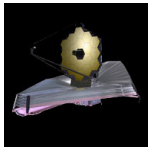

1791 - The Early Assembly History of the Most Massive Halo in the Reionization Era

Cycle: 1, Proposal Category: GO

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1	NIRCAM-CENTRALS	NIRCam Imaging	(2) SPT0311-58-NIRCAM
	3	REDO-NIRCAM-CENTRALS	NIRCam Imaging	(2) SPT0311-58-NIRCAM
	2	MIRI-CENTRALS	MIRI Imaging	(1) SPT0311-58-CENTRALS

ABSTRACT

We propose to measure accurate stellar masses and formation histories in the most massive halo known in the epoch of reionziation, SPT0311-58 at z=6.900. The structure is anchored by the most distant dust-rich galaxies known, a pair of ultramassive merging galaxies resolved into a chaotic and clumpy rapidly-assembling structure at 0.05" resolution with ALMA. Individual 300pc-size regions within these galaxies span the gamut of galaxy properties seen in the reionization epoch from UV-luminous to totally dust-obscured. Even counting only the currently known spectroscopically-confirmed galaxies, the minimum halo mass is ~10^13Msun just 800Myr after the Big Bang, more than an order of magnitude greater than any other overdensity found at z>6 and among the most massive halos expected over an area of thousands of square degrees. This structure offers the unique chance to understand the formation of an extreme peak in the primordial density field and the role of environment in the early evolution of massive galaxies. Using inexpensive and comprehensive NIRCam and MIRI imaging, we propose to measure accurate stellar masses and assembly histories of these galaxies on sub-kpc scales, constrain the very earliest z>10 formation history, and map out the wider environment of this benchmark system. The combination of the unique high-resolution ALMA data, very deep HST imaging, and the proposed JWST data will allow a full characterization of the stars, gas, dust, and star formation in this cosmologically important halo of primordial starburst galaxies, well into the epoch of reionization.

OBSERVING DESCRIPTION

We propose comprehensive NIRCam and MIRI imaging of SPT0311-58 at z=6.90, the most massive halo known in the epoch of reionization. Our observations are designed to measure the stellar masses and formation histories of the SPT0311-58 galaxies, and overlap in coverage with the deepest HST ACS+WFC3 imaging (existing + scheduled 2021) expected to reveal a strong overdensity of less-massive and less-luminous galaxies in the surrounding environment.

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NIRCam imaging:

The NIRCam imaging uses 3 filters in the long wavelength channel, F300M, F335M, and F444W, with F200W in the short channel for all observations. The medium bands bracket the Balmer/4000A break at z=6.9, allowing a constraint on the early star formation history of these galaxies, while F200W probes the rest-UV and complements the deeper HST/WFC3 F125W+F160W imaging available in this field.
The PA is restricted to four broad ranges that allow an additional z=6.9 galaxy detected with ALMA to fall in the other NIRCam module while ensuring that the central galaxies receive the full depth. The target coordinates (target SPT0311-58-NIRCAM) are shifted from the true position of the primary galaxies of interest (target SPT0311-58-CENTRALS) to accommodate this restriction.
Depths are determined based on SED fits to the existing broad-band photometry, including shallow HST/WFC3, Spitzer/IRAC 3.6 and 4.5um, and many far-IR/submillimeter bands from Herschel, ALMA, and SPT, with a primary goal of reaching S/N>~20 integrated over the source, or >~5-10 in individual 0.2" apertures. High-resolution ALMA imaging reveals a complicated and clumpy dust morphology, and we expect that the rest-optical/NIR light will also be highly nonuniform. We use the readout modes and groups/integration recommended in JDox for maximal sensitivity in a given observing time, SHALLOW4 & 10 groups/integration for the F200W/F444W imaging (2104s total on-source integration) and MEDIUM8 & 7 groups/integration for the F200W/F300M and F200W/F335M imaging (2920s each).
We use the INTRAMODULEBOX 4-point dither pattern, as we do not require the gap between modules to be filled in and are more interested in achieving maximal depth for the central galaxies of interest.

MIRI imaging:

The MIRI imaging targets the central galaxies in four filters, F560W, F777W, F1280W, and F1800W, covering the rest-optical/NIR at z=6.9. We have no PA requirements for these observations (although we presume they will be executed at the same time as the NIRCAM imaging).
Depths again are determined based on our SED fits to the existing photometry, with the same target S/N as the NIRCam imaging. We use the FAST readout mode with 100 groups/integration for all 4 filters (1110s on-source per filter), which is sufficient for our purposes because the target galaxies are expected to be brighter at longer mid-IR wavelengths.
We use the 4-point dither sets with starting position 5 to ensure the central target galaxies receive the full depth.

Proposal 1791 - Targets - The Early Assembly History of the Most Massive Halo in the Reionization Era

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	SPT0311-58-CENTRALS	RA: 03 11 33.1400 (47.8880833d) Dec: -58 23 33.40 (-58.39261d) Equinox: J2000		
Comments: *Category=Galaxy* *Description=[Galaxy halos, High-redshift galaxies, Starburst galaxies, Ultraluminous infrared galaxies]*				
(2)	SPT0311-58-NIRCAM	RA: 03 11 23.3000 (47.8470833d) Dec: -58 23 16.00 (-58.38778d) Equinox: J2000		
Comments: *Category=Galaxy* *Description=[Ultraluminous infrared galaxies]*				

Observation

Proposal 1791, Observation 1: NIRCAM-CENTRALS

Fri Oct 21 15:02:03 GMT 2022

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

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
(2)	SPT0311-58-NIRCAM	RA: 03 11 23.3000 (47.8470833d) Dec: -58 23 16.00 (-58.38778d) Equinox: J2000		

Comments:
Category=Galaxy
Description=[Ultraluminous infrared galaxies]

Template

Module	Subarray
ALL	FULL

Dithers

#	Primary Dither Type	Primary Dithers	Subpixel Dither Type	Dither Size	Subpixel Positions
1	INTRAMODULEBOX	4	SMALL-GRID-DITHER		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	F200W	F300M	MEDIUM8	7	1	4	4	2920.401	
2	F200W	F335M	MEDIUM8	7	1	4	4	2920.401	
3	F200W	F444W	SHALLOW4	10	1	4	4	2104.407	

Special Requirements

Aperture PA Range 19 to 58 Degrees (V3 19.0713531 to 58.0713531)
Aperture PA Range 146 to 182 Degrees (V3 146.0713531 to 182.0713531)
Aperture PA Range 204 to 240 Degrees (V3 204.0713531 to 240.0713531)
Aperture PA Range 326 to 2 Degrees (V3 326.0713531 to 2.0713531)

Observation

Proposal 1791, Observation 3: REDO-NIRCAM-CENTRALS Fri Oct 21 15:02:03 GMT 2022

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

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
(2)	SPT0311-58-NIRCAM	RA: 03 11 23.3000 (47.8470833d) Dec: -58 23 16.00 (-58.38778d) Equinox: J2000		

Comments:
Category=Galaxy
Description=[Ultraluminous infrared galaxies]

Template

Module	Subarray
ALL	FULL

Dithers

#	Primary Dither Type	Primary Dithers	Subpixel Dither Type	Dither Size	Subpixel Positions
1	INTRAMODULEBOX	4	SMALL-GRID-DITHER		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	F200W	F300M	MEDIUM8	7	1	4	4	2920.401	
2	F200W	F335M	MEDIUM8	7	1	4	4	2920.401	
3	F200W	F444W	SHALLOW4	10	1	4	4	2104.407	

Special Requirements

Aperture PA Range 19 to 58 Degrees (V3 19.0713531 to 58.0713531)
Aperture PA Range 146 to 182 Degrees (V3 146.0713531 to 182.0713531)
Aperture PA Range 204 to 240 Degrees (V3 204.0713531 to 240.0713531)
Aperture PA Range 326 to 2 Degrees (V3 326.0713531 to 2.0713531)

Observation

Proposal 1791, Observation 2: MIRI-CENTRALS

Fri Oct 21 15:02:03 GMT 2022

Diagnostic Status: Warning

Observing Template: MIRI Imaging

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
(1)	SPT0311-58-CENTRALS	RA: 03 11 33.1400 (47.8880833d) Dec: -58 23 33.40 (-58.39261d) Equinox: J2000		

Comments:
Category=Galaxy
Description=[Galaxy halos, High-redshift galaxies, Starburst galaxies, Ultraluminous infrared galaxies]

Template

Subarray
FULL

Dithers

#	Dither Type	Starting Point	Number of Points	Points	Starting Set	Number of Sets	Optimized For	Direction	Pattern Size
1	CYCLING	1	4		5	1			DEFAULT

Spectral Elements

#	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F560W	FASTR1	100	1	1	Dither 1	4	4	1110.016	
2	F770W	FASTR1	100	1	1	Dither 1	4	4	1110.016	
3	F1280W	FASTR1	100	1	1	Dither 1	4	4	1110.016	
4	F1800W	FASTR1	100	1	1	Dither 1	4	4	1110.016	