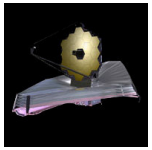

12468 - The First Near-Infrared Nebular Spectrum of a Pair-Instability Supernova

Cycle: 4, Proposal Category: DD

INVESTIGATORS

Name	*Institution*
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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1		NIRSpec Fixed Slit Spectroscopy	(1) SN2023vbw

ABSTRACT

Pair-instability supernovae (PISNe) are the predicted final fate of the most massive stars, with zero-age main-sequence masses of 140-260 Msun which generally require low metallicity. These explosions are expected to be much more luminous and long-lived than ordinary core-collapse SNe, due to the production of several solar masses of radioactive nickel. To date no definitive case of a PISN explosion has been found, and their actual observed properties remain unknown. We recently discovered and studied the unusual SN 2023vbw, which exploded in a star-forming, low-metallicity dwarf galaxy at z=0.088. The SN exhibits an extraordinary luminous and long-lived light curve, and modeling of the light curve and spectra points to an ejected mass of about 200 Msun, a radioactive nickel mass of about 1.5 Msun, and an explosion energy of about 1e53 erg, values consistent only with PISN. In the first 2 years, the SN spectrum was dominated by the thick hydrogen envelope and interaction with a circumstellar medium, masking the inner ejecta. However, our recent optical spectra indicate that SN 2023vbw has entered the nebular phase, and it is now possible to carry out a decisive test of its origin, namely, the detection of iron (as well as silicon and sulfur) lines in the near-infrared which are a direct prediction of the PISN models. Here we request a deep NIRSpec spectrum to directly test the nature of SN 2023vbw -- a positive detection will

yield a direct nickel mass and confirm SN 2023vbw as the first robust PISN, while a nondetection will place stringent limits on nickel production and challenge the PISN hypothesis, despite the observed and inferred extraordinary properties.

OBSERVING DESCRIPTION

We select the NIRSpec G140M/F100LP grating/filter combination with the S200A1 fixed slit to cover 1-1.8 microns and resolve the prominent PISN emission lines. To maximize SNR and spatial sampling, we use ALLSLITS subarray, NRSRAPID readout, and 5 primary dither positions. Four integrations of 96 groups will result in SNR>20 over the spectral range for a total exposure time of 3.0 hours and charged time including overheads of 4.6 hours.

Proposal 12468 - Targets - The First Near-Infrared Nebular Spectrum of a Pair-Instability Supernova

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	SN2023vbw	RA: 08 15 4.3560 (123.7681500d) Dec: +57 10 55.60 (57.18211d) Equinox: J2000	Epoch of Position: 2000	

Comments:
Category=Star
Description=[Supernovae]
Extended=NO

Observation

Proposal 12468, Observation 1

Thu Nov 13 19:00:10 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec Fixed Slit 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
(1)	SN2023vbw	RA: 08 15 4.3560 (123.7681500d) Dec: +57 10 55.60 (57.18211d) Equinox: J2000	Epoch of Position: 2000	

Comments:
Category=Star
Description=[Supernovae]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	Optional ETC ID
1	SAME	WATA	FULL	CLEAR	NRSRAPID	3	1	1	42.947	269146.8

Template

HFF Readout Mode	Slit	Subarray
false	S200A1	ALLSLITS

Dithers

#	Primary Dither Positions	Sub-Pixel Pattern
1	5	NONE

Spectral Elements

#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Exp	#	Autocal	Total Dithers	Total Integrations	Total Exposure Time	Optional ETC ID
1	G140M/F100LP	S200A1	NRSRAPID	96	4	1	NONE	5	20	10658.77	