



18449 - Probing Magnetar Energy Input with the First Sample of Late-Time Superluminous Supernovae

Cycle: 34, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

<i>Name</i>	<i>Institution</i>
Dr. Peter Blanchard (PI) (Contact)	Harvard University
Prof. Edo Berger (CoI)	Harvard University
Dr. Sebastian Gomez (CoI)	University of Texas at Austin
Prof. Daichi Hiramatsu (CoI)	University of Florida
Dr. Harsh Kumar (CoI)	Center for Astrophysics Harvard & Smithsonian

VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(1) SN2021AHPL	WFC3/UVIS	1	07-Aug-2026 14:00:38.0	yes
02	(2) SN2022AAWB	WFC3/UVIS	1	07-Aug-2026 14:00:39.0	yes
03	(3) SN2022LXD	WFC3/UVIS	1	07-Aug-2026 14:00:39.0	yes
04	(4) SN2022NPQ	WFC3/UVIS	1	07-Aug-2026 14:00:39.0	yes
05	(5) SN2022XGC	WFC3/UVIS	1	07-Aug-2026 14:00:40.0	yes
06	(6) SN2023AAFK	WFC3/UVIS	1	07-Aug-2026 14:00:40.0	yes
07	(7) SN2023CMX	WFC3/UVIS	1	07-Aug-2026 14:00:40.0	yes
08	(8) SN2023OUS	WFC3/UVIS	1	07-Aug-2026 14:00:41.0	yes

8 Total Orbits Used

ABSTRACT

Since the discovery of hydrogen-poor superluminous supernovae (SLSNe) over a decade ago, research has focused on identifying the source of their enormous luminosities that can reach up to a hundred times brighter than normal supernovae. Early on, it was realized that the standard radioactive decay model that powers normal supernovae is unable to explain these events. Since then, light curve modeling of large samples, spectral modeling of both early and late-time nebular spectra, and analyses of their dwarf host galaxies have pointed towards a scenario in which the spin-down of a newly-formed magnetar central engine provides energy that is thermalized in the SN ejecta and radiated in the UV/optical. Perhaps the best evidence in favor of this model are the recent HST observations of two events at 400-1100 days after peak that match the power-law decline predicted by magnetar energy input. These observations strongly motivate new observations of a large and diverse sample to measure the distribution of power-law slopes and assess whether the diversity evident in the early light curves of SLSNe correlates with diversity at late times. We therefore propose to observe 8 new SLSNe each at three epochs spread accross Cycles 32, 33, and 34 (plus one template observation of an old event). As the late-time optical light curve is highly sensitive to the thermalization of the magnetar's energy, a key goal is to compare our observations with recent radiative transfer simulations to infer properties of the magnetar wind nebulae, the region where the magnetar's energy is transfered to the ejecta. This will be the most comprehensive test to date of the magnetar model for SLSNe.

OBSERVING DESCRIPTION

In Cycle 32 we will observe 9 superluminous supernovae one time each in a single filter, 8 with WFC3/UVIS and one with ACS/WFC. Each visit will consist of a dithered observation (standard ACS or WFC3 dither pattern) in one filter lasting one orbit. We will observe 8 of these supernovae two additional times, once in Cycle 33 and a final epoch in Cycle 34.

Proposal 18449 - SN2021ahpl Epoch 1 (01) - Probing Magnetar Energy Input with the First Sample of Late-Time Superluminous Supe...

Visit	Proposal 18449, SN2021ahpl Epoch 1 (01), implementation Fri Aug 07 18:00:41 GMT 2026				
	Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: (none)				
Patterns	#	Primary Pattern	Secondary Pattern		Exposures
	(2)	Pattern Type=WFC3-UVIS-DITHER-BOX Coordinate Frame=POS-TARG Pattern Orientation=23.884 Purpose=DITHER Angle Between Sides=81.785 Number Of Points=4 Center Pattern=false Point Spacing=0.173 Line Spacing=0.112			(1)
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes
	(1)	SN2021AHPL	RA: 15 15 57.9400 (228.9914167d) Dec: -19 17 31.96 (-19.29221d) Equinox: J2000		V=26.0
	Comments: Category=EXT-STAR Description=[SUPERNOVA]				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.
	1	(1) SN2021AHPL		WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F625W
				Opt. Params.	Special Reqs.
				FLASH=2.0	
				Groups	Exp. Time (Total)/[Actual Dur.]
				Pattern 2, Exps 1-1 in SN2021ahpl Epoch 1 (01) (2)	568 Secs (2272 Secs)
					[==>(Pattern 1)]
					[==>(Pattern 2)]
					[==>(Pattern 3)]
					[==>(Pattern 4)]
					[1]
Orbit Structure	Orbit 1 Server Version: 20260618				

Proposal 18449 - SN2022aawb Epoch 1 (02) - Probing Magnetar Energy Input with the First Sample of Late-Time Superluminous Sup...

Visit	Proposal 18449, SN2022aawb Epoch 1 (02), implementation										Fri Aug 07 18:00:41 GMT 2026	
	Diagnostic Status: No Diagnostics											
	Scientific Instruments: WFC3/UVIS											
	Special Requirements: (none)											
Patterns	#	Primary Pattern					Secondary Pattern			Exposures		
	(3)	Pattern Type=WFC3-UVIS-DITHER- LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing=					Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false			(1)		
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections		Fluxes		Miscellaneous			
	(2)	SN2022AAWB	RA: 01 44 52.3800 (26.2182500d) Dec: +23 00 43.85 (23.01218d) Equinox: J2000				V=26.0		Reference Frame: ICRS			
	Comments: Category=EXT-STAR Description=[SUPERNOVA]											
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit	
	1		(2) SN2022AAWB	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F775W	FLASH=2.0		Pattern 3, Exps 1-1 i n SN2022aawb Epoc h 1 (02) (3)	802 Secs (2406 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)]	[1]		
Orbit Structure	Orbit 1											Server Version: 20260618

Proposal 18449 - SN2022lxd Epoch 1 (03) - Probing Magnetar Energy Input with the First Sample of Late-Time Superluminous Super...

Visit	Proposal 18449, SN2022lxd Epoch 1 (03), implementation										Fri Aug 07 18:00:41 GMT 2026	
	Diagnostic Status: No Diagnostics											
	Scientific Instruments: WFC3/UVIS											
	Special Requirements: (none)											
Patterns	#	Primary Pattern					Secondary Pattern			Exposures		
	(3)	Pattern Type=WFC3-UVIS-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing= Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false								(1)		
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections		Fluxes		Miscellaneous			
	(3)	SN2022LXD	RA: 17 36 38.6830 (264.1611792d) Dec: +61 33 18.66 (61.55518d) Equinox: J2000				V=26.0		Reference Frame: ICRS			
Exposures	Comments: Category=EXT-STAR Description=[SUPERNOVA]											
	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit	
	1		(3) SN2022LXD	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F850LP	FLASH=10.0		Pattern 3, Exps 1-1 in SN2022lxd Epoch 1 (03) (3)	827 Secs (2481 Secs)			
									[==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)]		[1]	
Orbit Structure	Orbit 1											Server Version: 20260618

Proposal 18449 - SN2022npq Epoch 1 (04) - Probing Magnetar Energy Input with the First Sample of Late-Time Superluminous Super...

Visit	Proposal 18449, SN2022npq Epoch 1 (04), implementation Fri Aug 07 18:00:41 GMT 2026				
	Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: (none)				
Patterns	#	Primary Pattern	Secondary Pattern		Exposures
	(3)	Pattern Type=WFC3-UVIS-DITHER- LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing= Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false			(1)
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes
	(4)	SN2022NPQ	RA: 16 21 3.7320 (245.2655500d) Dec: +14 50 54.75 (14.84854d) Equinox: J2000		V=26.0
	Comments: Category=EXT-STAR Description=[SUPERNOVA]				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.
	1	(4) SN2022NPQ		WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F775W
				Opt. Params.	Special Reqs.
				FLASH=2.0	
				Groups	Exp. Time (Total)/[Actual Dur.]
				Pattern 3, Exps 1-1 i n SN2022npq Epoch 1 (04) (3)	801 Secs (2403 Secs)
					[==>(Pattern 1)]
					[==>(Pattern 2)]
					[==>(Pattern 3)]
					[1]
Orbit Structure	Orbit 1 Server Version: 20260618				

Visit	Proposal 18449, SN2022xgc Epoch 1 (05), implementation Fri Aug 07 18:00:41 GMT 2026				
	Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: (none)				
Patterns	#	Primary Pattern		Secondary Pattern	Exposures
	(3)	Pattern Type=WFC3-UVIS-DITHER- LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing= Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false			(1)
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes
	(5)	SN2022XGC	RA: 07 12 41.8100 (108.1742083d) Dec: +07 18 59.95 (7.31665d) Equinox: J2000		V=26.0
Exposures	Comments: Category=EXT-STAR Description=[SUPERNOVA]				
	#	Label	Target	Config,Mode,Aperture	Spectral Els.
Orbit Structure	1	(5) SN2022XGC	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F775W	FLASH=2.0
					Special Reqs. Groups Exp. Time (Total)/[Actual Dur.] Orbit
Orbit Structure	Orbit 1 Server Version: 20260618				

Proposal 18449 - SN2023aafk Epoch 1 (06) - Probing Magnetar Energy Input with the First Sample of Late-Time Superluminous Supe...

Visit	Proposal 18449, SN2023aafk Epoch 1 (06), implementation Fri Aug 07 18:00:41 GMT 2026				
	Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: (none)				
Patterns	#	Primary Pattern		Secondary Pattern	Exposures
	(3)	Pattern Type=WFC3-UVIS-DITHER- LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing=		Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false	(1)
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes
	(6)	SN2023AAFK	RA: 04 30 41.6710 (67.6736292d) Dec: +02 56 42.89 (2.94525d) Equinox: J2000		V=26.0
	Comments: Category=EXT-STAR Description=[SUPERNOVA]				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.
	1	(6) SN2023AAFK		WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F775W
				Opt. Params.	Special Reqs.
				FLASH=2.0	
				Groups	Exp. Time (Total)/[Actual Dur.]
				Pattern 3, Exps 1-1 i n SN2023aafk Epoch 1 (06) (3)	802 Secs (2406 Secs)
					[==>(Pattern 1)]
					[==>(Pattern 2)]
					[==>(Pattern 3)]
					[1]
Orbit Structure	Orbit 1 Server Version: 20260618				
	Orbit Structure diagram showing a timeline from 0 to 6000 seconds. Key events include GS Acq, Exp. 1 (green box), Pointing Maneuver, Overhead, and Occultation. A blue checkered bar represents the observation period, and a black bar represents the occultation period. Unused orbital visibility is 2 minutes.				

Proposal 18449 - SN2023cmx Epoch 1 (07) - Probing Magnetar Energy Input with the First Sample of Late-Time Superluminous Supe...

Visit	Proposal 18449, SN2023cmx Epoch 1 (07), implementation Fri Aug 07 18:00:41 GMT 2026				
	Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: (none)				
Patterns	#	Primary Pattern		Secondary Pattern	Exposures
	(3)	Pattern Type=WFC3-UVIS-DITHER- LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing=		Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false	(1)
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes
	(7)	SN2023CMX	RA: 07 06 54.6500 (106.7277083d) Dec: +37 58 35.54 (37.97654d) Equinox: J2000		V=26.0
	Comments: Category=EXT-STAR Description=[SUPERNOVA]				
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.
	1	(7) SN2023CMX		WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F775W
				Opt. Params.	FLASH=2.0
				Special Reqs.	
				Groups	Pattern 3, Exps 1-1 i n SN2023cmx Epoch 1 (07) (3)
				Exp. Time (Total)/[Actual Dur.]	806 Secs (2418 Secs)
					[==>(Pattern 1)]
					[==>(Pattern 2)]
					[==>(Pattern 3)]
					[1]
Orbit Structure	Orbit 1 Server Version: 20260618				
	Unused Orbital Visibility = 3				

Proposal 18449 - SN2023ous Epoch 1 (08) - Probing Magnetar Energy Input with the First Sample of Late-Time Superluminous Super...

Visit	Proposal 18449, SN2023ous Epoch 1 (08), implementation										Fri Aug 07 18:00:41 GMT 2026	
	Diagnostic Status: No Diagnostics											
	Scientific Instruments: WFC3/UVIS											
	Special Requirements: (none)											
Patterns	#	Primary Pattern					Secondary Pattern			Exposures		
	(3)	Pattern Type=WFC3-UVIS-DITHER- LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing=					Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false			(1)		
Fixed Targets	#	Name		Target Coordinates		Targ. Coord. Corrections		Fluxes		Miscellaneous		
	(8)	SN2023OUS		RA: 04 25 50.1000 (66.4587500d) Dec: -09 09 28.08 (-9.15780d) Equinox: J2000				V=26.0		Reference Frame: ICRS		
	Comments: Category=EXT-STAR Description=[SUPERNOVA]											
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit	
	1		(8) SN2023OUS	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F775W	FLASH=2.0		Pattern 3, Exps 1-1 i n SN2023ous Epoch 1 (08) (3)	802 Secs (2406 Secs) [==>(Pattern 1)] [==>(Pattern 2)] [==>(Pattern 3)]	[1]		
Orbit Structure	Orbit 1											Server Version: 20260618