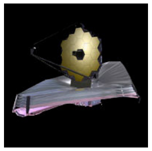

7806 - The infancy of a supernova remnant: Probing ejecta dynamics, dust evolution, and the emerging compact object in SN 1987A with JWST

Cycle: 4, Proposal Category: GO

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OBSERVATIONS

Folder	***Observation***	***Label***	***Observing Template***	***Science Target***
MIRI				
	2	MRS - BKG	MIRI Medium Resolution Spectroscopy	(2) SN1987A-BKG-SE
	1	MRS	MIRI Medium Resolution Spectroscopy	(1) SN-1987A
NIRSpec				
	3	NIRSpec IFU - G140H	NIRSpec IFU Spectroscopy	(3) SN-1987A-nirspec
	4	NIRSpec IFU - G235H/ G395H	NIRSpec IFU Spectroscopy	(3) SN-1987A-nirspec
	5	NIRSpec IFU - G140M /G395M	NIRSpec IFU Spectroscopy	(3) SN-1987A-nirspec

ABSTRACT

SN 1987A in the Large Magellanic Cloud is the closest observed supernova (SN) in centuries and provides a truly unique opportunity to probe various aspects of SN physics and evolution. SN 1987A has been continuously scrutinized as it changes significantly year after year providing new discoveries and insights into the evolution of SNe in general. Previous JWST observations revealed the onset, and early evolution of the interaction between the rapidly expanding, metal-rich inner ejecta and the circumstellar equatorial ring (ER), a new phase in the evolution of the remnant. The observations also revealed the first clear evidence of the compact object created in the explosion. The goals of this proposal are to determine the metal-rich ejecta structure and composition in the interaction regions, and monitor the emerging compact object and evolution of dust in the outer ejecta. JWST NIRSpec and MIRI give access to numerous important diagnostic lines for the ejecta-ER interaction, the ejecta morphology, and is the only telescope that has unambiguously detected emission associated with the compact object. The science objectives rely on analyzing time variations compared to the previous JWST observations. By Cycle 4, the ejecta and the interaction regions will have evolved substantially in the two years since the last JWST observations. The proposed observations also hold great legacy value for the community. SN 1987A has been observed regularly by all major telescopes since the very beginning, which has created a unique observational record of the evolution of a SN into a SN remnant across the electromagnetic spectrum.

OBSERVING DESCRIPTION

NIRSpec/IFU and MIRI/MRS will be used to observe SN1987A at a third epoch with continuous spectral coverage from 1 to 28 microns.

NIRSpec/IFU observations use the G140H/F100LP, G235H/F170LP, G395H/F290LP, and G140H/F070LP with a 4-point dither on the SMALL CYCLING pattern. The high resolution gratings are required to disentangle all the emission components, including the compact object. Observations with G140M/F100LP G395M/F290W disperser/filter combinations with a 4-point dither on the SMALL CYCLING pattern are taken to to cover the wavelength gaps of G140H and G395 which include the [Fe I] 1.44 micron line and the continuum near the [Ca V] 4.16 micron line, crucial to our science goals.

The telescope PA is constrained based on the Cycle 2 observation to 65.5 (+-10) degrees so that the leakcal from Cycle 2 observations of SN 1987A can be used to assess contamination by nebulosity in this region. Point source contamination is easily removed either with the updated outlier rejection in the pipeline or manual masking. The readout pattern used is NRSIRS2RAPID for all NIRCAM exposures.

MIRI/MRS observations use the SHORT, MEDIUM and LONG dispersers to obtaining the full 4.9-28 micron coverage with a 4-point dither on the EXTENDED SOURCE pattern. The SLOWR1 readout pattern is used with 1 integations of 49 groups at each dither position across all dispersers on each detectors. A dedicated backgorund to the south of SN1987A is taken to subtract from our science exposures and correct for detector effects such as warm pixels and residual dark current. A 4-point dither on the EXTENDED SOURCE pattern is used with a reduced number of integrations compared to the science observations, namely 1 integrations of 20 groups at each dither, which is sufficient characterise and remove the background. SLOWR1 is necessary to avoid data excess exceeding the middle threshold.

The MIRI/MRS on-source and background observations are to be carried out in a non-interruptible sequence to ensure the background is representative of the source field.
The MIRI/MRS and NIRSpec/IFU observations are ‘Grouped within 14 days’ to minimise variability.

The blind pointing accuracy of JWST is sufficient for this programme so no TA is requested. SN 1987A is in the JWST continuous viewing zone.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	SN-1987A	RA: 05 35 27.9680 (83.8665333d) Dec: -69 16 11.09 (-69.26975d) Equinox: J2000		
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Category=Star* *Description=[Supernovae]* *Extended=YES*				
(2)	SN1987A-BKG-SE	RA: 05 35 28.5915 (83.8691312d) Dec: -69 16 20.99 (-69.27250d) Equinox: J2000		
Comments: *Category=Calibration* *Description=[Telescope/sky background]*				
(3)	SN-1987A-nirspec	RA: 05 35 27.9680 (83.8665333d) Dec: -69 16 11.09 (-69.26975d) Equinox: J2000		
Comments: This entry is a duplicate of Source 1 SN-1987A only without a backgroud specification to allow NIRSpec observations with no dedicated background. *Category=Star* *Description=[Supernovae]* *Extended=YES*				

Observation

Proposal 7806, Observation 2: MRS - BKG

Tue Mar 11 21:06:59 GMT 2025

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observation For: [MRS (Obs 1)]

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
(2)	SN1987A-BKG-SE	RA: 05 35 28.5915 (83.8691312d) Dec: -69 16 20.99 (-69.27250d) Equinox: J2000		

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

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
F560W	All MRS	NO	FULL	Allow Auto Reorder

Dithers

#	Dither Type	Optimized For	Direction
1	4-Point	EXTENDED SOURCE	NEGATIVE
2	2-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	20	1	1	Dither 1	4	4	1911.194	
1	LONG(C)	MRSSHORT		SLOWR1	20	1	1	Dither 1	4	4	1911.194	
2	MEDIUM(B)	MRSLONG		SLOWR1	20	1	1	Dither 1	4	4	1911.194	
2	MEDIUM(B)	MRSSHORT		SLOWR1	20	1	1	Dither 1	4	4	1911.194	
3	SHORT(A)	MRSLONG		SLOWR1	20	1	1	Dither 1	4	4	1911.194	
3	SHORT(A)	MRSSHORT		SLOWR1	20	1	1	Dither 1	4	4	1911.194	

Special Requirements	
	Sequence Observations 1, 2, Non-interruptible Group Observations 1, 2, 3, 4, 5 within 14 Days

Observation

Proposal 7806, Observation 1: MRS

Tue Mar 11 21:06:59 GMT 2025

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observations:[MRS - BKG (Obs 2)]

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)	SN-1987A	RA: 05 35 27.9680 (83.8665333d) Dec: -69 16 11.09 (-69.26975d) Equinox: J2000		

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=Star
Description=[Supernovae]
Extended=YES

Acquisition

#	Target
1	NONE

Template

AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
F560W	All MRS	NO	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	LONG(C)	MRSLONG		SLOWR1	49	1	1	Dither 1	4	4	4682.424	
1	LONG(C)	MRSSHORT		SLOWR1	49	1	1	Dither 1	4	4	4682.424	
2	MEDIUM(B)	MRSLONG		SLOWR1	49	1	1	Dither 1	4	4	4682.424	
2	MEDIUM(B)	MRSSHORT		SLOWR1	49	1	1	Dither 1	4	4	4682.424	
3	SHORT(A)	MRSLONG		SLOWR1	49	1	1	Dither 1	4	4	4682.424	
3	SHORT(A)	MRSSHORT		SLOWR1	49	1	1	Dither 1	4	4	4682.424	

Special Requirements	Sequence Observations 1, 2, Non-interruptible Group Observations 1, 2, 3, 4, 5 within 14 Days

Observation

Proposal 7806, Observation 3: NIRSpec IFU - G140H

Tue Mar 11 21:06:59 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Diagnostics

(Visit 3:1) Warning (Form): Data Excess over lower threshold

(Visit 3:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(3)	SN-1987A-nirspec	RA: 05 35 27.9680 (83.8665333d) Dec: -69 16 11.09 (-69.26975d) Equinox: J2000		

Comments: This entry is a duplicate of Source 1 SN-1987A only without a backgroud specification to allow NIRSpec observations with no dedicated background.
Category=Star
Description=[Supernovae]
Extended=YES

Template

TA Method	HFF Readout Mode
NONE	false

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	CYCLING	SMALL	1	4	

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	G140H/F100LP	NRSIRS2RAPID	105	1	false	true	NONE	4	4	6185.689	
2	G140H/F070LP	NRSIRS2RAPID	105	1	false	true	NONE	4	4	6185.689	

Special Requirements

Aperture PA Range 55.5 to 75.5 Degrees (V3 276.52835083 to 296.52835083)

Group Observations 1, 2, 3, 4, 5 within 14 Days

Observation

Proposal 7806, Observation 4: NIRSpec IFU - G235H/G395H

Tue Mar 11 21:06:59 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Diagnostics

(Visit 4:1) Warning (Form): Data Excess over lower threshold

(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)	SN-1987A-nirspec	RA: 05 35 27.9680 (83.8665333d) Dec: -69 16 11.09 (-69.26975d) Equinox: J2000		

Comments: This entry is a duplicate of Source 1 SN-1987A only without a backgroud specification to allow NIRSpec observations with no dedicated background.
Category=Star
Description=[Supernovae]
Extended=YES

Template

TA Method	HFF Readout Mode
NONE	false

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	CYCLING	SMALL	1	4	

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	77	1	false	true	NONE	4	4	4551.734	
2	G395H/F290LP	NRSIRS2RAPID	63	2	false	true	NONE	4	8	7469.512	

Special Requirements

Aperture PA Range 55.5 to 75.5 Degrees (V3 276.52835083 to 296.52835083)

Group Observations 1, 2, 3, 4, 5 within 14 Days

Observation

Proposal 7806, Observation 5: NIRSpec IFU - G140M/G395M

Tue Mar 11 21:06:59 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

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
(3)	SN-1987A-nirspec	RA: 05 35 27.9680 (83.8665333d) Dec: -69 16 11.09 (-69.26975d) Equinox: J2000		

Comments: This entry is a duplicate of Source 1 SN-1987A only without a backgroud specification to allow NIRSpec observations with no dedicated background.
Category=Star
Description=[Supernovae]
Extended=YES

Template

TA Method	HFF Readout Mode
NONE	false

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	CYCLING	SMALL	1	4	

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	G140M/F100LP	NRSIRS2RAPID	29	1	false	true	NONE	4	4	1750.667	
2	G395M/F290LP	NRSIRS2RAPID	20	1	false	true	NONE	4	4	1225.467	

Special Requirements

Aperture PA Range 55.5 to 75.5 Degrees (V3 276.52835083 to 296.52835083)

Group Observations 1, 2, 3, 4, 5 within 14 Days