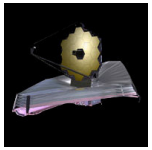

6591 - Cracking the Cosmic Calcium Conundrum: discovering the origin of Ca-rich transient SN 2024uj with late-time infrared spectroscopy

Cycle: 2, Proposal Category: DD

INVESTIGATORS

Name	*Institution*
Lindsey Kwok (PI)	**Rutgers the State University of New Jersey**
Dr. Saurabh W. Jha (CoI) (US Admin CoI)	Rutgers the State University of New Jersey
Prof. Ryan Foley (CoI)	University of California - Santa Cruz
Mr. Wynn Vicente Jacobson-Galan (CoI)	California Institute of Technology
Dr. Luc Dessart (CoI) (ESA Member)	CNRS, Institut d'Astrophysique de Paris
Prof. David J. Sand (CoI)	University of Arizona
Prof. Alex V. Filippenko (CoI)	University of California - Berkeley
Dr. Craig Pellegrino (CoI)	The University of Virginia
Dr. Dale Andrew Howell (CoI)	Las Cumbres Observatory Global Telescope Network
Prof. Maryam Modjaz (CoI)	The University of Virginia
Dr. Stefano Valenti (CoI)	University of California - Davis
Conor Larison (CoI)	Rutgers the State University of New Jersey

OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1	LRS	MIRI Low Resolution Spectroscopy	(1) SN2024uj
	2	NIRSpec Gratings	NIRSpec Fixed Slit Spectroscopy	(1) SN2024uj

ABSTRACT

Calcium-rich (Ca-rich) transients are among the most enigmatic cosmic explosions and may be important drivers of galactic chemical enrichment. Despite two decades of observations of these rare and faint objects, we still don't know which of the two fundamentally different stellar evolution pathways produce Ca-rich transients: the gravitational collapse of a massive star or the thermonuclear disruption of a white dwarf. With only 3 ground-based near-infrared (NIR) and no mid-infrared (MIR) spectra for this entire class of objects, infrared spectroscopy is a key missing ingredient to understanding Ca-rich transients. The recent, nearby SN 2024uj provides a unique opportunity to study the infrared characteristics of a Ca-rich transient and test its origin scenario. Here we request 7.9 hrs of DDT to obtain a late-time nebular phase NIR+MIR spectrum of SN 2024uj, opening a new, unexplored window to Ca-rich transients and providing the novel data we desperately need to distinguish between their progenitor systems and determine their role in galactic Ca production. JWST is uniquely powerful enough to reveal the nebular NIR+MIR properties of SN 2024uj, which will be too faint after the upcoming observing window.

OBSERVING DESCRIPTION

We will observe the nearby calcium-rich transient SN 2024uj in its late-time nebular phase in a single visit between about 100-160 days post maximum-light. For this observation, we will use the NIRSpec G140M, G295M, and G395M gratings and MIRI LRS to obtain spectroscopic coverage from 1 to 5 microns at medium resolution (R~1000) and 5 to 13 microns at low resolution (R ~ 100). The low-resolution MIR observations cover many important MIR emission lines of Ar, Co, Ni, and Ne; while the higher-resolution NIR data will cover important, less isolated He, Ti, Ca, and Fe emission lines that are either not accessible or very difficult to observe with high S/N (due to the intrinsically faint nature of these objects) from the ground. These NIR + MIR emission lines will allow us to distinguish between different models for the origins of Ca-rich transients.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	SN2024uj	RA: 11 07 49.0601 (166.9544171d) Dec: -20 01 34.25 (-20.02618d) Equinox: J2000		

Comments:
Category=Star
Description=[Supernovae, Type Ia supernovae, Type Ib supernovae]

Observation

Proposal 6591, Observation 1: LRS

Fri Apr 26 19:04:10 GMT 2024

Diagnostic Status: Warning

Observing Template: MIRI Low Resolution 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)	SN2024uj	RA: 11 07 49.0601 (166.9544171d) Dec: -20 01 34.25 (-20.02618d) Equinox: J2000		

Comments:
Category=Star
Description=[Supernovae, Type Ia supernovae, Type Ib supernovae]

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	1 SN2024uj	F1000W	FASTGRPAVG32	8	1	1	710.41	191940

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	256	1	1	1	1	710.41		F1000W

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	FASTR1	180	6	12	1	2	6021.837	191940

Special Requirements

Between Dates 01-APR-2024 and 01-JUL-2024

Group Observations 1, 2, Non-interruptible

Observation

Proposal 6591, Observation 2: NIRSpec Gratings Fri Apr 26 19:04:10 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec Fixed Slit Spectroscopy

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
(1)	SN2024uj	RA: 11 07 49.0601 (166.9544171d) Dec: -20 01 34.25 (-20.02618d) Equinox: J2000		

Comments:
Category=Star
Description=[Supernovae, Type Ia supernovae, Type Ib supernovae]

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	WATA	FULL	CLEAR	NRSRAPID	3	1	1	42.947	191940

Template

Slit	Subarray
S200A1	FULL

Dithers

#	Primary Dither Positions	Sub-Pixel Pattern
1	3	NONE

Spectral Elements

#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Exp	#	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395M/F290LP	S200A1	NRSIRS2	18	1	1	NONE	3	3	3982.767	191940
2	G235M/F170LP	S200A1	NRSIRS2	17	1	2	NONE	3	3	3763.934	191940
3	G140M/F100LP	S200A1	NRSIRS2	17	1	3	NONE	3	3	3763.934	191940

Special Requirements	Group Observations 1, 2, Non-interruptible