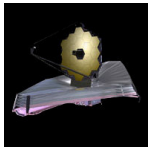

2782 - Heavy element formation in the brightest gamma-ray burst of all time

Cycle: 1, Proposal Category: DD

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OBSERVATIONS

Folder	***Observation***	***Label***	***Observing Template***	***Science Target***
Observations disruptive ToO epoch2				
	4	NIRSpec Fixed Slit	NIRSpec Fixed Slit Spectroscopy	(1) GRB221009
	5	MIRI LRS	MIRI Low Resolution Spectroscopy	(1) GRB221009

ABSTRACT

The long duration gamma-ray burst GRB 221009A is the brightest GRB in 50-years of observations and ~10,000 GRBs. Not only is it the brightest ever seen, but optical observations show it to be relatively local (z = 0.15), making it a very rare nearby, but high luminosity system, with an energy E_iso > 10^54 erg (if released isotropically), comparable with the bursts seen at high redshift in the early Universe. Here we propose a modest JWST observation to obtain an optical-mid-IR spectrum of the counterpart and associated supernova at the peak of the SN light (in 10-14 days time). The critical expansion into the mid-IR will allow us to search for signatures of heavy element production in the burst. Long GRBs (especially highly-energetic ones) have been suggested to be important contributors to the nucleosynthesis of heavy elements via the r-process. Due to its proximity and rarity, GRB 221009A is the only highly luminous event for which JWST will be ever able to directly test this model. The high signal to noise spectra will allow us to disentangle afterglow, supernova and r-process signatures to provide unique scientific insight, while also providing a template for future mid-IR observations of GRBs and their supernovae. Indeed, even a single NIRSPEC observation would enable dramatic new science in its own right.

OBSERVING DESCRIPTION

We request observations of GRB 221009A with NIRSPEC and MIRI. Our observational strategy is simple.

For NIRSpec, we will use the prism, and assume (pessimistically) that the source will be a ~10000~K black body, scaled to the absolute magnitude of SN~1998bw and with appropriate A_V added. Using NRSIRS2 with 6 groups/integration, 1 integration/exposure and 4 dither positions will provide S/N >100 over 0.7--3.5 μm and >50 over the remaining wavelength range. This is sufficient to provide a high quality spectral observation for searching for supernova features.

In addition, MIRI observations can extend the wavelength baseline by a factor of >2, providing the first mid-IR spectrum of a GRB. These observations (especially at the redder end) will be free of both foreground and host extinction and supernova light and so will accurately measure the afterglow properties.

For MIRI observations, we select LRS slit spectroscopy as we expect some crowding from neighboring sources, and don't need time series spectroscopy. For our observations, we select 100 groups, 1 integration, and 1 exposure as reasonable defaults for MIRI LRS, and will dither using ``ALONG SLIT NOD". Only in the case that the afterglow is exceptionally bright do we expect a few pixels of saturation, and only in the last few groups. We use a simple power law to estimate reasonable wavelength dependence for an expected afterglow. We estimate the SNR for different brightnesses of the afterglow, we expect that the source will have H(AB) $<$ 17 at the time of our observations, nd our observing strategy provides enough signal to noise for a significant (SNR 10) detection down to 10 μm in all cases. We additionally test acquisition and find that 4 frames is adequate in all cases to achieve high signal to noise, and expect to be able to acquire the target in any instance.

The low Galactic latitude of the field does mean that it is relatively crowded, but we have a precise position for the GRB and so can place it accurately within the slit for both instruments.

Proposal 2782 - Targets - Heavy element formation in the brightest gamma-ray burst of all time

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	GRB221009	RA: 19 13 3.5040 (288.2646000d) Dec: +19 46 24.27 (19.77341d) Equinox: J2000		

Comments:
Category=Unidentified
Description=[Infrared sources, X-ray sources]

Observation

Proposal 2782, Observation 4: NIRSpec Fixed Slit Fri Oct 14 18:00:57 GMT 2022

Diagnostic Status: Warning

Observing Template: NIRSpec Fixed Slit Spectroscopy

Diagnostics

(NIRSpec Fixed Slit (Obs 4)) Warning (Form): Response time < 14.0 Days is disruptive to the scheduling process. Only a limited number of disruptive ToOs will be accepted.

(Visit 4:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	GRB221009	RA: 19 13 3.5040 (288.2646000d) Dec: +19 46 24.27 (19.77341d) Equinox: J2000		

Comments:
Category=Unidentified
Description=[Infrared sources, X-ray sources]

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	WATA	SUB2048	F140X	NRSRAPID	3	1	1	3.628	122406

Template

Slit	Subarray
S200A1	FULL

Dithers

#	Primary Dither Positions	Sub-Pixel Pattern
1	2	SPATIAL

Spectral Elements

#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Exp	#	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	PRISM/CLEAR	S200A1	NRSRAPID	6	6	1	NONE	4	24	1803.777	63789

Special Requirements	
	Target Of Opportunity response time 10 Days Sequence Observations 4, 5, Non-interruptible

Observation

Proposal 2782, Observation 5: MIRI LRS Fri Oct 14 18:00:57 GMT 2022

Diagnostic Status: Warning

Observing Template: MIRI Low Resolution Spectroscopy

Diagnostics

(MIRI LRS (Obs 5)) Warning (Form): Response time < 14.0 Days is disruptive to the scheduling process. Only a limited number of disruptive ToOs will be accepted.

(Visit 5:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	GRB221009	RA: 19 13 3.5040 (288.2646000d) Dec: +19 46 24.27 (19.77341d) Equinox: J2000		

Comments:
Category=Unidentified
Description=[Infrared sources, X-ray sources]

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	SAME	F560W	FAST	4	1	1	11.1	126476

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

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	FAST	4	1	1	11.1	126476

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	FASTR1	100	1	2	1	2	555.008	126476

Special Requirements

Target Of Opportunity response time 10 Days

Sequence Observations 4, 5, Non-interruptible