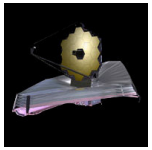

1798 - Characterizing Accretion Signatures in the Youngest Protostars: The Case of L1527 IRS

Cycle: 1, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1	L1527 NIRSpec	NIRSpec IFU Spectroscopy	(3) L1527IRS-NIRSPEC
	3	L1527 MIRI MRS Background	MIRI Medium Resolution Spectroscopy	(2) L1527-IRS-BG
	2	L1527 MIRI MRS	MIRI Medium Resolution Spectroscopy	(1) L1527IRS
Observation Folder				
	4	L1527 NIRSpec redo	NIRSpec IFU Spectroscopy	(3) L1527IRS-NIRSPEC
	5	L1527 MIRI MRS Background redo	MIRI Medium Resolution Spectroscopy	(4) L1527-IRS-BG-2
	6	L1527 MIRI MRS redo	MIRI Medium Resolution Spectroscopy	(5) L1527IRS-MRS-2

ABSTRACT

We propose to use JWST to characterize the mode of accretion (magnetospheric or boundary layer) and its rate onto one of the nearest (d=140 pc) and best characterized Class 0 protostars, L1527 IRS. Accretion is the fundamental process of building up stellar mass and this process has not been directly characterized toward the youngest, Class 0 protostars. Accretion is typically probed using hydrogen lines, and more-evolved protostars are found to be undergoing magnetospheric accretion with their rates characterized using spectroscopy from 1 to 2.5 microns. However, direct probes of accretion onto Class 0 protostars do not currently exist because the protostars are enshrouded in dense envelopes, making them prohibitively faint for ground-based spectroscopy between 1 and 5 microns. Only JWST provides the sensitivity required to detect hydrogen recombination lines toward Class 0 protostars between 3 and 8 microns where they exhibit their brightest emission shortward of 10 microns. We will use the NIRSpec and MIRI MRS IFUs to observe the Br-alpha (4.05 microns), Pfund-alpha (7.46 microns), beta (4.65 micron), and gamma (3.74 micron) lines toward L1527 IRS. These data will provide some of the first direct evidence for the mode of accretion onto Class 0 protostars and the fraction of luminosity due to accretion in the system. Then, in conjunction with radiative transfer modeling, we will estimate the accretion rate onto the protostar using the hydrogen line luminosities, corrected for extinction using their intrinsic line ratios, estimated from accretion models.

OBSERVING DESCRIPTION

We will conduct NIRSpec IFU and MIRI MRS IFU observations toward the Class 0 protostar L1527 IRS. The goal is to characterize the mode of accretion (magnetospheric or boundary layer) and the luminosity of the hydrogen emission lines that we will be able to detect between 3 and 8 micron with the two instruments.

The NIRSpec IFU observations will be taken in a 4-point dither pattern centered on the scattered light disk previously observed toward L1527 IRS. We will use the medium resolution grating such that the Br-alpha line at 4.05 microns will be visible across the full IFU field of view. We will only observe with the G395M grating because shorter wavelengths are not expected to detect emission from the protostar due to extinction. We will take leakage calibrations as part of the program using the same expsosure time and dither pattern as the science observations in order to prevent contamination of the science target due to leakage through the MSA.

The MIRI MRS observations will be taken in a similar manner as the NIRSpec observations, in a 4-point dither pattern centered on the scattered light disk. The MIRI MRS observations are required to detect the Pfund alpha transition (7.46 microns) toward L1527 IRS in order to facilitate the interpretation of the hydrogen lines observed using NIRSpec. Near simultaneous observations with NIRSpec are required to avoid accretion variations causing the line luminosities to change. We only require observations using the long module as the Pfund-alpha line falls within the long

sub-band of Channel 1, continuous spectral coverage is not required. We will take dedicated background observations with MIRI MRS on blank sky near L1527 IRS, observing in a 4-point dither pattern. We will use the same number of groups as the science exposures, but only observe for a single integration per exposure in the background observations.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	L1527IRS	RA: 04 39 53.8790 (69.9744958d) Dec: +26 03 9.43 (26.05262d) Equinox: J2000	Proper Motion RA: 0.0 mas/yr Proper Motion Dec: -19.5 mas/yr Epoch of Position: 2021.0	
Comments: No TA is required. Blind pointing accuracy is sufficient. *Category=ISM* *Description=[Protostars]* *Extended=YES*				
(2)	L1527-IRS-BG	RA: 04 39 57.7115 (69.9904646d) Dec: +26 04 2.00 (26.06722d) Equinox: J2000		
Comments: No TA is required, this is a blank field sky background observation. *Category=Calibration* *Description=[Telescope/sky background]*				
(3)	L1527IRS-NIRSPEC	RA: 04 39 53.8790 (69.9744958d) Dec: +26 03 9.43 (26.05262d) Equinox: J2000	Proper Motion RA: 0.0 mas/yr Proper Motion Dec: -19.5 mas/yr Epoch of Position: 2021.0	
Comments: No TA is required. Blind pointing accuracy is sufficient. *Category=ISM* *Description=[Protostars]* *Extended=YES*				
(4)	L1527-IRS-BG-2	RA: 04 39 50.6728 (69.9611367d) Dec: +26 02 7.17 (26.03533d) Equinox: J2000		
Comments: *Category=Unidentified* *Description=[Blank field]*				
(5)	L1527IRS-MRS-2	RA: 04 39 53.8790 (69.9744958d) Dec: +26 03 9.43 (26.05262d) Equinox: J2000	Proper Motion RA: 0.0 mas/yr Proper Motion Dec: -19.5 mas/yr Epoch of Position: 2021.0	
Comments: No TA is required. Blind pointing accuracy is sufficient. *Category=ISM* *Description=[Protostars]* *Extended=YES*				

Observation

Proposal 1798, Observation 1: L1527 NIRSpec

Thu Jun 29 19:01:00 GMT 2023

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
(3)	L1527IRS-NIRSPEC	RA: 04 39 53.8790 (69.9744958d)	Proper Motion RA: 0.0 mas/yr	
		Dec: +26 03 9.43 (26.05262d)	Proper Motion Dec: -19.5 mas/yr	
		Equinox: J2000	Epoch of Position: 2021.0	

Comments: No TA is required. Blind pointing accuracy is sufficient.
Category=ISM
Description=[Protostars]
Extended=YES

Template

TA Method
NONE

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	4-POINT-DITHER				

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	G395M/F290LP	NRSIRS2RAPID	35	2	false	true	NONE	4	8	4201.6	58222
2	G395M/F290LP	NRSIRS2RAPID	35	2	true	true	NONE	4	8	4201.6	58222

Special Requirements

Sequence Observations 1, 2, 3, Non-interruptible

Observation

Proposal 1798, Observation 3: L1527 MIRI MRS Background Thu Jun 29 19:01:00 GMT 2023

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observation For: [L1527 MIRI MRS (Obs 2)]

Comments: This background observation is shorter than the total time on source for the science target. However, we expect that this will be sufficient given that the spectral line of interest for the science is at 7.46 microns and the telescope background is no expected to be high at this wavelength. The main background at this wavelength is expected to be zodiacal light that should be smooth across the source.

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)	L1527-IRS-BG	RA: 04 39 57.7115 (69.9904646d) Dec: +26 04 2.00 (26.06722d) Equinox: J2000		

Comments: No TA is required, this is a blank field sky background observation.
Category=Calibration
Description=[Telescope/sky background]

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
	CHANNEL1	YES	FULL	NEUTRAL

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	SLOWR1	16	1	1	Dither 1	4	4	1528.955	
1	LONG(C)	MRSLONG		SLOWR1	16	1	1	Dither 1	4	4	1528.955	
1	LONG(C)	MRSSHORT		SLOWR1	16	1	1	Dither 1	4	4	1528.955	

Special Requirements	Sequence Observations 1, 2, 3, Non-interruptible

Observation

Proposal 1798, Observation 2: L1527 MIRI MRS Thu Jun 29 19:01:00 GMT 2023

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observations:[L1527 MIRI MRS Background (Obs 3)]

Diagnostics

(L1527 MIRI MRS (Obs 2)) Warning (Form): The science and background exposures are not consistent and may result in non-optimal science output.

(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	L1527IRS	RA: 04 39 53.8790 (69.9744958d)	Proper Motion RA: 0.0 mas/yr	
		Dec: +26 03 9.43 (26.05262d)	Proper Motion Dec: -19.5 mas/yr	
		Equinox: J2000	Epoch of Position: 2021.0	

Comments: No TA is required. Blind pointing accuracy is sufficient.
Category=ISM
Description=[Protostars]
Extended=YES

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
	CHANNEL1	NO	FULL	NEUTRAL

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	LONG(C)	MRSLONG		SLOWR1	16	5	1	Dither 1	4	20	8027.013	58222
1	LONG(C)	MRSSHORT		SLOWR1	16	5	1	Dither 1	4	20	8027.013	58222

Special Requirements	Sequence Observations 1, 2, 3, Non-interruptible

Observation

Proposal 1798, Observation 4: L1527 NIRSpec redo

Thu Jun 29 19:01:00 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec IFU 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
(3)	L1527IRS-NIRSPEC	RA: 04 39 53.8790 (69.9744958d)	Proper Motion RA: 0.0 mas/yr	
		Dec: +26 03 9.43 (26.05262d)	Proper Motion Dec: -19.5 mas/yr	
		Equinox: J2000	Epoch of Position: 2021.0	

Comments: No TA is required. Blind pointing accuracy is sufficient.
Category=ISM
Description=[Protostars]
Extended=YES

Template

TA Method
NONE

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	4-POINT-DITHER				

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	G395M/F290LP	NRSIRS2RAPID	35	2	false	true	NONE	4	8	4201.6	58222

Special Requirements

Sequence Observations 4, 5, 6, Non-interruptible

Observation

Proposal 1798, Observation 5: L1527 MIRI MRS Background redo Thu Jun 29 19:01:00 GMT 2023

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observation For: [L1527 MIRI MRS redo (Obs 6)]

Comments: This background observation is shorter than the total time on source for the science target. However, we expect that this will be sufficient given that the spectral line of interest for the science is at 7.46 microns and the telescope background is no expected to be high at this wavelength. The main background at this wavelength is expected to be zodiacal light that should be smooth across the source.

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
(4)	L1527-IRS-BG-2	RA: 04 39 50.6728 (69.9611367d) Dec: +26 02 7.17 (26.03533d) Equinox: J2000		

Comments:
Category=Unidentified
Description=[Blank field]

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
	CHANNEL1	YES	FULL	NEUTRAL

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	SLOWR1	16	4	1	Dither 1	4	16	6402.499	
1	LONG(C)	MRSLONG		SLOWR1	16	4	1	Dither 1	4	16	6402.499	
1	LONG(C)	MRSSHORT		SLOWR1	16	4	1	Dither 1	4	16	6402.499	

Special Requirements	Sequence Observations 4, 5, 6, Non-interruptible

Observation

Proposal 1798, Observation 6: L1527 MIRI MRS redo Thu Jun 29 19:01:00 GMT 2023

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observations:[L1527 MIRI MRS Background redo (Obs 5)]

Diagnostics

(L1527 MIRI MRS redo (Obs 6)) Warning (Form): The science and background exposures are not consistent and may result in non-optimal science output.

(Visit 6:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(5)	L1527IRS-MRS-2	RA: 04 39 53.8790 (69.9744958d)	Proper Motion RA: 0.0 mas/yr	
		Dec: +26 03 9.43 (26.05262d)	Proper Motion Dec: -19.5 mas/yr	
		Equinox: J2000	Epoch of Position: 2021.0	

Comments: No TA is required. Blind pointing accuracy is sufficient.
Category=ISM
Description=[Protostars]
Extended=YES

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
	CHANNEL1	NO	FULL	NEUTRAL

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	LONG(C)	MRSLONG		SLOWR1	16	4	1	Dither 1	4	16	6402.499	58222
1	LONG(C)	MRSSHORT		SLOWR1	16	4	1	Dither 1	4	16	6402.499	58222

Special Requirements	Sequence Observations 4, 5, 6, Non-interruptible