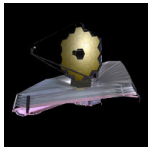

1232 - SN 1987A: The Formation and Evolution of Dust in a Supernova Explosion

Cycle: 1, Proposal Category: GTO

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
MIRI				
	1	BRIGHT SKY SUB array	MIRI Imaging	(1) SN-1987A
	2	MRS - ALL	MIRI Medium Resolution Spectroscopy	(1) SN-1987A
NIRspec IFU				
	3	NIRSpec IFU -medium resolution	NIRSpec IFU Spectroscopy	(1) SN-1987A

ABSTRACT

From Supernova to Supernova Remnant, SN 1987A has given us a unique opportunity to study the mechanics of a supernova explosion and now to witness the birth of a supernova remnant. We want to understand how massive stars age and explode, how their ejecta form dust and molecules and how the blast wave from their violent explosion affects their surroundings.

The central stellar ejecta of SN 1987A is surrounded by a ring of progenitor gas and dust that has been shocked by the blast wave of the explosion, which is now leaving it and moving farther into the Interstellar Medium (ISM), which can thus be explored for the first time. SPITZER observations have shown that silicate dust emission from the equatorial ring accounts for most of the energy observed in the 5 – 12 m region. However, extra emission in the short wavelength region of the spectrum (3 – 5m) has also been observed, whose origin is still unclear: The excess may be due either to the presence of a secondary dust component (most probably of carbon type) or to free-free radiation. Our MIRI observations will help resolve this issue.

ALMA has discovered a large quantity (0.4-0.7 M) of cold dust (20 – 25K) in the ejecta. This came as a surprise for the dust discovered at day about 500 was much warmer and in a much lower quantity. Although MIRI will not be able to help in studying this very cold dust, our observations may provide clues on the fate of this warmest dust, and hence about its evolution with time, through imaging and MRS spectroscopy. Further, the ejecta is now hit by the reverse shock whose effects will be observed with IFU spectroscopy (MRS and NIRSpec). In addition, MRS spectroscopy will study the 30m region where SOFIA has observed an excess emission at about day 10730 which is not understood.

In summary, both the MRS and NIRSpec IFU spectroscopy will measure key shocked line diagnostics that will constrain the shock physics as well as the elemental abundances in both the ring and the stellar ejecta, while imaging and IFU spectroscopy in the mid-IR will provide key information

about the morphology and the Spectral Energy Distribution of both components.

The environment of SN1987A has significant star formation activity, which has been studied using HST imaging during parallel HST spectroscopic observations of SN 1987A. This star formation will be studied using parallel fields when SN 1987A is the prime target.

OBSERVING DESCRIPTION

Observations of SN1987A

1) MIRI imaging using the bright sky sub array - NIRcam parallel
2) MIRI IFU - with simultaneous imaging with three filters: F560W, F770W, F1000W
3) NIRSpec IFU - medium resolution

MIRI filter imaging at F560W, F1000W, F1800W and F2550W using the bright sky sub array, together with MRS IFU and NIRSpec IFU imaging spectroscopy of the ring and ejecta will be obtained to measure the lines emission and continuum. Our goals are:

a) to study the effects of the interaction of the blast wave during its passage through the equatorial ring and to explore the farthest ISM.
b) to determine the nature of the ring's hot dust component discovered by Spitzer.
c) To study the evolution of the silicate dust emission observed in the ring.
d) to investigate the nature of the excess emission observed in the 30m region by SOFIA.
e) to search for the remains of the warm dust observed in the ejecta at much earlier epochs.
f) to study the presence of molecules in the ejecta.
g) to look for a remnant neutron star.

We will take all these measurements back-to-back in sufficient time to ensure the measurements are from the same epoch of this time-evolving object.

When MIRI imaging is prime we will be observing with NIRCam in parallel using the F140M/F335M, F115W/F356W, F150W/F444W and F200W/F277W NIRCam filters. The NIRCam observations will aim to pick up observations of young stellar objects in the environment and folds into Meixner's GTO program on YSOs in the nearby galaxies.

When the MRS IFU is prime we will use MIRI simultaneously to do imaging with the F560W, F770W, F1000W filtera: a 4pt dither pattern for

extended sources will be used.

The NIRSpec IFU observations will use the medium resolution grisms: G140M/F100LP, G235M/F170LP, G395M/F290LP with a 4pt dither cycling pattern. We will also take leakcal observations for the G395M filter using the same number of dither and integration time. This strategy is optimized for crowded fields.

To avoid the need for leakcal observations for other NIRSpec filters we have added a position angle constraint.

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)	TACQ-STAR	RA: 05 35 27.5910 (83.8649625d) Dec: -69 16 9.13 (-69.26920d) Equinox: J2000		
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *Wavelength: 3.6 4.5 5.8 8 24* *Star 2: 0.266 0.170 0.109 0.061 0.007* *Category=Star* *Description=[B stars]* *Extended=NO*				

Observation

Proposal 1232, Observation 1: BRIGHT SKY SUB array Sat Jun 18 00:01:28 GMT 2022

Diagnostic Status: Warning

Observing Template: MIRI Imaging

Coordinated Parallel Template(s): NIRCam Imaging

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

Template

MIRI Imaging	NIRCam Imaging
Subarray: BRIGHTSKY	Module: B Subarray: FULL

Dithers

#	Dither Type	Starting Point	Number of Points	Points	Starting Set	Number of Sets	Optimized For	Direction	Pattern Size
1	4-POINT-MIRI-F770W-WITH-NIRCam								DEFAULT
2	4-POINT-MIRI-F1000W-WITH-NIRCam								DEFAULT
3	4-POINT-MIRI-F1800W-WITH-NIRCam								DEFAULT
4	4-POINT-MIRI-F2550W-WITH-NIRCam								DEFAULT

Spectral Elements

MIRI Imaging	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F560W	FASTR1	16	18	1	Dither 1	4	72	1055.642	
2	F1000W	FASTR1	15	17	1	Dither 2	4	68	937.964	
3	F1800W	FASTR1	15	17	1	Dither 3	4	68	937.964	
4	F2550W	FASTR1	15	20	1	Dither 4	4	80	1104.097	

Spectral Elements

NIRCam Imaging	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	F140M	F335M	BRIGHT2	10	1	4	4	858.942	
2	F115W	F356W	BRIGHT2	10	1	4	4	858.942	
3	F150W	F444W	BRIGHT2	10	1	4	4	858.942	
4	F200W	F277W	BRIGHT2	10	1	4	4	858.942	

Special Requirements

No Parallel

Group Observations 1, 2, 3, Non-interruptible

Observation

Proposal 1232, Observation 2: MRS - ALL Sat Jun 18 00:01:28 GMT 2022

Diagnostic Status: Warning

Observing Template: MIRI Medium Resolution Spectroscopy

Diagnostics

(Visit 2:1) Warning (Form): Data Excess over lower threshold

(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)	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
F560W	ALL	YES	FULL

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	10	3	1	Dither 1	4	12	3057.91	
1	SHORT(A)	MRSLONG		FASTR1	94	3	1	Dither 1	4	12	3152.445	
1	SHORT(A)	MRSSHORT		FASTR1	94	3	1	Dither 1	4	12	3152.445	
2		IMAGER	F770W	SLOWR1	10	3	1	Dither 1	4	12	3057.91	
2	MEDIUM(B)	MRSLONG		FASTR1	94	3	1	Dither 1	4	12	3152.445	
2	MEDIUM(B)	MRSSHORT		FASTR1	94	3	1	Dither 1	4	12	3152.445	
3		IMAGER	F1000W	SLOWR1	10	3	1	Dither 1	4	12	3057.91	
3	LONG(C)	MRSLONG		FASTR1	94	3	1	Dither 1	4	12	3152.445	
3	LONG(C)	MRSSHORT		FASTR1	94	3	1	Dither 1	4	12	3152.445	

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

Observation

Proposal 1232, Observation 3: NIRSpec IFU -medium resolution Sat Jun 18 00:01:28 GMT 2022

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
(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

Template

TA Method
NONE

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	G235M/F170LP	NRSIRS2RAPID	29	1	false	true	NONE	4	4	1750.667	
3	G395M/F290LP	NRSIRS2RAPID	20	1	false	true	NONE	4	4	1225.467	
4	G395M/F290LP	NRSIRS2RAPID	20	1	true	true	NONE	4	4	1225.467	

Special Requirements

Aperture PA Range 190 to 70 Degrees (V3 51.03538513 to 291.03538513)

Group Observations 1, 2, 3, Non-interruptible