



6045 - Detecting ongoing gas-to-solid nucleation on the ultra-hot planet WASP-76 b

Cycle: 3, Proposal Category: GO

INVESTIGATORS

<i>Name</i>	<i>Institution</i>
Robin Baeyens (PI) (ESA Member)	University of Amsterdam
Prof. Jean-Michel Desert (CoI) (ESA Member)	Universiteit van Amsterdam
Dr. James Sikora (CoI)	Lowell Observatory
Ms. Hinna Shivkumar (CoI) (ESA Member)	University of Amsterdam
Mr. Saugata Barat (CoI) (ESA Member)	University of Amsterdam
Leen Decin (CoI) (ESA Member)	Institute of Astronomy, KU Leuven
Christiane Helling (CoI) (ESA Member)	Space Research Institute, Austrian Academy of Sciences
Helena Lecoq-Molinos (CoI) (ESA Member)	Space Research Institute, Austrian Academy of Sciences
Dr. David Gobrecht (CoI) (ESA Member)	Goteburg University, Chalmers Technical University
Jan Philip Sindel (CoI) (ESA Member)	Space Research Institute, Austrian Academy of Sciences
Mr. Arjun Baliga Savel (CoI)	University of Maryland
Prof. Eliza M.-R. Kempton (CoI) (US Admin CoI)	University of Maryland
Dr. Andrew Vanderburg (CoI)	Massachusetts Institute of Technology

OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Observation Folder				
	1	WASP-76b	MIRI Low Resolution Spectroscopy	(1) BD+01-316
	2	Background exposure	MIRI Low Resolution Spectroscopy	(2) Background

ABSTRACT

Nucleation, the process of single molecules clustering together to form a macroscopic particle, is an ill-understood but crucial process to a range of astrophysical environments. Nucleation is a necessary condition for cloud formation in hot, fully gaseous media, such as exoplanet and brown dwarf

atmospheres. Additionally, nucleation and subsequently circumstellar dust formation is the driving factor of stellar outflows.

We propose to measure the mid-infrared transmission spectrum of the ultra-hot gas giant WASP-76 b using MIRI/LRS, with the aim of observing ongoing nucleation for the first time on an exoplanet. We target the smallest and most refractory clusters (Al₂O₃)_N and (TiO₂)_N, which represent the first steps in the high-temperature transition from gaseous to solid material. New quantum-chemistry studies demonstrate that these clusters have detectable spectroscopic features in the MIRI wavelength range, and observations of WASP-76 b have shown evidence for ongoing condensation. Confirming the presence of these species on WASP-76 b would provide an explanation for the anomalous titanium and aluminium depletions that have been inferred on this planet, and constraining their abundances will be crucial for our understanding of how astrophysical solids grow and evolve.

OBSERVING DESCRIPTION

We request to observe a single transit of WASP-76 b with MIRI/LRS in slitless observing mode. The wavelength range is 5 to 14 micron.

The transit duration of WASP-76 b is 3.694 hours and we require an out-of-transit baseline observation of equal duration, with 30 additional minutes of instrument settling time. This amounts to a total observation request (not including overheads) of 7.89 hours.

The proposed observations will use the SLITLESSPRISM subarray and the FASTR1 readout pattern, using 25 groups per integration.

For Target Acquisition, we will use WASP-76 itself with the F560W filter, 4 groups, and the FAST readout pattern.

The requested observation would yield the first observation of WASP-76 b with any JWST instrument.

Proposal 6045 - Targets - Detecting ongoing gas-to-solid nucleation on the ultra-hot planet WASP-76 b

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(1)	BD+01-316	RA: 01 46 31.8576 (26.6327400d) Dec: +02 42 2.03 (2.70056d) Equinox: J2000	Proper Motion RA: 45.531 mas/yr Proper Motion Dec: -40.59300003973476 mas/yr Epoch of Position: 2000	
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>					
<i>Category=Star</i>					
<i>Description=[Exoplanet Systems, Exoplanets]</i>					
(2)	Background	RA: 01 46 33.8576 (26.6410733d) Dec: +02 41 2.03 (2.68390d) Equinox: J2000			
<i>Comments: Sky background to be taken at end of observation #1</i>					
<i>Category=Calibration</i>					
<i>Description=[Telescope/sky background]</i>					
<i>Extended=YES</i>					

Proposal 6045 - Observation 1 - Detecting ongoing gas-to-solid nucleation on the ultra-hot planet WASP-76 b

Mon Feb 24 17:00:09 GMT 2025

Observation	Proposal 6045, Observation 1: WASP-76b Diagnostic Status: Warning Observing Template: MIRI Low Resolution Spectroscopy Background Observations:[Background exposure (Obs 2)]																												
	(WASP-76b (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.																												
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	SLITLESSPRISM				true																								
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Proposal 6045 - Observation 1 - Detecting ongoing gas-to-solid nucleation on the ultra-hot planet WASP-76 b

Spectral Elements	#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
	Special Requirements	1	FASTR1	25	6868	6868	1	1	28399.296
Phase -0.108055 to -0.085033 with period 1.80988452 Days and zero-phase 2459371.069659127 HJD Time Series Observation No Parallel Attachments Sequence Observations 1, 2, Non-interruptible									

Proposal 6045 - Observation 2 - Detecting ongoing gas-to-solid nucleation on the ultra-hot planet WASP-76 b

Mon Feb 24 17:00:09 GMT 2025

Observation	Proposal 6045, Observation 2: Background exposure Diagnostic Status: Warning Observing Template: MIRI Low Resolution Spectroscopy Background Observation For: [WASP-76b (Obs 1)]							
Diagnostics	(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.							
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections		Miscellaneous		
	(2)	Background	RA: 01 46 33.8576 (26.6410733d) Dec: +02 41 2.03 (2.68390d) Equinox: J2000					
	Comments: Sky background to be taken at end of observation #1 Category=Calibration Description=[Telescope/sky background] Extended=YES							
Acquisition	#	Target						
	1	NONE						
Template	AcqFilter	Subarray		Obtain Verification Image?				
		SLITLESSPRISM		false				
Dithers	#	Dither Type	No. Spectral Steps	Spectral Step Offset	No. Spatial Steps	Spatial Step Offset		
	1	NONE						
Spectral Elements	#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time ETC Wkbk.Calc ID
	1	FASTR1	25	20	20	1	1	82.542

Proposal 6045 - Observation 2 - Detecting ongoing gas-to-solid nucleation on the ultra-hot planet WASP-76 b

Special Requirements

Time Series Observation
No Parallel Attachments

Sequence Observations 1, 2, Non-interruptible