



5290 - Building the Legacy of Supernova 2023ixf: How Does Molecule Formation Lead to Dust?

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>
567-600d				
	1	NIRSpec	NIRSpec Fixed Slit Spectroscopy	(1) SN2023ixf
	2	MIRI LRS	MIRI Low Resolution Spectroscopy	(1) SN2023ixf
	3	MIRI Imaging	MIRI Imaging	(1) SN2023ixf
700-750d				
	4	NIRSpec	NIRSpec Fixed Slit Spectroscopy	(1) SN2023ixf
	5	MIRI LRS	MIRI Low Resolution Spectroscopy	(1) SN2023ixf
	6	MIRI Imaging	MIRI Imaging	(1) SN2023ixf

ABSTRACT

Core collapse supernovae (SNe) with hydrogen-rich envelopes, aka Type II SNe (SNe II), are the most common stellar explosions in the Universe. They are the main producers of heavy elements, and produce significant amounts of dust. Thus, the study of these cosmic explosions probes the chemical evolution of the universe, sheds light on the composition of dust in our solar system, and ultimately the genesis of life. Despite the prevalence of SNe II, their exact role as dust producers is poorly understood. Molecules (e.g. CO and SiO) have been observed in the in the ejecta

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that form dust. These molecules determine which elements are present in interstellar gas and which are tied up in cosmic dust. To make progress in understanding the role of SNe II in dust formation, we must observe nearby SN from days to years after explosion. Here, we request 20.0 hours of time to observe the closest SN II in JWST's lifetime, SN 2023ixf. Data will be obtained at four epochs from 500-1500 d past explosion. Allowing us to determine, i) How molecule formation leads to dust formation? and ii) When, what kind, and how much dust is produced in the ejecta? With a spectroscopic time series of data, for the first time, we can use molecules to trace the physical conditions throughout the epochs of dust formation, along with the composition of the dust. JWST spectra will reveal the pathway from molecules to dust in a way which was not previously possible. Finally, the data presented here will contribute an important part of the SN 2023ixf legacy dataset which will be used for decades to come.

OBSERVING DESCRIPTION

We will obtain four epochs of data of the nearby hydrogen rich type II supernova 2023ixf, ranging from ~2-25 micron. These data will be observed over the next three cycles at the following dates and SN phases from explosion:

- 1) 6th December 2024 - 8th January 2025; +567-600 d,
- 2) 18th April 2025 - 7th June 2025; +700-750 d,
- 3) 18th April 2026 - 7th June 2026; +1065-1165 d,
- 4) 18th April 2027 - 7th June 2027; +1430-1530 d.

Our science case requires spectra, hence we will use NIRSpec (395M/F290LP+G235M/F170LP) and MIRI/LRS. To complete the SED at longer wavelengths we obtain F1500W, F1800W, F2100W and F2550W imaging. In total this requires 20.0hr of charged time

Proposal 5290 - Targets - Building the Legacy of Supernova 2023ixf: How Does Molecule Formation Lead to Dust?

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(1)	SN2023ixf	RA: 14 03 38.5640 (210.9106833d) Dec: +54 18 42.02 (54.31167d) Equinox: J2000		
<i>Comments:</i> Category=Star Description=[Type II supernovae] Extended=NO					

Proposal 5290 - Observation 1 - Building the Legacy of Supernova 2023ixf: How Does Molecule Formation Lead to Dust?

Fri Mar 21 20:00:12 GMT 2025

Observation	<p>Proposal 5290, Observation 1: NIRSpec Diagnostic Status: Warning Observing Template: NIRSpec Fixed Slit Spectroscopy</p>										
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		
	(1)	SN2023ixf	RA: 14 03 38.5640 (210.9106833d) Dec: +54 18 42.02 (54.31167d) Equinox: J2000								
	<p><i>Comments:</i> Category=Star Description=[Type II supernovae] Extended=NO</p>										
Acquisition	#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wbkk.Calc ID
	1	1 SN2023ixf	WATA	SUB2048	CLEAR	NRSRAPID	3	1	1	3.628	173508
Template	HFF Readout Mode				Slit			Subarray			
	false				S400A1			SUBS400A1			
Dithers	#	Primary Dither Positions					Sub-Pixel Pattern				
	1	3					NONE				
Spectral Elements	#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Ex #	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wbkk.Calc ID
	1	G395M/F290LP	S400A1	NRS	20	1	NONE	3	3	378.655	173508
	2	G235M/F170LP	S400A1	NRS	26	1	NONE	3	3	490.831	173508

Proposal 5290 - Observation 1 - Building the Legacy of Supernova 2023ixf: How Does Molecule Formation Lead to Dust?

Special Requirements

Between Dates 06-JAN-2025:00:00:00 and 08-FEB-2025:00:00:00

Proposal 5290 - Observation 2 - Building the Legacy of Supernova 2023ixf: How Does Molecule Formation Lead to Dust?

Fri Mar 21 20:00:12 GMT 2025

Observation	Proposal 5290, Observation 2: MIRI LRS Diagnostic Status: Warning Observing Template: MIRI Low Resolution Spectroscopy									
	(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)	SN2023ixf	RA: 14 03 38.5640 (210.9106833d) Dec: +54 18 42.02 (54.31167d) Equinox: J2000							
<i>Comments:</i> Category=Star Description=[Type II supernovae] Extended=NO										
Acquisition	#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID	
	1	1 SN2023ixf	F1000W	FASTGRPAVG	4	1	1	44.401	173508	
Template	Subarray				Obtain Verification Image?					
	FULL				true					
Dithers	#	Dither Type		No. Spectral Steps	Spectral Step Offset		No. Spatial Steps		Spatial Step Offset	
	1	ALONG SLIT NOD								
Pointing Verification	#	PV Readout Pattern	PV Groups/Int	PV Integrations/Exp	PV Total Integrations	PV Exposures/Dith	PV Total Dithers	PV Total Exposure Time	PV ETC Wkbk.Calc ID	Filter
	1	FASTR1	10	4	4	1	1	119.327		F1000W

Proposal 5290 - Observation 2 - Building the Legacy of Supernova 2023ixf: How Does Molecule Formation Lead to Dust?

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	100	1	2	1	2	555.008
Between Dates 06-JAN-2025:00:00:00 and 08-FEB-2025:00:00:00									

Proposal 5290 - Observation 3 - Building the Legacy of Supernova 2023ixf: How Does Molecule Formation Lead to Dust?

Fri Mar 21 20:00:12 GMT 2025

Observation	<p>Proposal 5290, Observation 3: MIRI Imaging</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: MIRI 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			
	(1)	SN2023ixf	RA: 14 03 38.5640 (210.9106833d) Dec: +54 18 42.02 (54.31167d) Equinox: J2000								
	<p><i>Comments:</i> <i>Category=Star</i> <i>Description=[Type II supernovae]</i> <i>Extended=NO</i></p>										
Template	<p>Subarray</p> <p>FULL</p>										
Dithers	#	Dither Type	Starting Point	Number of Points	Points	Starting Set	Number of Sets	Optimized For	Direction	Pattern Size	
	1	4-Point-Sets				1	1	POINT SOURCE	POSITIVE	DEFAULT	
	2	4-Point-Sets				1	2	POINT SOURCE	POSITIVE	DEFAULT	
Spectral Elements	#	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	F1500W	FASTR1	10	1	1	Dither 1	4	4	111.002	173508
	2	F1800W	FASTR1	20	1	1	Dither 1	4	4	222.003	173508
	3	F2100W	FASTR1	30	1	1	Dither 1	4	4	333.005	173508
	4	F2550W	FASTR1	18	3	1	Dither 2	8	24	1243.218	173508
Special Requirements	Between Dates 06-JAN-2025:00:00:00 and 08-FEB-2025:00:00:00										

Proposal 5290 - Observation 4 - Building the Legacy of Supernova 2023ixf: How Does Molecule Formation Lead to Dust?

Fri Mar 21 20:00:12 GMT 2025

Observation	<p>Proposal 5290, Observation 4: NIRSpec Diagnostic Status: Warning Observing Template: NIRSpec Fixed Slit Spectroscopy</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		
	(1)	SN2023ixf	RA: 14 03 38.5640 (210.9106833d) Dec: +54 18 42.02 (54.31167d) Equinox: J2000								
	<p><i>Comments:</i> Category=Star Description=[Type II supernovae] Extended=NO</p>										
Acquisition	#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	1 SN2023ixf	WATA	SUB2048	CLEAR	NRSRAPID	3	1	1	3.628	173508
Template	HFF Readout Mode				Slit			Subarray			
	false				S400A1			SUBS400A1			
Dithers	#	Primary Dither Positions					Sub-Pixel Pattern				
	1	3					NONE				
Spectral Elements	#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Ex #	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	G395M/F290LP	S400A1	NRS	20	1	NONE	3	3	378.655	
	2	G235M/F170LP	S400A1	NRS	26	1	NONE	3	3	490.831	

Proposal 5290 - Observation 4 - Building the Legacy of Supernova 2023ixf: How Does Molecule Formation Lead to Dust?

Special Requirements

Between Dates 18-APR-2025:00:00:00 and 07-JUN-2025:00:00:00

Proposal 5290 - Observation 5 - Building the Legacy of Supernova 2023ixf: How Does Molecule Formation Lead to Dust?

Fri Mar 21 20:00:12 GMT 2025

Observation	Proposal 5290, Observation 5: MIRI LRS Diagnostic Status: Warning Observing Template: MIRI Low Resolution Spectroscopy									
	(Visit 5:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.									
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections		Miscellaneous			
	(1)	SN2023ixf	RA: 14 03 38.5640 (210.9106833d) Dec: +54 18 42.02 (54.31167d) Equinox: J2000							
<i>Comments:</i> Category=Star Description=[Type II supernovae] Extended=NO										
Acquisition	#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID	
	1	1 SN2023ixf	F1000W	FASTGRPAVG	4	1	1	44.401	173508	
Template	Subarray				Obtain Verification Image?					
	FULL				true					
Dithers	#	Dither Type	No. Spectral Steps	Spectral Step Offset	No. Spatial Steps	Spatial Step Offset				
	1	ALONG SLIT NOD								
Pointing Verification	#	PV Readout Pattern	PV Groups/Int	PV Integrations/Exp	PV Total Integrations	PV Exposures/Dith	PV Total Dithers	PV Total Exposure Time	PV ETC Wkbk.Calc ID	Filter
	1	FASTR1	10	4	4	1	1	119.327		F770W

Proposal 5290 - Observation 5 - Building the Legacy of Supernova 2023ixf: How Does Molecule Formation Lead to Dust?

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	100	1	2	1	2	555.008
	Between Dates 18-APR-2025:00:00:00 and 07-JUN-2025:00:00:00								

Proposal 5290 - Observation 6 - Building the Legacy of Supernova 2023ixf: How Does Molecule Formation Lead to Dust?

Fri Mar 21 20:00:12 GMT 2025

Observation	<p>Proposal 5290, Observation 6: MIRI Imaging</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: MIRI Imaging</p>										
Diagnostics	(Visit 6:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.										
Fixed Targets	#	Name	Target Coordinates			Targ. Coord. Corrections		Miscellaneous			
	(1)	SN2023ixf	RA: 14 03 38.5640 (210.9106833d) Dec: +54 18 42.02 (54.31167d) Equinox: J2000								
	<p><i>Comments:</i> <i>Category=Star</i> <i>Description=[Type II supernovae]</i> <i>Extended=NO</i></p>										
Template	<p>Subarray</p> <p>FULL</p>										
Dithers	#	Dither Type	Starting Point	Number of Points	Points	Starting Set	Number of Sets	Optimized For	Direction	Pattern Size	
	1	4-Point-Sets				1	1	POINT SOURCE	POSITIVE	DEFAULT	
	2	4-Point-Sets				1	2	POINT SOURCE	POSITIVE	DEFAULT	
Spectral Elements	#	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	F1500W	FASTR1	10	1	1	Dither 1	4	4	111.002	173508
	2	F1800W	FASTR1	20	1	1	Dither 1	4	4	222.003	173508
	3	F2100W	FASTR1	30	1	1	Dither 1	4	4	333.005	173508
	4	F2550W	FASTR1	18	3	1	Dither 2	8	24	1243.218	173508
Special Requirements	Between Dates 18-APR-2025:00:00:00 and 07-JUN-2025:00:00:00										