



7340 - A NIRC*am* - MIRI - ALMA synergy to constrain planet formation at large orbital separations

Cycle: 4, Proposal Category: GO

INVESTIGATORS

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Dr. Laurent Pueyo (CoI)	Space Telescope Science Institute
Dr. Jane Huang (CoI)	Columbia University in the City of New York
Prof. Michael R. Meyer (CoI)	University of Michigan
Dr. Edwin Anthony Bergin (CoI)	University of Michigan
Prof. Richard Teague (CoI)	Massachusetts Institute of Technology
Julien Girard (CoI)	Space Telescope Science Institute
Dr. Polychronis Alexandros Patapis (CoI) (ESA Member)	
Dr. Per Calissendorff (CoI)	University of Michigan
Dr. Felipe Mauricio Alarcon (CoI) (ESA Member)	Universita di Milano

OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
AS209_obs				
	1	AS209_Coro	MIRI Coronagraphic Imaging	(1) EM-AS-209
	2	AS209_Coro	MIRI Coronagraphic Imaging	(1) EM-AS-209
	4	AS209_BACKGROUND	MIRI Coronagraphic Imaging	(2) EM-AS-209-BACKGROUND

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
	3	Ref - Coro	MIRI Coronagraphic Imaging	(6) -24-Sco
	5	Background - Ref	MIRI Coronagraphic Imaging	(7) Ref-BACKGROUND

ABSTRACT

Observations of different tracers by ALMA reveal striking evidence for the presence of one protoplanet candidate in the outer disk of AS 209, with both kinematic and chemical localised signatures of a massive accreting body. Available Cycle 1 JWST/NIRCam data do not detect thermal emission from the putative protoplanet, suggesting that the planet is either cold, or that radiative reprocessing by circumstellar and circumplanetary dust is still significant at 4.1 μm . We propose to observe the AS 209 system with the MIRI coronagraphic instrument at 10.6 μm to reach the following goals: a) confirm or discard the protoplanet nature of the candidate; b) mark the initial steps in discerning different planet formation models; c) empirically determine a correlation between the luminosity of growing protoplanets and chemical hotspots in a disk; d) benchmark kinematic searches of protoplanets. In synergy with the ALMA data, the proposed JWST/MIRI observations will provide the sorely needed proof of the strong connection between small anomalies in the gas kinematics and chemical properties in a protoplanetary disk and an embedded forming planet. Additionally, comparative observations in both the NIR and the MIR regimes will clarify the wavelength range where the SED of embedded protoplanets affected by circumplanetary dust peaks. The comparison of the NIRCam and MIRI observations will also be crucial in informing on the best strategy to observe protoplanets in disks in the next JWST cycles.

OBSERVING DESCRIPTION

Here, we aim to directly detect the protoplanet candidate embedded in the protoplanetary disk surrounding AS209. Based on previous ALMA detections with different tracers (^{13}CO , HCO^+ , H_2CO), the planet has been identified 1.4" ~south of the star. These proposed MIRI observations have been designed to detect a very cold ($\sim 300\text{-}500\text{ K}$) and extincted ($A_v=40\text{ mag}$) objects at a 5 sigma significance in only ~ 2 hours of on-source time. The observations will be compared to the ancillary NIRCam non-detection at 4 micron to provide first constraints of the planet luminosity and extinction from circumplanetary dust. We plan to use the 4-quadrant-phase-mask coronagraph coupled to the F1065C filter to reach the highest possible contrast.

Also, we plan to observe the reference star HD 150922, which was chosen because of its vicinity to the target and its brightness. For reference star observations we plan to use the 9-POINT-SMALL-GRID dithering to maximize the achieved contrast, crucial to detect the planet.

We include a background observation of both science target and reference star to mitigate the glow-stick effect. We perform the background observations in two opposite quadrants, following the specific guidelines by STScI for Cycle 4 for our requested observing mode.

Proposal 7340 - Targets - A NIRCam - MIRI - ALMA synergy to constrain planet formation at large orbital separations

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	EM-AS-209	RA: 16 49 15.2956 (252.3137317d) Dec: -14 22 9.01 (-14.36917d) Equinox: J2000	Proper Motion RA: -5.069248789722364E-4 sec of time/yr Proper Motion Dec: -0.02365800007737562 arcsec/yr Epoch of Position: 2015.5	
<p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> <i>Category=Star</i> <i>Description=[K stars, Pre-main sequence stars, Protoplanetary disks]</i></p>				
(2)	EM-AS-209-BACKGROUND	RA: 16 44 13.4100 (251.0558750d) Dec: -16 36 48.80 (-16.61356d) Equinox: J2000		
<p><i>Comments: Background observations to correct for glow sticks</i> <i>Category=Calibration</i> <i>Description=[Coronagraphic]</i></p>				
(6)	-24-Sco	RA: 16 41 34.3835 (250.3932646d) Dec: -17 44 31.80 (-17.74217d) Equinox: J2000	Proper Motion RA: -21.145 mas/yr Proper Motion Dec: -1.5719999510110938 mas/yr Parallax: 0.0084818" Epoch of Position: 2000	
<p><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=[G stars]</i> <i>Extended=NO</i></p>				
(7)	Ref-BACKGROUND	RA: 16 44 13.4100 (251.0558750d) Dec: -16 36 48.80 (-16.61356d) Equinox: J2000		
<p><i>Comments: Background observations to correct for glow sticks</i> <i>Category=Calibration</i> <i>Description=[Coronagraphic]</i></p>				

Fixed Targets

Proposal 7340 - Observation 1 - A NIRCcam - MIRI - ALMA synergy to constrain planet formation at large orbital separations

Thu Jun 12 16:00:16 GMT 2025

Observation	Proposal 7340, Observation 1: AS209_Coro Diagnostic Status: Warning Observing Template: MIRI Coronagraphic Imaging Background Observations:[AS209_Coro (Obs 2), AS209_BACKGROUND (Obs 4)]																																					
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Dithers	#																																					
	1 Dither Type: NONE																																					
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PSF References	Ref - Coro (Obs 3) (PSF Reference; Filters [F1065C])																																					
	Additional Justification: false																																					

Proposal 7340 - Observation 1 - A NIRCcam - MIRI - ALMA synergy to constrain planet formation at large orbital separations

Special Requirements

Aperture PA Range 96.6 to 116.77 Degrees (V3 91.76455103 to 111.93455103)
Aperture PA Range 274.0 to 287.0 Degrees (V3 269.16455103 to 282.16455103)
No Parallel Attachments

Sequence Observations 1, 2, 3, 4, 5, Non-interruptible
Aperture PA Offset 1 from 2 by 10 to 14 Degrees (Same offsets in V3)

Proposal 7340 - Observation 2 - A NIRCam - MIRI - ALMA synergy to constrain planet formation at large orbital separations

Thu Jun 12 16:00:16 GMT 2025

Observation	<p>Proposal 7340, Observation 2: AS209_Coro</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: MIRI Coronagraphic Imaging</p> <p>Background Observations:[AS209_Coro (Obs 1), AS209_BACKGROUND (Obs 4)]</p>																																					
Diagnostics	<p>(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.</p> <p>(AS209_Coro (Obs 2)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.</p>																																					
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PSF References	<p>Ref - Coro (Obs 3) (PSF Reference; Filters [F1065C])</p> <p>Additional Justification: false</p>																																					

Proposal 7340 - Observation 2 - A NIRCam - MIRI - ALMA synergy to constrain planet formation at large orbital separations

Special Requirements

Aperture PA Range 96.6 to 116.77 Degrees (V3 91.76455103 to 111.93455103)
Aperture PA Range 274.0 to 287.0 Degrees (V3 269.16455103 to 282.16455103)
No Parallel Attachments

Sequence Observations 1, 2, 3, 4, 5, Non-interruptible
Aperture PA Offset 1 from 2 by 10 to 14 Degrees (Same offsets in V3)

Proposal 7340 - Observation 4 - A NIRCam - MIRI - ALMA synergy to constrain planet formation at large orbital separations

Thu Jun 12 16:00:16 GMT 2025

Observation	Proposal 7340, Observation 4: AS209_BACKGROUND Diagnostic Status: Warning Observing Template: MIRI Coronagraphic Imaging Background Observation For: [AS209_Coro (Obs 1), AS209_Coro (Obs 2)]												
	(Visit 4:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.												
Fixed Targets	#	Name	Target Coordinates				Targ. Coord. Corrections			Miscellaneous			
	(2)	EM-AS-209-BACKGROUND	RA: 16 44 13.4100 (251.0558750d) Dec: -16 36 48.80 (-16.61356d) Equinox: J2000 <i>Comments: Background observations to correct for glow sticks</i> <i>Category=Calibration</i> <i>Description=[Coronagraphic]</i>										
Acquisition	#	Target											
	1	NONE											
Template	AcqFilter	Repeat observation				Background Quadrant							
		YES				1							
Dithers	#	Dither Type											
	1	BACKGROUND											
Spectral Elements	#	Coron Mask/Filter	Subarray	Mask	Filter	Readout Pattern	Groups/Int	Integrations/E xp	Exposures/Dit h	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	4QPM/F1065C	MASK1065	4QPM	F1065C	FASTR1	500	30	1	2	60	7204.301	
PSF References	Additional Justification: false												

Proposal 7340 - Observation 4 - A NIRCam - MIRI - ALMA synergy to constrain planet formation at large orbital separations

Special Requirements

No Parallel Attachments

Sequence Observations 1, 2, 3, 4, 5, Non-interruptible

Proposal 7340 - Observation 3 - A NIRCam - MIRI - ALMA synergy to constrain planet formation at large orbital separations

Thu Jun 12 16:00:16 GMT 2025

Observation	Proposal 7340, Observation 3: Ref - Coro Diagnostic Status: Warning Observing Template: MIRI Coronagraphic Imaging Background Observations:[Background - Ref (Obs 5)]																																					
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Proposal 7340 - Observation 3 - A NIRCam - MIRI - ALMA synergy to constrain planet formation at large orbital separations

PSF References	PSF Reference: true
Special Requirements	No Parallel Attachments Sequence Observations 1, 2, 3, 4, 5, Non-interruptible

Proposal 7340 - Observation 5 - A NIRCam - MIRI - ALMA synergy to constrain planet formation at large orbital separations

Thu Jun 12 16:00:17 GMT 2025

Observation	Proposal 7340, Observation 5: Background - Ref Diagnostic Status: Warning Observing Template: MIRI Coronagraphic Imaging Background Observation For: [Ref - Coro (Obs 3)]												
	(Visit 5:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.												
Fixed Targets	#	Name	Target Coordinates				Targ. Coord. Corrections			Miscellaneous			
	(7)	Ref-BACKGROUND	RA: 16 44 13.4100 (251.0558750d) Dec: -16 36 48.80 (-16.61356d) Equinox: J2000 <i>Comments: Background observations to correct for glow sticks</i> <i>Category=Calibration</i> <i>Description=[Coronagraphic]</i>										
Acquisition	#	Target											
	1	NONE											
Template	AcqFilter	Repeat observation				Background Quadrant							
		YES				1							
Dithers	#	Dither Type											
	1	BACKGROUND											
Spectral Elements	#	Coron Mask/Filter	Subarray	Mask	Filter	Readout Pattern	Groups/Int	Integrations/E xp	Exposures/Dit h	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	4QPM/F1065C	MASK1065	4QPM	F1065C	FASTR1	500	3	1	2	6	719.999	
PSF References	Additional Justification: false												

Proposal 7340 - Observation 5 - A NIRCam - MIRI - ALMA synergy to constrain planet formation at large orbital separations

Special Requirements

No Parallel Attachments

Sequence Observations 1, 2, 3, 4, 5, Non-interruptible