



1324 - Through the looking GLASS: a JWST exploration of galaxy formation and evolution from cosmic dawn to present day

Cycle: 1, Proposal Category: ERS

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OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
NIRISS Prime NIRCAM Parallel Abell 2744				
	1	A2744	NIRISS Wide Field Slitless Spectroscopy	(1) ABELL2744
NIRSpec Prime NIRCAM Parallel				
	5	APA_195_june19	NIRSpec MultiObject Spectroscopy	(6) TARGET-OBSERVATION-5

ABSTRACT

We propose a carefully designed set of observations of the lensing cluster Abell 2744 to study intrinsically faint magnified galaxies from the epoch of reionization to redshift of 1, demonstrating and characterizing complementary spectroscopic modes with NIRSPEC and NIRISS. The observations are designed to address the questions: 1) when did reionization happen and what were the sources of reionizing photons? 2) How do baryons cycle in and out of galaxies? This dataset with deep spectroscopy on the cluster and deep multiband NIRCAM imaging in parallel will enable a wealth of investigations and will thus be of interest to a broad section of the astronomical community.

The dataset will illustrate the power and challenges of: 1) combining rest frame UV and optical NIRSPEC spectroscopy for galaxies at the epoch of reionization, 2) obtaining spatially resolved emission line maps with NIRISS, 3) combining NIRISS and NIRSPEC spectroscopy. Building on our extensive experience with HST slitless spectroscopy and imaging in clusters of galaxies as part of the GLASS, WISP, SURFSUP, and ASTRODEEP projects, we will provide the following science-enabling products to the community: 1) quantitative comparison of spatially resolved (NIRISS) and spectrally resolved (NIRSPEC) spectroscopy, 2) Object based interactive exploration tools for multi-instrument datasets, 3) Interface for easy forced extraction of slitless spectra based on coordinates, 4) UV-optical spectroscopic templates of high redshift galaxies, 5) NIRCAM parallel catalogs and a list of 26 $z \geq 9$ dropouts for spectroscopic follow-up in Cycle-2.

This proposal is the follow-up to NoI number 26.

OBSERVING DESCRIPTION

We will target the Frontier Field Cluster, Abell 2744, using both NIRISS and NIRSPEC. In each case, observations include NIRCAM parallel imaging. The details of the observations are given below.

NIRSPEC + NIRCAM parallels:

Our science requires 5 hours of exposure in each of the three high-resolution gratings: G140H/F100LP, G235H/F170LP, and G395H/F290LP. In order to create MOS configurations, we compiled a catalog of photometrically selected and spectroscopically confirmed objects in Abell 2744. These include objects selected in the WFC3 Frontier Field footprint and MUSE catalogs, supplemented by galaxies in the ACS field. Since the ACS field is well-matched to the size of the micro shutter array (MSA), we are able to make efficient use of the MOS multiplexing. The targets in the catalog were weighted, with higher redshift objects given greater priority. In total, our catalog has 512 galaxies, and 35 "positions" marking intercluster light (a lower priority).

We use the MSA planning tool to design the MOS configurations and create the observations. First, we select our entire catalog as the source of

primary targets, and do not include secondary targets. We carried out several tests using subsets of the catalog as primary and filler targets and we find no difference. As a corollary, we note that all MOS observed targets are completed in all exposures, rather than a subset of the nods. Second, we use a three shutter slitlet with the "Entire Open Shutter Area" source centering constraint. This relaxed constraint improves multiplexing, and since our sources are extended, there is little additional loss from objects being off-center in their slits.

For dithering, we choose to nod in the 3-shutter slitlet. While the standard pipeline subtraction of each nod may be inappropriate for extended galaxies, we can still add the nods to obtain dithered data, and use non-local background subtraction. This approach has less overhead and maximizes multiplexing efficiency, compared to the fixed or flexible dithering options that require additional MSA configurations. At the time of flight-ready program submission, we will include extra background shutters in empty parts of the MSA, in order to ensure reliable background subtraction. We will also obtain an additional small sub-shutter dither ("2-POINT-WITH-NIRCAM-SIZE2") in each exposure, in order to improve PSF sampling of our NIRCAM parallel imaging.

We set up our NIRSPEC exposures using NRSIRS2, which is recommended for deep observations. Each NIRSPEC band is given 20 Groups, 1 integration, and 2 exposures. This gives six exposure slots, for which we plan NIRCAM imaging parallels. Packing the NIRSPEC observations as 20 Groups, 2 integrations, and 1 exposure would reduce exposure setup overhead, but would not provide sufficient flexibility for our seven bands of parallel imaging. For NIRSPEC, each dither/nod point is then 1473.5 seconds; with 3 nods, 2 sub-shutter dithers, and 2 separate exposures, the total time per band is 1473.5 seconds times 12, or 4.9 hours.

We define the NIRCAM parallel imaging, adding F090W + F444W in parallel to exposures 1 and 2, F115W + F444W in parallel to exposures 3 and 4, F150W + F277W in parallel to exposure 5, and F200W+F356W in parallel to exposure 6. In each, we use the DEEP8 readout pattern, with 7 groups and 1 integration. Each of the six exposure slots contain 8,310 seconds of imaging. In this way, we will obtain 4.6 hours each of F090W and F115W, 2.3 hours in F150W, F200W, and F356W, and 9.2 hours in F444W, reaching AB magnitudes limits of ~ 29.4 in each filter.

Finally, we note that multiple NIRSPEC APAs were tested, in order to ensure that our proposal was not sensitive to varying orient. We find 44-48 targets are observed in all orientations. Fortuitously, during the ERS period, the visible angles for Abell 2744 align the axes of the NIRSPEC MSA with the ACS footprint. Following the currently recommended practice, we do not define target acquisition (TA) at the time of proposal submission. Since the targeted galaxy cluster contains many compact, early-type galaxies in HST imaging, we anticipate that these will serve as reasonable TA sources, should stars prove to be insufficient.

NIRISS + NIRCAM parallels:

We will observe the cluster fields with NIRISS direct imaging and the two orthogonal R=150 grisms in three broad-band filters F115W, F150W and F200W to cover the wavelength range 1 to 2.2 micron. The total exposure time per filter per grism is divided into 6 exposures of 900s each with small dithers between them, total 2.9 hours per filter. As part of the WFSS observing sequence we obtain 4 direct images per filter (one before and after each orthogonal grism per filter) of 343s each, used to determine the flux, trace position and wavelength in the grism data. Grism continuum sensitivity at 3 sigma per pixel is AB=26.3, 26.0, 25.5 in F115W, F150W, F200W. Sensitivity limits for spatially-resolved information will be correspondingly shallower due to the larger area over which flux is distributed. Direct imaging sensitivity is 27.5AB in F115W, 27.6AB in F150W, and 27.8 in F200W (10 sigma). The workbook used for these calculations is #6564.

In parallel with NIRISS observations, we include NIRCAM imaging. In the LW arm of NIRCAM, we use the three wide filters F277W, F356W and F444W. The simultaneous NIRCAM SW filters are F090W, F115W, F150W, F200W. For each direct image exposure (2 per grism angle per filter) in NIRISS we observe with one SW and one LW NIRCAM filter in 3 groups of 311s each with the MEDIUM8 readout mode, and during each NIRISS grism exposure (6 exposures with small dithers) we observe with NIRCAM for 4 groups totalling 444s in the DEEP8 readout mode. In total, we observe with F444W for 5.6 hours, F090W and F115W for a total of 2.8 hours each, and F150W, F200W, F277W and F356W for 1.4 hours each. With this strategy we reach 5 sigma point source magnitude limits of $m_{ab} \sim 29$ in each filter.

Proposal 1324 - Targets - Through the looking GLASS: a JWST exploration of galaxy formation and evolution from cosmic dawn to pr...

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(1)	ABELL2744	RA: 00 14 20.9912 (3.5874633d) Dec: -30 23 49.03 (-30.39695d) Equinox: J2000		
	<i>Comments:</i> <i>Category=Clusters of Galaxies</i> <i>Description=[Abell clusters]</i>				
	(6)	TARGET-OBSERVATION-5	RA: 00 14 20.6878 (3.5861992d) Dec: -30 23 46.52 (-30.39626d) Equinox: J2000		
	<i>Comments: This target was generated automatically for MSA Observation 5</i> <i>Category=Galaxy</i> <i>Description=[Emission line galaxies, High-redshift galaxies, Lyman-alpha galaxies]</i>				

Proposal 1324 - Observation 1 - Through the looking GLASS: a JWST exploration of galaxy formation and evolution from cosmic daw...

Observation	Proposal 1324, Observation 1: A2744											Tue Jun 11 16:01:08 GMT 2019
	Diagnostic Status: Warning											
	Observing Template: NIRISS Wide Field Slitless Spectroscopy											
	Coordinated Parallel Template(s): NIRCам Imaging											
Diagnostics	(Visit 1:1) Warning (Form): Data volume for this visit 43672.14 MB exceeds half the maximum allowed of 58000.0 MB.											
	(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)	ABELL2744	RA: 00 14 20.9912 (3.5874633d) Dec: -30 23 49.03 (-30.39695d) Equinox: J2000									
	Comments: Category=Clusters of Galaxies Description=[Abell clusters]											
Template	NIRISS Wide Field Slitless Spectroscopy						NIRCам Imaging					
							Module: ALL Subarray: FULL					
Dithers	#	Image Dithers						Pattern Size				
	1	8						MEDIUM				
Direct Image	NIRISS Wide Field Slitless Spectroscopy		Exposure Type	Filter	Grism	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	DIRECT	F115W			NIS	8	1	1	1	354.313	
	2	DIRECT	F115W			NIS	8	1	1	1	354.313	
	3	DIRECT	F115W			NIS	8	1	1	1	354.313	
	4	DIRECT	F115W			NIS	8	1	1	1	354.313	
	5	DIRECT	F150W			NIS	8	1	1	1	354.313	
	6	DIRECT	F150W			NIS	8	1	1	1	354.313	
	7	DIRECT	F150W			NIS	8	1	1	1	354.313	
	8	DIRECT	F150W			NIS	8	1	1	1	354.313	
	9	DIRECT	F200W			NIS	8	1	1	1	354.313	
	10	DIRECT	F200W			NIS	8	1	1	1	354.313	
	11	DIRECT	F200W			NIS	8	1	1	1	354.313	
	12	DIRECT	F200W			NIS	8	1	1	1	354.313	

Proposal 1324 - Observation 1 - Through the looking GLASS: a JWST exploration of galaxy formation and evolution from cosmic daw...

Spectral Elements	NIRISS Wide Field Slitless Spectroscopy	Exposure Type	Filter	Grism	Readout Pattern	Groups/Int	Integrations/Exp	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	GRISM	F115W	GR150C	NIS	15	1	8	8	5239.544	
	2	GRISM	F115W	GR150R	NIS	15	1	8	8	5239.544	
	3	GRISM	F150W	GR150C	NIS	15	1	8	8	5239.544	
	4	GRISM	F150W	GR150R	NIS	15	1	8	8	5239.544	
	5	GRISM	F200W	GR150C	NIS	15	1	8	8	5239.544	
	6	GRISM	F200W	GR150R	NIS	15	1	8	8	5239.544	
Spectral Elements	NIRCam Imaging	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID	
	1	F090W	F444W	SHALLOW2	6	1	1	1	289.893		
	2	F090W	F444W	MEDIUM2	6	1	8	8	4466.496		
	3	F090W	F444W	SHALLOW2	6	1	1	1	289.893		
	4	F090W	F444W	SHALLOW2	6	1	1	1	289.893		
	5	F090W	F444W	MEDIUM2	6	1	8	8	4466.496		
	6	F090W	F444W	SHALLOW2	6	1	1	1	289.893		
	7	F115W	F444W	SHALLOW2	6	1	1	1	289.893		
	8	F115W	F444W	MEDIUM2	6	1	8	8	4466.496		
	9	F115W	F444W	SHALLOW2	6	1	1	1	289.893		
	10	F115W	F444W	SHALLOW2	6	1	1	1	289.893		
	11	F115W	F444W	MEDIUM2	6	1	8	8	4466.496		
	12	F115W	F444W	SHALLOW2	6	1	1	1	289.893		
	13	F150W	F356W	SHALLOW2	6	1	1	1	289.893		
	14	F150W	F356W	MEDIUM2	6	1	8	8	4466.496		
	15	F150W	F356W	SHALLOW2	6	1	1	1	289.893		
	16	F200W	F277W	SHALLOW2	6	1	1	1	289.893		
	17	F200W	F277W	MEDIUM2	6	1	8	8	4466.496		
	18	F200W	F277W	SHALLOW2	6	1	1	1	289.893		
Special Requirements	No Parallel										

Proposal 1324 - Observation 5 - Through the looking GLASS: a JWST exploration of galaxy formation and evolution from cosmic daw...

Observation	Proposal 1324, Observation 5: APA_195_june19											Tue Jun 11 16:01:08 GMT 2019
	Diagnostic Status: Warning											
	Observing Template: NIRSpec MultiObject Spectroscopy											
	Coordinated Parallel Template(s): NIRCcam Imaging											
Diagnostics	(Visit 5:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.											
Fixed Targets	#	Name	Target Coordinates			Targ. Coord. Corrections			Miscellaneous			
	(6)	TARGET-OBSERVATION-5	RA: 00 14 20.6878 (3.5861992d) Dec: -30 23 46.52 (-30.39626d) Equinox: J2000									
	Comments: This target was generated automatically for MSA Observation 5											
	Category=Galaxy Description=[Emission line galaxies, High-redshift galaxies, Lyman-alpha galaxies]											
Acquisition	NIRSpec MultiObject Spectroscopy	Reference Star Bin	Target	Filter	MSA Configuration	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID	
	1		SAME	F140X	Auto Acq MSA Config	NRS	3	1	4	558.312		
Template	NIRSpec MultiObject Spectroscopy					NIRCcam Imaging						
	TA Method: MSATA					Module: ALL						
	Obtain Confirmation Images: No					Subarray: FULL						
	Science Aperture: MSA Center											
Reference Stars												
Dithers	#	Dither Type										
	1	2-POINT-WITH-NIRCcam-SIZE2										
Spectral Elements	NIRSpec MultiObject Spectroscopy	Grating/Filter	MSA Configuration	Readout Pattern	Groups/Int	Integrations/Exp	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID	
	1	G140H/F100LP	Configuration: c0	NRSIRS2	20	1	NONE	6	6	8840.867		
	2	G140H/F100LP	Configuration: c0	NRSIRS2	20	1	NONE	6	6	8840.867		
	3	G235H/F170LP	Configuration: c0	NRSIRS2	20	1	NONE	6	6	8840.867		
	4	G235H/F170LP	Configuration: c0	NRSIRS2	20	1	NONE	6	6	8840.867		
	5	G395H/F290LP	Configuration: c0	NRSIRS2	20	1	NONE	6	6	8840.867		
	6	G395H/F290LP	Configuration: c0	NRSIRS2	20	1	NONE	6	6	8840.867		

Proposal 1324 - Observation 5 - Through the looking GLASS: a JWST exploration of galaxy formation and evolution from cosmic daw...

Spectral Elements	NIRCam Imaging	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
	1	F090W	F444W	DEEP8	7	1	6	6	8245.839	
	2	F090W	F444W	DEEP8	7	1	6	6	8245.839	
	3	F115W	F444W	DEEP8	7	1	6	6	8245.839	
	4	F115W	F444W	DEEP8	7	1	6	6	8245.839	
	5	F150W	F277W	DEEP8	7	1	6	6	8245.839	
	6	F200W	F356W	DEEP8	7	1	6	6	8245.839	
Special Requirements	No Parallel MSA Planned Aperture PA 195.0 to 195.0 Degrees (V3 56.50766 to 56.50766)									