



5917 - Mapping Star Cluster Feedback in a Galaxy 500 Myr after the Big Bang

Cycle: 3, Proposal Category: GO

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OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
SPT0615-JD				
	1	SPT0615-JD-NIRSpec	NIRSpec IFU Spectroscopy	(1) SPT0615-JD-NIRSpec
	2	SPT0615-JD-MIRI-background	MIRI Medium Resolution Spectroscopy	(2) SPT0615-JD-MRS-background
	3	SPT0615-JD-MIRI	MIRI Medium Resolution Spectroscopy	(3) SPT0615-JD-MRS

ABSTRACT

JWST has discovered many distant galaxies, yet most of them will remain unresolved, with their stellar populations only inferred and never observed directly. To understand early galaxies and their contribution to reionization, we must study the sources producing ionising radiation within. Highly lensed early galaxies are the only chance to directly study the engines that reionized the Universe.

We propose a detailed spectroscopic study of a galaxy at $z \sim 10$, observed just 500 Myr after the Big Bang, well before reionization was complete. SPT0615-JD is the brightest $z \sim 10$ galaxy known, magnified to AB mag 25 and stretched to an arc 5" long. Recent JWST NIRCcam imaging has revealed gravitationally-bound star clusters as small as $r \sim 1$ pc, the first detection of such features at this epoch.

We propose NIRSpec IFU prism and MIRI MRS spectroscopy in spatially resolved segments along the arc. We will clearly detect the UV continuum of the star clusters, enabling us to map their stellar ages, masses, extinctions, and UV slopes independently and more accurately than SED photometric analyses. Additionally, the HeII 1640 line will be clearly detected ($EW > 30$ Å) if these are low-metallicity or PopIII star clusters ($Z = 2-5\% Z_{\text{sun}}$ from NIRCcam SED fits). In the MIRI MRS observations, we will detect H-alpha emission, providing spatially-resolved maps of the star

formation rates and, when combined with the NIRSpec FUV spectroscopy, the ionizing photon production efficiency. The latter is a key parameter typically used to evaluate the contribution of galaxies to cosmic reionization, but for the first time here, derived from star clusters in a young galaxy 500 Myr after the Big Bang.

OBSERVING DESCRIPTION

We propose the following observations of the SPT0615-JD $z\sim 10$ arc and the SPT0615-57 cluster field:

* 5.7 hours exposure time with NIRSpec IFU prism spectroscopy on SPT0615-JD

* 9.6 hours exposure time with MIRI MRS LONG (C) spectroscopy on SPT0615-JD, plus MIRI F560W and F770W imaging that overlaps the SPT0615-57 cluster field

Specific roll angles are required to maximize the coverage of the ~ 5 -arcsec-long SPT0615-JD arc by placing it along the diagonals of the NIRSpec and MIRI IFUs. The position angles of the MIRI observations are additionally constrained to maximize the coverage of the MIRI imager on the SPT0615-57 cluster field.

For the MIRI MRS observations, we will obtain two dedicated sky frame observations with the same readout pattern and N_{group} as the science exposures. We set the sky position such that SPT0615-JD (and the cluster field) will be within the FOV of the MIRI imager, which will be operating in parallel during sky acquisition. A NON-INTERRUPTIBLE sequence requirement is added to ensure that the sky and science observations are obtained sequentially.

To maximize the SNR of the observations, we use the "background limited" requirement with the lowest backgrounds that can be scheduled (10% and 20% percentile settings for NIRSpec and MIRI, respectively).

Proposal 5917 - Targets - Mapping Star Cluster Feedback in a Galaxy 500 Myr after the Big Bang

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	SPT0615-JD-NIRSpec	RA: 06 15 55.0450 (93.9793542d) Dec: -57 46 19.90 (-57.77219d) Equinox: J2000		
Fixed Targets	<p><i>Comments: Pointing 1 targets the candidate redshift 10 arc, including star-complexes straddling the caustic (magnification > 40). The stellar continuum is expected to be detected at SNR>3 per spectra pixel; ultraviolet emission line, from Lyα, CIV1550, HeII1640, OIII]1661-1666, NIV 1750, CIII]1909, MgII2800 will be covered in the range 1-3μm, along with NeIII] and [OII]3727 at ~4μm.</i></p> <p>Category=Galaxy Description=[High-redshift galaxies, Primordial galaxies] Extended=YES</p>			
	(2)	SPT0615-JD-MRS-background	RA: 06 15 54.5264 (93.9771933d) Dec: -57 46 24.70 (-57.77353d) Equinox: J2000	
	<p><i>Comments: Target for dedicated MIRI MRS background observations.</i></p> <p>Category=Unidentified Description=[Blank field] Extended=YES</p>			
(3)	SPT0615-JD-MRS	RA: 06 15 55.0450 (93.9793542d) Dec: -57 46 19.90 (-57.77219d) Equinox: J2000		
<p><i>Comments: Pointing 1 targets the candidate redshift 10 arc, including star-complexes straddling the caustic (magnification > 40). The stellar continuum is expected to be detected at SNR>3 per spectra pixel; ultraviolet emission line, from Lyα, CIV1550, HeII1640, OIII]1661-1666, NIV 1750, CIII]1909, MgII2800 will be covered in the range 1-3μm, along with NeIII] and [OII]3727 at ~4μm.</i></p> <p>Category=Galaxy Description=[High-redshift galaxies, Primordial galaxies] Extended=YES</p>				

Proposal 5917 - Observation 1 - Mapping Star Cluster Feedback in a Galaxy 500 Myr after the Big Bang

Tue Dec 17 18:00:11 GMT 2024

Observation	<p>Proposal 5917, Observation 1: SPT0615-JD-NIRSpec</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRSpec IFU Spectroscopy</p>											
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)	SPT0615-JD-NIRSpec	RA: 06 15 55.0450 (93.9793542d) Dec: -57 46 19.90 (-57.77219d) Equinox: J2000									
	<p><i>Comments: Pointing 1 targets the candidate redshift 10 arc, including star-complexes straddling the caustic (magnification > 40). The stellar continuum is expected to be detected at SNR>3 per spectra pixel; ultraviolet emission line, from Lya, CIV1550, HeII1640, OIII]1661-1666, NIV 1750, CIII]1909, MgII2800 will be covered in the range 1-3um, along with NeIII] and [OII]3727 at ~4um.</i></p> <p>Category=Galaxy Description=[High-redshift galaxies, Primordial galaxies] Extended=YES</p>											
Template	TA Method						HFF Readout Mode					
	NONE						false					
Dithers	#	Dither Type		Size	Starting Point		Number of Points		Points			
	1	CYCLING		SMALL	1		8					
Spectral Elements	#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Ex p	Leakcal	Dither	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	PRISM/CLEAR	NRSIRS2	18	2	false	true	NONE	8	16	21241.424	
Special Requirements	<p>Aperture PA Range 85 to 95 Degrees (V3 306.02835083 to 316.02835083) Aperture PA Range 175 to 185 Degrees (V3 36.02835083 to 46.02835083) Aperture PA Range 265 to 275 Degrees (V3 126.02835083 to 136.02835083) Aperture PA Range 355 to 5 Degrees (V3 216.02835083 to 226.02835083) Background Limited. Background no more than 10th percentile above minimum</p>											

Proposal 5917 - Observation 2 - Mapping Star Cluster Feedback in a Galaxy 500 Myr after the Big Bang

Tue Dec 17 18:00:11 GMT 2024

Observation	Proposal 5917, Observation 2: SPT0615-JD-MIRI-background Diagnostic Status: Warning Observing Template: MIRI Medium Resolution Spectroscopy Background Observation For: [SPT0615-JD-MIRI (Obs 3)]												
	(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.												
Diagnosics													
Fixed Targets	#	Name	Target Coordinates			Targ. Coord. Corrections			Miscellaneous				
	(2)	SPT0615-JD-MRS-background	RA: 06 15 54.5264 (93.9771933d) Dec: -57 46 24.70 (-57.77353d) Equinox: J2000										
<i>Comments: Target for dedicated MIRI MRS background observations.</i> <i>Category=Unidentified</i> <i>Description=[Blank field]</i> <i>Extended=YES</i>													
Acquisition	#	Target											
	1	NONE											
Template	AcqFilter	Primary Channel			Simultaneous Imaging			Imager Subarray		Grating Wheel Direction			
	F560W	Imager			YES			FULL		Allow Auto Reorder			
Dithers	#	Dither Type			Optimized For			Direction					
	1	4-Point			BACKGROUND			NEGATIVE					
Spectral Elements	#	Wavelength Range	Detector	Filter	Readout Pattern	Groups/Int	Integrations/E xp	Exposures/Dit h	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1		IMAGER	F560W	FASTR1	76	2	1	Dither 1	4	8	1698.324	
	1	LONG(C)	MRSLONG		SLOWR1	18	1	1	Dither 1	4	4	1720.074	
	1	LONG(C)	MRSSHORT		SLOWR1	18	1	1	Dither 1	4	4	1720.074	
	2		IMAGER	F770W	FASTR1	76	2	1	Dither 1	4	8	1698.324	
	2	LONG(C)	MRSLONG		SLOWR1	18	1	1	Dither 1	4	4	1720.074	
	2	LONG(C)	MRSSHORT		SLOWR1	18	1	1	Dither 1	4	4	1720.074	
	2	LONG(C)	MRSSHORT		SLOWR1	18	1	1	Dither 1	4	4	1720.074	

Proposal 5917 - Observation 2 - Mapping Star Cluster Feedback in a Galaxy 500 Myr after the Big Bang

Special Requirements

Aperture PA Range 85 to 95 Degrees (V3 80.16455103 to 90.16455103)

Background Limited. Background no more than 20th percentile above minimum

Sequence Observations 2, 3, Non-interruptible

Proposal 5917 - Observation 3 - Mapping Star Cluster Feedback in a Galaxy 500 Myr after the Big Bang

Tue Dec 17 18:00:12 GMT 2024

Observation	<p>Proposal 5917, Observation 3: SPT0615-JD-MIRI</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: MIRI Medium Resolution Spectroscopy</p> <p>Background Observations:[SPT0615-JD-MIRI-background (Obs 2)]</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
	(3)	SPT0615-JD-MRS	RA: 06 15 55.0450 (93.9793542d) Dec: -57 46 19.90 (-57.77219d) Equinox: J2000		
	<p><i>Comments: Pointing 1 targets the candidate redshift 10 arc, including star-complexes straddling the caustic (magnification > 40). The stellar continuum is expected to be detected at SNR>3 per spectra pixel; ultraviolet emission line, from Lya, CIV1550, HeII1640, OIII]1661-1666, NIV 1750, CIII]1909, MgII2800 will be covered in the range 1-3um, along with NeIII] and [OII]3727 at ~4um.</i></p> <p>Category=Galaxy Description=[High-redshift galaxies, Primordial galaxies] Extended=YES</p>				
Acquisition	#	Target			
	1	NONE			
Template	AcqFilter	Primary Channel	Simultaneous Imaging	Imager Subarray	Grating Wheel Direction
	F560W	Channel 1	YES	FULL	Allow Auto Reorder
Dithers	#	Dither Type	Optimized For	Direction	
	1	4-Point	EXTENDED SOURCE	NEGATIVE	

Proposal 5917 - Observation 3 - Mapping Star Cluster Feedback in a Galaxy 500 Myr after the Big Bang

	#	Wavelength Range	Detector	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
Spectral Elements	1		IMAGER	F560W	FASTR1	18	5	1	Dither 1	4	20	1043.415	
	1	LONG(C)	MRSLONG		SLOWR1	18	5	1	Dither 1	4	20	8982.61	
	1	LONG(C)	MRSSHORT		SLOWR1	18	5	1	Dither 1	4	20	8982.61	
	2		IMAGER	F560W	FASTR1	18	5	1	Dither 1	4	20	1043.415	
	2	LONG(C)	MRSLONG		SLOWR1	18	5	1	Dither 1	4	20	8982.61	
	2	LONG(C)	MRSSHORT		SLOWR1	18	5	1	Dither 1	4	20	8982.61	
	3		IMAGER	F770W	FASTR1	18	5	1	Dither 1	4	20	1043.415	
	3	LONG(C)	MRSLONG		SLOWR1	18	5	1	Dither 1	4	20	8982.61	
	3	LONG(C)	MRSSHORT		SLOWR1	18	5	1	Dither 1	4	20	8982.61	
	4		IMAGER	F770W	FASTR1	18	5	1	Dither 1	4	20	1043.415	
	4	LONG(C)	MRSLONG		SLOWR1	18	5	1	Dither 1	4	20	8982.61	
	4	LONG(C)	MRSSHORT		SLOWR1	18	5	1	Dither 1	4	20	8982.61	
Special Requirements	Aperture PA Range 85 to 95 Degrees (V3 85.0 to 95.0)												
	Background Limited. Background no more than 20th percentile above minimum												
	Sequence Observations 2, 3, Non-interruptible												