



4446 - SN H0pe: Independent Measurement of H0 by the Time Delay of a Multiply-imaged Supernova

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				
	1	MSA_G165	NIRSpec MultiObject Spectroscopy	(8) msa_g165_cat_fix
	2		NIRCam Imaging	(9) SNH0pe-2b
	3		NIRCam Imaging	(9) SNH0pe-2b

ABSTRACT

We serendipitously discovered a bright ($AB \sim 24$ mag), $z \sim 2$ supernova (SN) Ia candidate in JWST/NIRCam imaging acquired on 2023 March 30 that is triply-imaged (2a, 2b, 2c) and named "H0pe." Follow-up is time critical: if confirmed, SN H0pe matches the highest redshift SN Ia ever discovered, and offers the extremely rare opportunity to measure H_0 using time delays from a multiply-imaged SN Ia but with reduced systematics because of cluster-scale lensing. JWST rapid follow-up observations are needed to:

- 1) Measure the time delay of a multiply-imaged SN Ia. The model light curves predict for 2a to be already fading but still detectable to $SNR \sim 5$, and 2b and 2c to be caught between the first and second IR peaks. Image 2b will peak again May 12-June 12 and be brightest in F277W, requiring JWST (before the visibility cutoff on May 31);
- 2) The time delays (~ 50 and ~ 100 days) are long enough to enable a direct H_0 measurement with $\sim 10\%$ precision, with systematics distinct from alternative probes and galaxy-scale time delay cosmography. SN H0pe is only the second multiply-imaged SN with these characteristics, and the first of probable Type Ia;
- 3) Analyze SN Ia spectrum. Crucial diagnostic absorption lines redshift to wavelengths > 1.8 microns, requiring NIRSpec. Applying the best-fit time delays from our most precise lens model yields a Type Ia classification probability of $> 90\%$. The spectrum is needed to assign the SN type.

SN H0pe promises an unambiguous measurement of H_0 , and it matches the record for the brightest (magnification factor up to 10) and most distant SN Ia. This is a unique opportunity and must not be lost.

OBSERVING DESCRIPTION

We propose 2 epochs to observe a new multiply-imaged SN Ia candidate. The first epoch uses NIRSpec MSA with the G140M and G235M grisms and the PRISM to obtain spectra of the SN images to type the supernova. Also in the first epoch is 4 filter pairs of NIRCcam imaging to catch image 2b at its second rest-frame near-IR peak. The second epoch contains only NIRCcam imaging, the same 4 filter pairs but with slightly longer exposure times to account for a fading light curve. In sum, we will measure H_0 through the measurement of time delays.

Proposal 4446 - Targets - SN H0pe: Independent Measurement of H0 by the Time Delay of a Multiply-imaged Supernova

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(2)	PLCK-G165	RA: 11 27 13.0000 (171.8041667d) Dec: +42 29 0.00 (42.48333d) Equinox: J2000		
<i>Comments:</i> Category=Clusters of Galaxies Description=[Galaxy groups]				
(3)	SNH0pe-2a	RA: 11 27 15.3057 (171.8137737d) Dec: +42 28 40.74 (42.47798d) Equinox: J2000		
<i>Comments:</i> Category=Star Description=[Supernovae]				
(8)	msa_g165_cat_fix	RA: 11 27 11.1404 (171.7964183d) Dec: +42 28 29.37 (42.47483d) Equinox: J2000		
<i>Comments:</i> Description=[]				
(9)	SNH0pe-2b	RA: 11 27 15.5938 (171.8149742d) Dec: +42 28 33.46 (42.47596d) Equinox: J2000		
<i>Comments:</i> Category=Star Description=[Supernovae]				
(10)	SNH0pe-2c	RA: 11 27 15.5938 (171.8149742d) Dec: +42 28 33.46 (42.47596d) Equinox: J2000		
<i>Comments:</i> Category=Star Description=[Supernovae]				

Fixed Targets

Proposal 4446 - Observation 1 - SN H0pe: Independent Measurement of H0 by the Time Delay of a Multiply-imaged Supernova

Wed Apr 26 00:00:38 GMT 2023

Observation	Proposal 4446, Observation 1: MSA_G165 Diagnostic Status: Warning Observing Template: NIRSpec MultiObject Spectroscopy										
	(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run. (Visit 1:1) Warning (Form): The recommended value is 8 Reference Stars for this template.										
Fixed Targets	#	Name	Target Coordinates			Targ. Coord. Corrections			Miscellaneous		
	(8)	msa_g165_cat_fix	RA: 11 27 11.1404 (171.7964183d) Dec: +42 28 29.37 (42.47483d) Equinox: J2000								
<i>Comments: Description=[]</i>											
Acquisition	#	Reference Star Bin	Target	Filter	MSA Configuration	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1		SAME	F110W	Auto Acq MSA Config	NRSRAPIDD6	3	1	4	687.153	
		Filter: F110W; Readout: NRSRAPIDD6; 7 sources in 2 quads; [Optimal TA Accuracy]									
Template	TA Method	Obtain Confirmation Images	Science Aperture	Primary Candidate List	Filler Candidate List	Spectral Overlap Map	Spectral Overlap Threshold				
	MSATA	No	MSA Center	primary3 (7 sources)	filler3 (1605 sources)	jwst-nirspec-hr	1.5				
Reference Stars	Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude	
	1	1596	171.821310	42.474217	22.6709	1	1607	171.825714	42.485854	22.7045	
	1	1601	171.829692	42.477133	22.9501	1	1608	171.812093	42.486468	22.6683	
	1	1604	171.768183	42.480845	21.9618	1	1610	171.827010	42.489524	22.8838	
	1	1606	171.830282	42.484672	22.1863						
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/F100LP)	c1	3 Shutter Slitlet	171.79391170833 333 Degrees 42.464237777777 78 Degrees	276.05348539842 674			3	3	4420.434
	2	2 (G235M/F170LP)	c1	3 Shutter Slitlet	171.79391170833 333 Degrees 42.464237777777 78 Degrees	276.05348539842 674			3	9	6696.301
	3	3 (PRISM/CLEAR)	c1	3 Shutter Slitlet	171.79391170833 333 Degrees 42.464237777777 78 Degrees	276.05348539842 674			3	3	919.1

Proposal 4446 - Observation 1 - SN H0pe: Independent Measurement of H0 by the Time Delay of a Multiply-imaged Supernova

Special Requirements

MSA Scheduled Aperture PA 276.0551597 to 276.0551597 Degrees (V3 137.48059 to 137.48059)

Sequence Observations 1, 2, Non-interruptible

Proposal 4446 - Observation 2 - SN H0pe: Independent Measurement of H0 by the Time Delay of a Multiply-imaged Supernova

Wed Apr 26 00:00:38 GMT 2023

Observation	<p>Proposal 4446, Observation 2</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRCam Imaging</p>									
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		
	(9)	SNH0pe-2b	RA: 11 27 15.5938 (171.8149742d) Dec: +42 28 33.46 (42.47596d) Equinox: J2000							
	<p><i>Comments:</i> <i>Category=Star</i> <i>Description=[Supernovae]</i></p>									
Template	Module		Subarray			Target Placement				
	B		FULL			Module Gap				
Dithers	#	Primary Dither Type		Primary Dithers	Subpixel Dither Type		Dither Size	Subpixel Positions		
	1	INTRAMODULEBOX		4	STANDARD			1		
Spectral Elements	#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
	1	F090W	F444W	BRIGHT2	7	2	8	4	1245.465	
	2	F150W	F356W	BRIGHT2	10	1	4	4	858.942	
	3	F200W	F277W	BRIGHT2	10	2	8	4	1760.83	
Special Requirements	<p>Offset 38.83 arcsec, -32.6 arcsec</p> <p>3 After 2 by 10 Days to 40 Days</p> <p>Sequence Observations 1, 2, Non-interruptible</p>									

Proposal 4446 - Observation 3 - SN H0pe: Independent Measurement of H0 by the Time Delay of a Multiply-imaged Supernova

Wed Apr 26 00:00:38 GMT 2023

Observation	<p>Proposal 4446, Observation 3</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRCam Imaging</p>									
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		
	(9)	SNH0pe-2b	RA: 11 27 15.5938 (171.8149742d) Dec: +42 28 33.46 (42.47596d) Equinox: J2000							
	<p><i>Comments:</i> <i>Category=Star</i> <i>Description=[Supernovae]</i></p>									
Template	Module		Subarray			Target Placement				
	B		FULL			Module Gap				
Dithers	#	Primary Dither Type		Primary Dithers	Subpixel Dither Type		Dither Size	Subpixel Positions		
	1	INTRAMODULEBOX		4	STANDARD			1		
Spectral Elements	#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
	1	F090W	F444W	BRIGHT2	8	2	8	4	1417.254	
	2	F150W	F356W	BRIGHT2	7	2	8	4	1245.465	
	3	F200W	F277W	BRIGHT2	10	2	8	4	1760.83	
Special Requirements	<p>Offset 38.83 arcsec, -32.6 arcsec</p> <p>3 After 2 by 10 Days to 40 Days</p>									