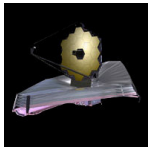

2028 - Mapping A Distant Protocluster Anchored by A Luminous Quasar in the Epoch of Reionization

Cycle: 1, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

Folder	***Observation***	***Label***	***Observing Template***	***Science Target***
MSA				
	1	J0910_new_observable_mpt	NIRSpec MultiObject Spectroscopy	(6) J0910m0414_all_objects_new
IFU				
	3	J0910Q-NIRSpec IFU	NIRSpec IFU Spectroscopy	(1) J0910Q

ABSTRACT

Theoretical models predict that luminous quasars should act as signposts for protoclusters in the young Universe. However, despite extensive searching, protoclusters traced by quasars have not yet been discovered in the epoch of reionization (EoR). Recent ALMA/JCMT sub-mm observations and Subaru narrow/broad band imaging of a luminous quasar at z=6.63 have finally revealed a spectacular overdensity of [CII] emitters, sub-mm galaxies, and Lyman alpha emitters, suggesting that it is the most distant known protocluster harboring quasar activity, and the first such system discovered in the EoR. An approved HST program will mosaic two 3.6'x3.6' fields, centered at the quasar and a galaxy merging system within this protocluster, respectively. The quasar, with both strong gas outflow as indicated by broad absorption lines and inflow as indicated by multiple metal absorption lines, is hosted by an extended massive merging galaxy. Moreover, the quasar host features an extremely broad [CII] line with a FWHM of 930 km/s, suggesting that this quasar resides in a deep gravitational potential and could be a progenitor of the brightest cluster galaxy (BCG).

We propose NIRSpec MSA observations to identify galaxies physically associated to this protocluster by targeting galaxies selected from HST observations. The MSA observations will allow us to map the 3D structure of the protocluster, measure AGN fraction of protocluster member galaxies, and characterize the physical properties of galaxies in the most dense structure yet known in the EoR. In addition, we will perform NIRSpec IFU observation of the quasar to study the formation of the BCG progenitor.

OBSERVING DESCRIPTION

Observation 1 - NIRSpec MSA observation of a field around the central luminous quasar

This is NIRSpec MSA follow-up of high redshift galaxies selected from HST/WFC3 imaging. The HST observations are scheduled in early 2021 and would give us plenty time to select targets.

We use the G395M/F290LP setup for observing Hbeta, [OIII] 4959, 5007, and Halpha emission lines of galaxies at z=6.6. The MSA observation will also target the luminous quasar, which will deliver a very high quality spectrum of the quasar.

We also perform coordinated parallel observations with NIRCam. We use the F115W+F356W and F070W+F444W combinations to select z~6.6 galaxies in an additional sky area within this giant protocluster.

Observation 2 - NIRSpec MSA observation of a field centered at a merging system in the protocluster

This observation is similar to Observation 1 but centered at a galaxy merger within the protocluster.

Observation 3 - NIRSpec IFU observations of the central quasar

The central quasar has strong outflow and inflow features and is hosted by a massive galaxy merger. We will use the IFU G395H/F290LP to map the strongest optical nebular lines (Hbeta, [OIII], Halpha, [NII]). The main science goals of this observation are characterizing the quasar outflow, detecting star formation in quasar host galaxy, and investigating the black hole fueling.

We will observe this object with IFU PRISM/CLEAR for detecting quasar host galaxy in continuum over the whole wavelength range covered by NIRSpec. We include leakcal at the first dither position for the PRISM observation.

We are using no target acquisition (i.e. point-and-shoot) for this observation. At any of the constrained PA range there are Gaia GS that can be selected for guiding and that will ensure the proper location of the target within the IFU aperture, with the required accuracy.

We are using NRSIRS2RAPID for a better identification and rejection of cosmic rays.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	J0910Q	RA: 09 10 54.5383 (137.7272429d) Dec: -04 14 6.98 (-4.23527d) Equinox: J2000	Proper Motion RA: 0 Proper Motion Dec: 0	
Comments: *Category=Galaxy* *Description=[High-redshift galaxies, Quasars]* *Extended=YES*				
(5)	J0910_new_observable_mpt	RA: 09 10 51.5845 (137.7149354d) Dec: -04 14 23.78 (-4.23994d) Equinox: J2000		
Comments: *Description=[]*				
(6)	J0910m0414_all_objects_new	RA: 09 10 50.8630 (137.7119292d) Dec: -04 14 21.50 (-4.23931d) Equinox: J2000		
Comments: *Description=[]*				

Observation

Proposal 2028, Observation 1: J0910_new_observable_mpt Tue Oct 17 17:00:49 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec MultiObject Spectroscopy

Coordinated Parallel Template(s): NIRCam Imaging

Comments: The target selection for the MSA observations will be based on our on-going HST program. Since our HST observations are delayed to March 2021, the MSA observations are not suitable for early observing windows. The assigned aperture angle could also be changed when we planning the MSA.

Diagnostics

(J0910_new_observable_mpt (Obs 1)) Warning (Form): Config c1 : J0910_empt_final_gg0-2 (#3) has 1 primary slits affected by failed closed shutters.

(J0910_new_observable_mpt (Obs 1)) Warning (Form): Config c1 : J0910_empt_final_gg1-2 (#4) has 1 primary slits affected by failed closed shutters.

(J0910_new_observable_mpt (Obs 1)) Warning (Form): Config c1 : J0910_empt_final_pp1-2 (#2) has 2 primary slits affected by failed closed shutters.

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

(Visit 1:2) Warning (Form): Overheads are provisional until the Visit Planner has been run.

(Visit 1:3) Warning (Form): Overheads are provisional until the Visit Planner has been run.

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

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(6)	J0910m0414_all_objects_new	RA: 09 10 50.8630 (137.7119292d) Dec: -04 14 21.50 (-4.23931d) Equinox: J2000		

Comments:
Description=[]

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	Filter: CLEAR; Readout: NRSRAPID; 8 sources in 4 quads; [Optimal TA Accuracy]	SAME	CLEAR	Auto Acq MSA Config	NRSRAPID	3	1	4	171.788	
2	Filter: CLEAR; Readout: NRSRAPID; 8 sources in 3 quads; [Optimal TA Accuracy]	SAME	CLEAR	Auto Acq MSA Config	NRSRAPID	3	1	4	171.788	
3	Filter: F140X; Readout: NRSRAPID; 8 sources in 3 quads; [Optimal TA Accuracy]	SAME	F140X	Auto Acq MSA Config	NRSRAPID	3	1	4	171.788	
4	Filter: CLEAR; Readout: NRSRAPID; 8 sources in 4 quads; [Optimal TA Accuracy]	SAME	CLEAR	Auto Acq MSA Config	NRSRAPID	3	1	4	171.788	

Template

NIRSpec MultiObject Spectroscopy	NIRCam Imaging
TA Method: MSATA	Module: ALL
Obtain Confirmation Images: No	Subarray: FULL
Science Aperture: MSA Center	Target Placement: Module Gap
Primary Candidate List: all_objects (20586 sources)	
Filler Candidate List: null	
Spectral Overlap Map: jwst-nirspec-hr	
Spectral Overlap Threshold: 1.5	

Reference Stars

Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude
1	5704	137.716354	-4.210172	21.35110092163086	1	12762	137.740123	-4.203600	22.00023078918457
1	10716	137.757706	-4.224849	22.34585952758789	1	13179	137.718220	-4.251922	22.41022872924804 7
1	11232	137.757851	-4.206585	22.54026794433593 8	1	14357	137.722138	-4.201382	21.92655372619629
1	11879	137.746169	-4.214421	22.36391448974609 4	1	14499	137.711306	-4.226407	21.5692138671875

Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude
2	3173	137.724503	-4.245120	22.07489967346191 4	2	10791	137.744716	-4.258630	21.72292327880859 4
2	3581	137.728714	-4.224166	22.25970077514648 4	2	15731	137.689286	-4.253932	23.06963157653808 6
2	5431	137.704910	-4.253550	21.50419998168945 3	2	16033	137.691762	-4.237468	21.49945068359375
2	10077	137.746852	-4.275422	21.3117733001709	2	16045	137.691464	-4.239818	22.81817245483398 4

Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude
3	275	137.736633	-4.267491	21.13599967956543	3	10338	137.762097	-4.223361	22.50615692138672
3	1204	137.733597	-4.258400	20.94540023803711	3	10716	137.757706	-4.224849	22.34585952758789
3	3581	137.728714	-4.224166	22.17609977722168	3	12626	137.740971	-4.206740	21.56042861938476 6
3	10285	137.761897	-4.224359	21.01115608215332	3	13179	137.718220	-4.251922	22.41022872924804 7

Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude
4	4764	137.706741	-4.264294	22.70999908447265 6	4	16089	137.687321	-4.250363	22.62482452392578
4	12918	137.722338	-4.251181	21.3936824798584	4	16132	137.695611	-4.224975	22.45500183105468 8
4	13179	137.718220	-4.251922	22.41022872924804 7	4	16876	137.681584	-4.239279	21.96625137329101 6
4	14499	137.711306	-4.226407	21.5692138671875	4	17120	137.681579	-4.232619	22.72784805297851 6

Dithers

#	Dither Type
1	NONE

Spectral Elements

NIRSpec MultiObject Spectroscopy	Exposure Specification	MSA Configuration	Nod Pattern	Pointing	Aperture PA	Dispersion Offset (Shutters)	Cross-Dispersion Offset (Shutters)	Total Dithers	Total Integrations	Total Exposure Time
1	2 (PRISM/CLEAR)	c1 : J0910_empt_final_pp0-2	3 Shutter Slitlet	137.73727291666665 Degrees -4.223900000000015 Degrees	70.8259757792843			3	6	4026.534
2	2 (PRISM/CLEAR)	c1 : J0910_empt_final_pp1-2	3 Shutter Slitlet	137.71654208333334 Degrees -4.256113888888876 Degrees	70.82743092589297			3	6	4026.534
3	1 (G395M/F290LP)	c1 : J0910_empt_final_gg0-2	3 Shutter Slitlet	137.74225166666665 Degrees -4.236825000000001 Degrees	70.82558446107561			3	6	6652.534
4	1 (G395M/F290LP)	c1 : J0910_empt_final_gg1-2	3 Shutter Slitlet	137.71009541666666 Degrees -4.246699999999976 Degrees	70.82792010285505			3	6	6652.534

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	F115W	F356W	MEDIUM8	6	2	6	3	3768.606	
2	F115W	F356W	MEDIUM8	6	2	6	3	3768.606	
3	F070W	F444W	MEDIUM8	10	2	6	3	6345.431	
4	F070W	F444W	MEDIUM8	10	2	6	3	6345.431	

Special Requirements

Group Visits within 53.0 Days
Visits Same PA
No Parallel Attachments
MSA Scheduled Aperture PA 70.8278 to 70.8278 Degrees (V3 292.25323 to 292.25323)

Observation

Proposal 2028, Observation 3: J0910Q-NIRSpec IFU

Tue Oct 17 17:00:49 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

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
(1)	J0910Q	RA: 09 10 54.5383 (137.7272429d) Dec: -04 14 6.98 (-4.23527d) Equinox: J2000	Proper Motion RA: 0 Proper Motion Dec: 0	

Comments:
Category=Galaxy
Description=[High-redshift galaxies, Quasars]
Extended=YES

Template

TA Method
NONE

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	CYCLING	MEDIUM	1	9	

Spectral Elements

#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Leakcal	Dither	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G395H/F290LP	NRSIRS2	17	1	false	true	NONE	9	9	11291.801	52382.10
2	PRISM/CLEAR	NRSIRS2RAPID	30	1	false	true	NONE	9	9	4070.3	52382.4
3	PRISM/CLEAR	NRSIRS2RAPID	30	1	true	false	NONE	1	1	452.256	