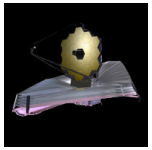

5405 - Accretion Irradiation as an Agent of Protoplanetary Disk Evolution: JWST IFU Observations of a Protostellar Pulsed Accretor

Cycle: 3, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1	NRS pre-peak	NIRSpec IFU Spectroscopy	(4) LRLL54361-NRS
	2	NRS peak	NIRSpec IFU Spectroscopy	(4) LRLL54361-NRS
	3	NRS post-peak	NIRSpec IFU Spectroscopy	(4) LRLL54361-NRS
	4	MRS bright	MIRI Medium Resolution Spectroscopy	(4) LRLL54361-NRS
	5	MRS bright offset	MIRI Medium Resolution Spectroscopy	(2) LRLL54361-OFFSET

ABSTRACT

Accretion-driven UV irradiation of protoplanetary disks is an important factor in setting disk structure and chemical pathways across a wide range of evolutionary states, from deeply embedded protostars to the dispersal of protoplanetary disks. However, other mechanisms such as viscous dissipation and shocks are also operating, and the typically stochastic nature of accretion variability hinders our ability to disentangle these competing effects. To help address this issue, we propose MIRI MRS and multi-epoch NIRSpec IFU observations of a rare periodically-varying protostar. The pulse-like variability in this low-mass object exhibits a tenfold-increase in accretion luminosity every 25 days, which subjects the surrounding disk and infalling envelope to repeated blasts of UV radiation. The predictability of this source provides a unique opportunity to quantify the importance of UV irradiation on molecular gas in disks and outflows at a very early evolutionary stage, during which direct measures of UV light are impossible because of high dust extinction from protostellar envelopes. Spectral imaging will provide characterization of molecular emission from several key constituents of the circumstellar material; comparison with pulse phase and simultaneous accretion diagnostics will illuminate the connection to UV irradiation. The results will in turn provide key constraints needed to fully test theories of planet formation in protoplanetary disks, and will set the stage for future multi-epoch studies with JWST.

OBSERVING DESCRIPTION

We propose spectral imaging observations of the variable protostar LRLL 54361. These will include single pointings with the NIRSpec IFU at three epochs, and a single epoch with MIRI MRS. For NIRSpec, we plan to observe with the G235H and G395H gratings and a 4-point dither pattern for each epoch. No dedicated background or MSA leakage exposures are needed given the low background expected in the MSA and IFU FOVs. NIRSpec exposure times have been estimated to achieve a limiting S/N >~ 20 per resel per pixel for extended molecular emission. For MIRI, we plan a single observation using all MRS channels and the 4-point dither pattern for extended sources. Exposure times have been estimated to achieve a limiting S/N ranging from 30 to > 200 per pixel in the continuum across the full MRS wavelength range, assuming a point source (most of the source continuum light at these wavelengths is expected to be relatively compact). The spacecraft blind pointing accuracy will be sufficient to place the full extent of the target within the IFU/MRS FOVs, so target acquisition is not required for either instrument. We have added special requirement timing (phase) and sequence constraints in order to observe the target at certain predicted brightness levels, as required by our science goals.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	LRLL54361-MRS	RA: 03 43 51.0020 (55.9625083d) Dec: +32 03 8.08 (32.05224d) Equinox: J2000		
Comments: *Category=Star* *Description=[Circumstellar disks, Periodic variable stars, Protoplanetary disks, Protostars, Young stellar objects]* *Extended=YES*				
(2)	LRLL54361-OFFSET	RA: 03 43 53.2097 (55.9717071d) Dec: +32 04 1.91 (32.06720d) Equinox: J2000		
Comments: *Category=Calibration* *Description=[Telescope/sky background]* *Extended=YES*				
(3)	Group L54361-MRS-GROUP			
Comments: *Target Selection=[1 LRLL54361-MRS, 2 LRLL54361-OFFSET]*				
(4)	LRLL54361-NRS	RA: 03 43 51.0020 (55.9625083d) Dec: +32 03 8.08 (32.05224d) Equinox: J2000		
Comments: *Category=Star* *Description=[Circumstellar disks, Periodic variable stars, Protoplanetary disks, Protostars, Young stellar objects]* *Extended=YES*				

Observation

Proposal 5405, Observation 1: NRS pre-peak Mon Dec 16 16:00:11 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Diagnostics

(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(4)	LRLL54361-NRS	RA: 03 43 51.0020 (55.9625083d) Dec: +32 03 8.08 (32.05224d) Equinox: J2000		

Comments:
Category=Star
Description=[Circumstellar disks, Periodic variable stars, Protoplanetary disks, Protostars, Young stellar objects]
Extended=YES

Template

TA Method	HFF Readout Mode
NONE	false

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	CYCLING	MEDIUM	1	8	

Spectral Elements

#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Leakcal	Dither	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G235H/F170LP	NRSIRS2	10	1	false	true	NONE	8	8	5952.267	
2	G395H/F290LP	NRSIRS2	10	1	false	true	NONE	8	8	5952.267	

Special Requirements

Phase 0.85 to 0.9 with period 25.34 Days and zero-phase 2455121.203 HJD

2 After 1 by 4 Days to 5 Days

Observation

Proposal 5405, Observation 2: NRS peak

Mon Dec 16 16:00:11 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

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
(4)	LRLL54361-NRS	RA: 03 43 51.0020 (55.9625083d) Dec: +32 03 8.08 (32.05224d) Equinox: J2000		

Comments:
Category=Star
Description=[Circumstellar disks, Periodic variable stars, Protoplanetary disks, Protostars, Young stellar objects]
Extended=YES

Template

TA Method	HFF Readout Mode
NONE	false

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	CYCLING	MEDIUM	1	8	

Spectral Elements

#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Leakcal	Dither	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G235H/F170LP	NRSIRS2RAPID	15	1	false	true	NONE	8	8	1867.378	
2	G395H/F290LP	NRSIRS2RAPID	5	3	false	true	NONE	8	24	2100.8	

Special Requirements

2 After 1 by 4 Days to 5 Days
3 After 2 by 10 Days to 16 Days
Sequence Observations 2, 4 within 1 Days

Observation

Proposal 5405, Observation 3: NRS post-peak Mon Dec 16 16:00:11 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

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
(4)	LRLL54361-NRS	RA: 03 43 51.0020 (55.9625083d) Dec: +32 03 8.08 (32.05224d) Equinox: J2000		

Comments:
Category=Star
Description=[Circumstellar disks, Periodic variable stars, Protoplanetary disks, Protostars, Young stellar objects]
Extended=YES

Template

TA Method	HFF Readout Mode
NONE	false

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	CYCLING	MEDIUM	1	8	

Spectral Elements

#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Leakcal	Dither	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G235H/F170LP	NRSIRS2	10	1	false	true	NONE	8	8	5952.267	
2	G395H/F290LP	NRSIRS2	10	1	false	true	NONE	8	8	5952.267	

Special Requirements

3 After 2 by 10 Days to 16 Days

Observation

Proposal 5405, Observation 4: MRS bright Mon Dec 16 16:00:11 GMT 2024

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

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
(4)	LRLL54361-NRS	RA: 03 43 51.0020 (55.9625083d) Dec: +32 03 8.08 (32.05224d) Equinox: J2000		

Comments:
Category=Star
Description=[Circumstellar disks, Periodic variable stars, Protoplanetary disks, Protostars, Young stellar objects]
Extended=YES

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
	All MRS	YES	FULL	Allow Auto Reorder

Dithers

#	Dither Type	Optimized For	Direction
1	4-Point	EXTENDED SOURCE	NEGATIVE

Spectral Elements

#	Wavelength Range	Detector	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1		IMAGER	F1000W	FASTR1	40	1	1	Dither 1	4	4	444.006	
1	LONG(C)	MRSLONG		FASTR1	40	1	1	Dither 1	4	4	444.006	
1	LONG(C)	MRSSHORT		FASTR1	40	1	1	Dither 1	4	4	444.006	
2		IMAGER	F770W	FASTR1	50	1	1	Dither 1	4	4	555.008	
2	MEDIUM(B)	MRSLONG		FASTR1	50	1	1	Dither 1	4	4	555.008	
2	MEDIUM(B)	MRSSHORT		FASTR1	50	1	1	Dither 1	4	4	555.008	
3		IMAGER	F560W	FASTR1	30	1	1	Dither 1	4	4	333.005	
3	SHORT(A)	MRSLONG		FASTR1	30	1	1	Dither 1	4	4	333.005	
3	SHORT(A)	MRSSHORT		FASTR1	30	1	1	Dither 1	4	4	333.005	

Special Requirements	Sequence Observations 2, 4 within 1 Days Group Observations 4, 5, Non-interruptible

Observation

Proposal 5405, Observation 5: MRS bright offset Mon Dec 16 16:00:11 GMT 2024

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observation For: []

Diagnostics

(Visit 5:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(2)	LRLL54361-OFFSET	RA: 03 43 53.2097 (55.9717071d) Dec: +32 04 1.91 (32.06720d) Equinox: J2000		

Comments:
Category=Calibration
Description=[Telescope/sky background]
Extended=YES

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
	All MRS	YES	FULL	Allow Auto Reorder

Dithers

#	Dither Type	Optimized For	Direction
1	4-Point	EXTENDED SOURCE	NEGATIVE

Spectral Elements

#	Wavelength Range	Detector	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1		IMAGER	F560W	FASTR1	30	1	1	Dither 1	4	4	333.005	
1	SHORT(A)	MRSLONG		FASTR1	30	1	1	Dither 1	4	4	333.005	
1	SHORT(A)	MRSSHORT		FASTR1	30	1	1	Dither 1	4	4	333.005	
2		IMAGER	F770W	FASTR1	50	1	1	Dither 1	4	4	555.008	
2	MEDIUM(B)	MRSLONG		FASTR1	50	1	1	Dither 1	4	4	555.008	
2	MEDIUM(B)	MRSSHORT		FASTR1	50	1	1	Dither 1	4	4	555.008	
3		IMAGER	F1000W	FASTR1	40	1	1	Dither 1	4	4	444.006	
3	LONG(C)	MRSLONG		FASTR1	40	1	1	Dither 1	4	4	444.006	
3	LONG(C)	MRSSHORT		FASTR1	40	1	1	Dither 1	4	4	444.006	

Special Requirements	Group Observations 4, 5, Non-interruptible