



5261 - Confirming the youngest gap-opening protoplanet undergoing runaway gas accretion

Cycle: 3, 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>
MWC 480				
	1	SW_Pa_alpha	NIRCam Coronagraphic Imaging	(1) MWC480
	2	SW_cont	NIRCam Coronagraphic Imaging	(1) MWC480
	3	PSF_calibrator_Pa_alpha	NIRCam Coronagraphic Imaging	(2) HD31234
	4	PSF_calibrator_cont	NIRCam Coronagraphic Imaging	(2) HD31234

ABSTRACT

We propose to confirm an accreting protoplanet candidate in MWC 480 disk. This candidate has been recently detected with Subaru SCExAO/VAMPIRES H-alpha imaging observations. Situated within a prominent dust continuum gap $\sim 0.4''$ from the host, this candidate spatially coincides with a group of carbon-rich molecular line-emission rings observed by ALMA. These configurations are consistent with the chemical footprint of a hot accreting planet, which triggers the release of C-rich ice into the gas phase inside the dust gap.

To independently confirm this candidate, we propose to observe the Pa-alpha emission line from the accreting planet / circumplanetary disk with the F187N filter and M210R mask on NIRCam. This is a unique target for this scientific case, and JWST is the only facility capable of measuring the Pa-alpha emission which ground-based facilities cannot due to the opaque atmosphere.

Successful confirmation of the planet will mark a unique detection of a gap-opening protoplanet still undergoing the so-called runaway gas accretion. This is different from the previously detected 'low' accreting super Jupiter protoplanets in the large cavity of PDS 70, which will put the candidate robustly as the youngest planet that can be directly detected. It would present as a Rosetta stone to guide observational studies and vastly improve our theoretical understanding of giant planet formation and planet-disk interactions.

OBSERVING DESCRIPTION

JWST Proposal 5261 (Created: Wednesday, January 8, 2025, 9:00:09AM Eastern Standard Time) - Overview

This program aims to validate the presence of a protoplanet candidate within MWC 480, by re-detecting the planetary accretion signal through the Pa-alpha line. This unique scientific task can only be accomplished using the F187N filter on NIRCcam, an exclusive capability provided by JWST.

We will take NIRCcam coronagraphic observations with the F187N filters to observe the Pa-alpha emission line from the planet and with the F182M filter to observe any potential disk feature, which enables continuum-line subtraction and ensures that we can distinguish the planet signal from the disk scatter-light feature. In order to achieve the highest throughput at the protoplanet location, and ensure coronagraphic imaging with the smallest feasible inner working angle, we will use the M210R mask. As a by-product, we will simultaneously collect F335M observations, which hold the potential to detect the thermal continuum emissions from the circumplanetary disk. The small separation of the candidate prohibits us from using 2-rolls Angular Differential Imaging. Hence, we will rely on Reference Differential Imaging to remove the starlight and reveal the planet.

The successful detection of planetary accretion line emissions from two distinct facilities will provide robust confirmation of the existence of the protoplanet. The line ratio will be used to constrain the extinction level at different wavelengths and precisely decide the mass and accretion luminosity of the candidate, these data will be fed to the giant planet formation simulation. Additionally, the potential detection of the thermal continuum will enhance our ability to refine the estimates of the circumplanetary disk's mass and size.

Proposal 5261 - Targets - Confirming the youngest gap-opening protoplanet undergoing runaway gas accretion

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(1)	MWC480	RA: 04 58 46.2656 (74.6927733d) Dec: +29 50 36.99 (29.84361d) Equinox: J2000	Proper Motion RA: 4.661 mas/yr Proper Motion Dec: -25.167999933728424 mas/yr Epoch of Position: 2000	
	<p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> <i>Category=Star</i> <i>Description=[Herbig Ae/Be stars, Protoplanetary disks, Young stellar objects]</i> <i>Extended=NO</i></p>				
(2)	HD31234	RA: 04 55 28.1350 (73.8672292d) Dec: +32 09 17.29 (32.15480d) Equinox: J2000	Proper Motion RA: 10.334 mas/yr Proper Motion Dec: -15.935000033096003 mas/yr Epoch of Position: 2000		
	<p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> <i>Category=Calibration</i> <i>Description=[A stars, Point spread function]</i> <i>Extended=NO</i></p>				

Proposal 5261 - Observation 1 - Confirming the youngest gap-opening protoplanet undergoing runaway gas accretion

Wed Jan 08 14:00:09 GMT 2025

Observation	<p>Proposal 5261, Observation 1: SW_Pa_alpha</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRCcam Coronagraphic Imaging</p>									
	<p>(SW_Pa_alpha (Obs 1)) Warning (Form): Science observations should be linked to at least one other compatible science observation by an Aperture PA Offset of 1-14 degrees</p> <p>(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.</p>									
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections			Miscellaneous		
	(1)	MWC480	RA: 04 58 46.2656 (74.6927733d) Dec: +29 50 36.99 (29.84361d) Equinox: J2000		Proper Motion RA: 4.661 mas/yr Proper Motion Dec: -25.167999933728424 mas/yr Epoch of Position: 2000					
<p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i></p> <p><i>Category=Star</i></p> <p><i>Description=[Herbig Ae/Be stars, Protoplanetary disks, Young stellar objects]</i></p> <p><i>Extended=NO</i></p>										
Acquisition	#	Target	Filter	Target Brightness	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	SAME	F210M	BRIGHT (ND Square)	SHALLOW4	17	1	1	15.475	174100
Template	Module		Occulting Mask		Obtain Astrometric Confirmation Images?		Subarray	Dither Pattern		
	A		MASK210R		true		SUB640A210R	NONE		
Confirmation	#	Conf. Readout Pattern		Conf. Groups/Int	Conf. Integrations/Exp		Conf. Total Integrations	Conf. Total Exposure Time		Conf. Total Dithers
	1	RAPID		3	1		1	32.21		1
Spectral Elements	#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	F187N	F335M	SHALLOW4	10	18	1	18	3767.625	174012

Proposal 5261 - Observation 1 - Confirming the youngest gap-opening protoplanet undergoing runaway gas accretion

PSF References	PSF_calibrator_Pa_alpha (Obs 3) (PSF Reference; Filters [F187N/F335M]) Additional Justification: false
Special Requirements	Offset -0.004 arcsec, -0.011 arcsec No Parallel Attachments Sequence Observations 1, 2, 3, 4, Non-interruptible

Proposal 5261 - Observation 2 - Confirming the youngest gap-opening protoplanet undergoing runaway gas accretion

Wed Jan 08 14:00:09 GMT 2025

Observation	<p>Proposal 5261, Observation 2: SW_cont</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRCcam Coronagraphic Imaging</p>									
	<p>(SW_cont (Obs 2)) Warning (Form): Science observations should be linked to at least one other compatible science observation by an Aperture PA Offset of 1-14 degrees</p> <p>(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.</p>									
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections			Miscellaneous		
	(1)	MWC480	RA: 04 58 46.2656 (74.6927733d) Dec: +29 50 36.99 (29.84361d) Equinox: J2000		Proper Motion RA: 4.661 mas/yr Proper Motion Dec: -25.167999933728424 mas/yr Epoch of Position: 2000					
<p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i></p> <p><i>Category=Star</i></p> <p><i>Description=[Herbig Ae/Be stars, Protoplanetary disks, Young stellar objects]</i></p> <p><i>Extended=NO</i></p>										
Acquisition	#	Target	Filter	Target Brightness	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	SAME	F210M	BRIGHT (ND Square)	SHALLOW4	17	1	1	15.475	174100
Template	Module		Occulting Mask		Obtain Astrometric Confirmation Images?		Subarray	Dither Pattern		
	A		MASK210R		true		SUB640A210R	NONE		
Confirmation	#	Conf. Readout Pattern		Conf. Groups/Int	Conf. Integrations/Exp		Conf. Total Integrations	Conf. Total Exposure Time		Conf. Total Dithers
	1	RAPID		3	1		1	32.21		1
Spectral Elements	#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	F182M	F335M	SHALLOW4	10	18	1	18	3767.625	174012

Proposal 5261 - Observation 2 - Confirming the youngest gap-opening protoplanet undergoing runaway gas accretion

PSF References	PSF_calibrator_cont (Obs 4) (PSF Reference; Filters [F182M/F335M]) Additional Justification: false
Special Requirements	Offset -0.004 arcsec, -0.011 arcsec No Parallel Attachments Sequence Observations 1, 2, 3, 4, Non-interruptible

Proposal 5261 - Observation 3 - Confirming the youngest gap-opening protoplanet undergoing runaway gas accretion

Wed Jan 08 14:00:09 GMT 2025

Observation	<p>Proposal 5261, Observation 3: PSF_calibrator_Pa_alpha</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRCcam Coronagraphic Imaging</p>									
Diagnostics	(Visit 3:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.									
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections			Miscellaneous		
	(2)	HD31234	RA: 04 55 28.1350 (73.8672292d) Dec: +32 09 17.29 (32.15480d) Equinox: J2000		Proper Motion RA: 10.334 mas/yr Proper Motion Dec: -15.935000033096003 mas/yr Epoch of Position: 2000					
	<p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i></p> <p><i>Category=Calibration</i></p> <p><i>Description=[A stars, Point spread function]</i></p> <p><i>Extended=NO</i></p>									
Acquisition	#	Target	Filter	Target Brightness	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	SAME	F210M	BRIGHT (ND Square)	SHALLOW4	65	1	1	59.155	174100
Template	Module		Occulting Mask		Obtain Astrometric Confirmation Images?		Subarray	Dither Pattern		
	A		MASK210R		false		SUB640A210R	5-POINT-BOX		
Spectral Elements	#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	F187N	F335M	SHALLOW4	10	3	5	15	3139.687	174012
PSF References	PSF Reference: true									

Proposal 5261 - Observation 3 - Confirming the youngest gap-opening protoplanet undergoing runaway gas accretion

Special Requirements

Offset -0.004 arcsec, -0.011 arcsec

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

Proposal 5261 - Observation 4 - Confirming the youngest gap-opening protoplanet undergoing runaway gas accretion

Wed Jan 08 14:00:09 GMT 2025

Observation	<p>Proposal 5261, Observation 4: PSF_calibrator_cont</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRCam Coronagraphic Imaging</p>									
Diagnostics	(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)	HD31234	RA: 04 55 28.1350 (73.8672292d) Dec: +32 09 17.29 (32.15480d) Equinox: J2000		Proper Motion RA: 10.334 mas/yr Proper Motion Dec: -15.935000033096003 mas/yr Epoch of Position: 2000					
	<p><i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i></p> <p><i>Category=Calibration</i></p> <p><i>Description=[A stars, Point spread function]</i></p> <p><i>Extended=NO</i></p>									
Acquisition	#	Target	Filter	Target Brightness	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	SAME	F210M	BRIGHT (ND Square)	SHALLOW4	65	1	1	59.155	174100
Template	Module		Occulting Mask		Obtain Astrometric Confirmation Images?		Subarray		Dither Pattern	
	A		MASK210R		false		SUB640A210R		5-POINT-BOX	
Spectral Elements	#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	F182M	F335M	SHALLOW4	10	3	5	15	3139.687	174012
PSF References	PSF Reference: true									

Proposal 5261 - Observation 4 - Confirming the youngest gap-opening protoplanet undergoing runaway gas accretion

Special Requirements

Offset -0.004 arcsec, -0.011 arcsec

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