



# 2767 - Imaging and Spectroscopy of Three Highly Magnified Images of a Supernova at $z=1.5$

Cycle: 1, Proposal Category: DD

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## OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Observation Folder				

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
	2	NIRCam Imaging	NIRCam Imaging	(1) RXJ2129
	5	G140 try again fixed un constrained v7, PRISM unconstrained v10	NIRSpec MultiObject Spectroscopy	(2) RXJ2129-CAT-V3

## ABSTRACT

We have detected a strongly lensed supernova (SN) in HST imaging of the RX J2129 galaxy-cluster field acquired on August 7, 2022. The SN's apparent F110W magnitude of 24.70 $\pm$ 0.15 and a non-detection in F606W yield an 80% probability that the transient is a Type Ia SN. The foreground galaxy-cluster gravitational lens creates a set of three images of the SN's host galaxy at redshift 1.52, and we have detected the SN in the trailing, or last-arriving image. The other images are predicted to have arrived  $\sim$ 320 and  $\sim$ 1000 days previously.

A target-of-opportunity program with HST has been triggered to measure the transient's light curve through late October. Here we propose NIRSpec G140M and PRISM spectroscopy at the locations of all three images in early October, when the field becomes accessible to JWST. If the SN is a Type Ia SN, then we will be able to calibrate its luminosity and directly measure its magnification. This will provide a novel test of galaxy-cluster mass models. The spectra will be the first high S/N spectra of a  $z>1$  SN and enable comparison with low-redshift SNe Ia to address an important systematic that may affect SN Ia cosmology. The PRISM observations will acquire spectra of  $\sim$ 150 objects and will also improve the mass model.

We also propose for deep JWST NIRCam imaging to measure the flux of the previous arrival of the SN. With 5-sigma limiting depth of 29.2, imaging in F150W can be expected to detect the fading image. Its brightness will constrain the SN's age, and therefore the image's relative time delay. A strong detection and well-characterized SN Ia may enable a new, independent measurement of the Hubble constant.

## OBSERVING DESCRIPTION

We request NIRCam follow-up imaging (F115W, F150W, F200W, F277W, F356W, and F444W) of the images of the newly identified supernova (SN) at  $z=1.52$ .

We also propose for NIRSpec G140M/F070LP and G140M/F100LP medium-resolution MSA spectroscopy, and PRISM MSA spectroscopy of the three images of the SN, as well as background sources in the galaxy cluster field.

The galaxy-cluster field becomes accessible to JWST in early October, and we request that the observations be scheduled shortly after they can be acquired.

Proposal 2767 - Targets - Imaging and Spectroscopy of Three Highly Magnified Images of a Supernova at z=1.5

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	RXJ2129	RA: 21 29 39.9400 (322.4164167d) Dec: +00 05 18.80 (.08856d) Equinox: J2000		
<i>Comments:</i> Category=Clusters of Galaxies Description=[Rich clusters]				
(2)	RXJ2129-CAT-V3	RA: 21 29 41.3815 (322.4224229d) Dec: +00 05 42.86 (.09524d) Equinox: J2000		
<i>Comments:</i> Description=[]				
(4)	RXJ2129-CAT-V3-COPY	RA: 21 29 41.4214 (322.4225892d) Dec: +00 05 42.95 (.09526d) Equinox: J2000		
<i>Comments:</i> Description=[]				

Proposal 2767 - Observation 2 - Imaging and Spectroscopy of Three Highly Magnified Images of a Supernova at z=1.5

Sat Oct 15 00:00:36 GMT 2022

<b>Observation</b>	<p><b>Proposal 2767, Observation 2: NIRCam Imaging</b></p> <p><b>Diagnostic Status: Warning</b></p> <p>Observing Template: NIRCam Imaging</p>									
<b>Diagnostics</b>	(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.									
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>		<b>Targ. Coord. Corrections</b>			<b>Miscellaneous</b>		
	(1)	RXJ2129	RA: 21 29 39.9400 (322.4164167d) Dec: +00 05 18.80 (.08856d) Equinox: J2000							
	<p><i>Comments:</i>  <i>Category=Clusters of Galaxies</i>  <i>Description=[Rich clusters]</i></p>									
<b>Template</b>	<b>Module</b>					<b>Subarray</b>				
	B					FULL				
<b>Dithers</b>	<b>#</b>	<b>Primary Dither Type</b>		<b>Primary Dithers</b>		<b>Subpixel Dither Type</b>		<b>Dither Size</b>		<b>Subpixel Positions</b>
	1	INTRAMODULEBOX		4		SMALL-GRID-DITHER				2
<b>Spectral Elements</b>	<b>#</b>	<b>Short Filter</b>	<b>Long Filter</b>	<b>Readout Pattern</b>	<b>Groups/Int</b>	<b>Integrations/Exp</b>	<b>Total Integrations</b>	<b>Total Dithers</b>	<b>Total Exposure Time</b>	<b>ETC Wkbk.Calc ID</b>
	1	F115W	F444W	SHALLOW4	5	1	8	8	2061.46	
	2	F150W	F356W	SHALLOW4	6	2	16	8	5067.755	
	3	F200W	F277W	SHALLOW4	5	1	8	8	2061.46	
<b>Special Requirements</b>	<p>Before Date 17-OCT-2022:00:00                  Offset -23.0 arcsec, 33.0 arcsec                  Background Limited. Background no more than 40th percentile above minimum</p>									

# Proposal 2767 - Observation 5 - Imaging and Spectroscopy of Three Highly Magnified Images of a Supernova at z=1.5

Sat Oct 15 00:00:36 GMT 2022

<b>Observation</b>	<b>Proposal 2767, Observation 5: G140 try again fixed unconstrained v7, PRISM unconstrained v10</b> <b>Diagnostic Status: Warning</b> Observing Template: NIRSpec MultiObject Spectroscopy										
	(Visit 5:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.										
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>			<b>Targ. Coord. Corrections</b>			<b>Miscellaneous</b>		
	(2)	RXJ2129-CAT-V3	RA: 21 29 41.3815 (322.4224229d) Dec: +00 05 42.86 (.09524d) Equinox: J2000								
<i>Comments: Description=[]</i>											
<b>Acquisition</b>	<b>#</b>	<b>Reference Star Bin</b>	<b>Target</b>	<b>Filter</b>	<b>MSA Configuration</b>	<b>Readout Pattern</b>	<b>Groups/Int</b>	<b>Integrations/Exp</b>	<b>Total Integrations</b>	<b>Total Exposure Time</b>	<b>ETC Wkbk.Calc ID</b>
	1		SAME	CLEAR	Auto Acq MSA Config	NRSRAPID	3	1	4	171.788	
Filter: CLEAR; Readout: NRSRAPID; 8 sources in 2 quads; [ Optimal TA Accuracy ]											
<b>Template</b>	<b>TA Method</b>		<b>Obtain Confirmation Images</b>	<b>Science Aperture</b>	<b>Primary Candidate List</b>		<b>Filler Candidate List</b>		<b>Spectral Overlap Map</b>	<b>Spectral Overlap Threshold</b>	
	MSATA		After Target ACQ and New MSA Config	MSA Center	Primary (36 sources)		Filler (3379 sources)		jwst-nirspec-hr	1.5	
<b>Reference Stars</b>	<b>Visit</b>	<b>ID</b>	<b>RA</b>	<b>Dec</b>	<b>Magnitude</b>	<b>Visit</b>	<b>ID</b>	<b>RA</b>	<b>Dec</b>	<b>Magnitude</b>	
	1	1894	322.419590	0.109240	21.83	1	3738	322.428119	0.087739	21.93	
	1	2320	322.422412	0.106056	22.23	1	4031	322.421445	0.092182	22.17	
	1	3124	322.409740	0.096998	22.23	1	4179	322.416201	0.092155	21.89	
	1	3199	322.414718	0.097013	21.91	1	4613	322.395617	0.078401	22.24	
<b>Confirmation</b>	<b>#</b>	<b>Confirmation Type</b>		<b>Conf. Readout Pattern</b>	<b>Conf. Groups/Int</b>	<b>Conf. Integrations/Exp</b>		<b>Conf. Total Integrations</b>	<b>Conf. Total Exposure Time</b>		
	1	c1 : G140 try again fixed unconstrained v7		NRSIRS2	3	1		1	233.422		
	2	c1 : PRISM unconstrained v10		NRSIRS2	3	1		1	233.422		

Proposal 2767 - Observation 5 - Imaging and Spectroscopy of Three Highly Magnified Images of a Supernova at z=1.5

Spectral Elements	#	Exposure Specification	MSA Configuration	Nod Pattern	Pointing	Aperture PA	Dispersion Offset (Shutters)	Cross-Dispersion Offset (Shutters)	Total Dithers	Total Integrations	Total Exposure Time
	1	1 (G140M/F070LP)	c1 : G140 try again fixed unconstrained v7	3 Shutter Slitlet	322.39934916666 67 Degrees 0.09095 Degrees	214.99996987552 28			3	6	4026.534
	2	2 (G140M/F100LP)	c1 : G140 try again fixed unconstrained v7	3 Shutter Slitlet	322.39934916666 67 Degrees 0.09095 Degrees	214.99996987552 28			3	6	4026.534
	3	3 (PRISM/CLEAR)	c1 : PRISM unconstrained v10	3 Shutter Slitlet	322.39733958333 335 Degrees 0.0918305555555 5555 Degrees	214.99996397093 05			3	6	4464.2
Special Requirements	MSA Scheduled Aperture PA 215.0000097 to 215.0000097 Degrees (V3 76.42544 to 76.42544)										