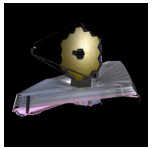

3117 - Mapping Quasar Light Echoes with Lyman-alpha Forest Tomography during the Epoch of Reionization

Cycle: 2, Proposal Category: GO

INVESTIGATORS

Name	*Institution*
Prof. Anna-Christina Eilers (PI)	**Massachusetts Institute of Technology**
Prof. Robert Andrew Simcoe (CoI) (US Admin CoI)	Massachusetts Institute of Technology
Dr. Jorryt Matthee (CoI) (ESA Member) (CoPI)	Institute of Science and Technology Austria
Dr. Rohan Naidu (CoI) (CoPI)	Massachusetts Institute of Technology
Dr. Frederick Davies (CoI) (ESA Member) (CoPI)	Max Planck Institute for Astronomy
Prof. Joseph Hennawi (CoI)	University of California - Santa Barbara
Prof. Simon J. Lilly (CoI) (ESA Member)	Eidgenossiche Technische Hochschule (ETH)
Dr. Minghao Yue (CoI)	Massachusetts Institute of Technology
Dr. Rongmon Bordoloi (CoI)	North Carolina State University
Dr. Ruari Mackenzie (CoI) (ESA Member)	ETH Zurich
Dr. Daichi Kashino (CoI)	National Astronomical Observatory of Japan (NAOJ)

OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	2	J1148_PAfixed_left_v4_2, J1148_PAfixed_right_v4_2	NIRSpec MultiObject Spectroscopy	(1) catalog_J1148_phaseII_v3

ABSTRACT

The ultraviolet radiation of luminous high-redshift quasars within the Epoch of Reionization carves out large bubbles of highly ionized intergalactic gas in the quasars' environments, making the otherwise opaque Lyman-alpha (Lya) forest highly transparent at redshifts near to the systemic redshift of the quasar, which is known as the proximity effect. In this proposal we aim to leverage the unique capabilities of JWST's NIRSpec/MSA to observe an overdensity of spectroscopically confirmed, bright galaxies in the background of two z>6 highly luminous quasars at close projected distances, in order to tomographically map the quasars' ionized regions for the first time by means of the transverse proximity effect. These observations will uniquely reveal the geometry of the quasar's ionization cone, and constrain its opening angle and obscuration. Additionally, the extent of the ionized regions, also known as the quasars' light echoes, provide a model-independent constraint on the quasar's age based on the light travel time, which will enable new insights on the puzzle of the early growth of supermassive black holes. Simultaneously, the quasars' highly ionized regions provide a unique laboratory to study the intrinsic ionizing properties of high-redshift galaxies without absorption by the IGM. By measuring the unattenuated line profiles of the Lya emission combined with a first census of high-ionization UV emission lines for ~60 galaxies at 5.7<z<7, our proposed observations aim to finally reveal the elusive protagonists that reionize the universe.

OBSERVING DESCRIPTION

We target bright (m_AB<27 mag in F115W) galaxies in two high-redshift (z>6), luminous quasar fields using NIRSpec/MSA. The targeted galaxies are spectroscopically confirmed by previous NIRCam/WFSS observations and are at redshifts 5.7<z<7.0, i.e. in the foreground (within the quasars' proximity zones) and background of the two quasars (at z=6.327 and z=6.4189).

In order to obtain a spatially well distributed sample of galaxies required for our science goals we need two NIRSpec/MSA configurations per quasar field. Using the APT's MSA Planning Tool we first assign weights to all ~120 spectroscopically confirmed galaxies at 5.7<z<7.0 in the quasar fields (1st priority to bright background sources, 2nd priority to bright galaxies within the proximity zone) and determine the best PA for our observations. In total we can observe 31-35 galaxies per field.

We choose the medium resolution grating + filter G140M/F070LP, which provides continuous wavelengths coverage between 0.70–1.27 m with a resolution of R~1000. For Lyman-alpha at the quasars' redshifts at approximately 0.9 m, the resolution is slightly lower, i.e. R~700, corresponding to a pixel scale of v~420 km/s. This resolution will enable us to resolve flux transmission within the Lyman-alpha forest of background galaxies with approximately 2-16 spectral pixels (depending on the pathlengths with high flux transmission), as well as de-blend the low EW of the UV emission lines and Lya emission of high-redshift galaxies.

Using the ETC we estimate that we need approximately 7.4 hours on source to obtain SNR~2 per resolution element for a galaxy of m_AB~26.5

mag, which corresponds to the 20% brightest galaxies in our sample. This will enable us to obtain a >3 sigma detection of the transverse proximity effect in four independent radial and azimuthal bins, allowing constraints on the extent and geometry of the quasar's ionzied region.

We chose 100 groups per integration, and adapt the recommended dither pattern with 3 nods in the shutter slitlets. These observations are duplicated six times, in order to achieve the required exposure time per MSA configuration.

We will use the readout mode NRSIRS2RAPID for its improved noise performance.

We will obtain target confirmation images, with 5 groups per integration, which will result in >3 sigma detections even for the faintest sources on slits (m_AB~28 mag).

Proposal 3117 - Targets - Mapping Quasar Light Echoes with Lyman-alpha Forest Tomography during the Epoch of Reionization

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	catalog_J1148_phaseII_v3	RA: 11 48 17.0446 (177.0710192d) Dec: +52 51 47.09 (52.86308d) Equinox: J2000		
Comments: *Description=[]*				

Observation

Proposal 3117, Observation 2: J1148_PAfixed_left_v4_2, J1148_PAfixed_right_v4_2 Thu Dec 21 01:00:33 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec MultiObject Spectroscopy

Diagnostics

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

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

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	catalog_J1148_phaseII_v3	RA: 11 48 17.0446 (177.0710192d) Dec: +52 51 47.09 (52.86308d) Equinox: J2000		

Comments:
Description=[]

Acquisition

#	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: NRSRAPIDD1; 8 sources in 3 quads; [Optimal TA Accuracy]	SAME	CLEAR	Auto Acq MSA Config	NRSRAPIDD1	3	1	4	257.682	
2	Filter: CLEAR; Readout: NRSRAPIDD1; 8 sources in 4 quads; [Optimal TA Accuracy]	SAME	CLEAR	Auto Acq MSA Config	NRSRAPIDD1	3	1	4	257.682	

Template

TA Method	Obtain Confirmation Images	Science Aperture	Primary Candidate List	Filler Candidate List	Spectral Overlap Map	Spectral Overlap Threshold
MSATA	After Target ACQ and New MSA Config	MSA Center	primary (129 sources)	secondary (1186 sources)	jwst-nirspec-g140m	1.5

Reference Stars

Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude
1	3627	177.117746	52.901392	22.74392651661791	1	14626	177.045952	52.869510	24.273263445939186
1	5465	177.107164	52.898827	23.572083941544655	1	18678	177.067646	52.904334	22.367614260758536
1	6088	177.108435	52.912684	24.220260134781974	1	20802	177.076449	52.907432	23.41053723439135
1	12916	177.065479	52.860175	23.469533434952872	1	22999	177.048755	52.910673	23.78597401722825

Visit	ID	RA	Dec	Magnitude	Visit	ID	RA	Dec	Magnitude
2	3883	177.099159	52.840124	24.109427920426505	2	15428	177.036390	52.827357	22.964717379655006
2	4207	177.093461	52.824192	22.426782122697013	2	18271	177.048772	52.835382	22.43836354359545
2	12916	177.065479	52.860175	23.469533434952872	2	20367	177.022212	52.868193	22.967320910538795
2	13138	177.065476	52.862554	23.170707217301505	2	22966	177.035475	52.862001	23.165893069352286

Confirmation

#	Confirmation Type	Conf. Readout Pattern	Conf. Groups/Int	Conf. Integrations/Exp	Conf. Total Integrations	Conf. Total Exposure Time
1	c1 : J1148_PAfixed_left_v4_2	NRSIRS2	6	1	1	452.256
2	c1 : J1148_PAfixed_right_v4_2	NRSIRS2	6	1	1	452.256

Spectral Elements

#	Exposure Specification	MSA Configuration	Nod Pattern	Pointing	Aperture PA	Dispersion Offset (Shutters)	Cross-Dispersion Offset (Shutters)	Total Dithers	Total Integrations	Total Exposure Time
1	1 (G140M/F070LP)	c1 : J1148_PAfixed_left_v4_2	3 Shutter Slitlet	177.09148954166668 Degrees 52.884543055555554 Degrees	356.5204275196853			3	18	27835.602
2	1 (G140M/F070LP)	c1 : J1148_PAfixed_right_v4_2	3 Shutter Slitlet	177.05494891666666 Degrees 52.847185 Degrees	356.4912853819863			3	18	27835.602

Special Requirements

Group Visits within 53.0 Days
Visits Same PA
MSA Scheduled Aperture PA 356.5041 to 356.5041 Degrees (V3 217.92958 to 217.92958)