of 39,649 integrations, taken in a continuous sequence. For the secondary transit, we request one exposure with 22,140 integrations, and for the secondary eclipse, one exposure with 53,017 integrations.

To include an adequate baseline, the primary transit observation should begin between BJD 2461307.704 and BJD 2461307.746, and end between BJD 2461308.536 and BJD 2461308.577. The secondary transit observation should begin between BJD 2461308.583 and BJD 2461308.625, and end

## JWST Proposal 11302 (Created: Friday, March 13, 2026, 4:03:54PM Eastern Standard Time) - Overview

between BJD 2461308.815 and BJD 2461308.856. The secondary eclipse observation should begin between BJD 2461308.768 and BJD 2461308.809, and end between BJD 2461309.323 and BJD 2461309.364. Due to the timings of the secondary transit and secondary eclipse they can be observed in a single sequence, which would total 75,157 integrations and should be split into two consecutive exposures.

These observations will provide coverage of the eclipse and transits of TOI-1338b in a circumbinary system with three observations totaling 39.7 hours of requested time, with 29.2 hours of science time and a total of 49.1 hours of charged time calculated in the Astronomer's Proposal Tool.

We will perform target acquisition on our target star using the F110W filter and SUB32 subarray with 3 groups/integration for a single integration. This saturates a single pixel on the detector which does not impact the observation.

We have provided some flexibility on when the transit observations can begin and end, but require specific times rather than a phase because the presence of the central binary significantly alters the transit timings.

# Proposal 11302 - Targets - Sunsets on Tatooine: Characterising the First Circumbinary Planet Atmosphere

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(1)	TOI-1338	RA: 06 08 31.9675 (92.1331979d) Dec: -59 32 28.08 (-59.54113d) Equinox: J2000	Proper Motion RA: -12.057 mas/yr Proper Motion Dec: 34.513 mas/yr Parallax: 0.0024752" Epoch of Position: 2000	
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>					
<i>SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.</i>					
<i>Category=Star</i>					
<i>Description=[Eclipsing binary stars, Exoplanets]</i>					

Proposal 11302 - Observation 1 - Sunsets on Tatoonie: Characterising the First Circumbinary Planet Atmosphere

Fri Mar 13 21:03:54 GMT 2026

<b>Observation</b>	<p><b>Proposal 11302, Observation 1: Transit Across Primary Star</b></p> <p><b>Diagnostic Status: Warning</b></p> <p>Observing Template: NIRSpec Bright Object Time Series</p> <p><i>Comments: Transit of the planet across the primary star. Transit mid-time of this event is at BJD = 2461308.180. Transit window should begin between BJD = 2461307.704 and BJD = 2461307.746. The transit window should end between BJD = 2461308.536 and BJD =2461308.577.</i></p>																															
	<p>(Transit Across Primary Star (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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Proposal 11302 - Observation 1 - Sunsets on Tatooine: Characterising the First Circumbinary Planet Atmosphere

Special Requirements

Between Dates 24-SEP-2026:04:53:45 and 24-SEP-2026:05:54:14  
Time Series Observation  
No Parallel Attachments

# Proposal 11302 - Observation 2 - Sunsets on Tatooine: Characterising the First Circumbinary Planet Atmosphere

Fri Mar 13 21:03:54 GMT 2026

<b>Observation</b>	<b>Proposal 11302, Observation 2: Transit Across Secondary Star</b> <b>Diagnostic Status: Warning</b> Observing Template: NIRSpec Bright Object Time Series <i>Comments: Transit of the planet across the secondary star. Transit mid-time of this event is at BJD = 2461308.740. Transit window should begin between BJD = 2461308.583 and BJD = 2461308.625. The transit window should end between BJD = 2461308.815 and BJD = 2461308.856.</i>																															
	(Transit Across Secondary Star (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.																															
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## Proposal 11302 - Observation 2 - Sunsets on Tatooine: Characterising the First Circumbinary Planet Atmosphere

### Special Requirements

Between Dates 25-SEP-2026:01:59:31 and 25-SEP-2026:03:00:00  
Time Series Observation  
No Parallel Attachments

Proposal 11302 - Observation 3 - Sunsets on Tatoonie: Characterising the First Circumbinary Planet Atmosphere

Fri Mar 13 21:03:54 GMT 2026

<b>Observation</b>	<p><b>Proposal 11302, Observation 3: Secondary Eclipse</b></p> <p><b>Diagnostic Status: Warning</b></p> <p>Observing Template: NIRSpec Bright Object Time Series</p> <p><i>Comments: Secondary eclipse of the binary. Eclipse mid-time of this event is at BJD = 2461308.983. Transit window should begin between BJD = 2461308.768 and BJD = 2461308.809. Transit window should end between BJD = 2461309.323 and BJD = 2461309.364.</i></p>																															
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Proposal 11302 - Observation 3 - Sunsets on Tatooine: Characterising the First Circumbinary Planet Atmosphere

Special Requirements

Between Dates 25-SEP-2026:06:25:55 and 25-SEP-2026:07:25:55  
Time Series Observation  
No Parallel Attachments