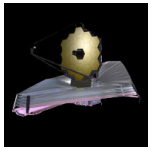

6595 - Giant in the Infant Universe: Identification of A Record-breaking Strongly-lensed (Ancestor of) Extremely Massive Quiescent Galaxy

Cycle: 2, Proposal Category: DD

INVESTIGATORS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1		NIRSpec IFU Spectroscopy	(1) COSMOS-GL-1
	2		MIRI Imaging	(1) COSMOS-GL-1

ABSTRACT

The discovery of massive (>10^10Msun) quiescent galaxies 1–2 Gyr after the Big Bang challenges our current understanding of galaxy evolution and cosmology. We report a new serendipitously discovered galaxy-scale strong gravitational lensing system, dubbed COSMOS-GL-1, which exhibits exceptionally red color with a dramatic flux drop of >~4.4 mag between the NIRCam F150W and F277W filters. Photometric redshifts derived from different codes consistently converge to two solutions: (1) a record-breaking highest redshift (z=4.8-5.7), most massive (stellar mass~1.5×10^11Msun), compact (size~300 pc), quiescent galaxy, which formed most of its stars before z~11; (2) a record-breaking z~12.5 ultra-luminous galaxy with absolute UV magnitude ~22.5 mag, manifesting itself as the most luminous and most massive (~10^10Msun) object at z>9 and the potential progenitor of the oldest quiescent galaxies at 3<z<5. The unique strength of strong lensing magnification makes our target to date the

only object capable of studying the stellar properties of such rare objects in a spatially resolved manner.

We propose to obtain NIRSpec IFU spectroscopy and MIRI F770W, F1000W, and F1280W imaging to derive unambiguous redshift and robust spatially-resolved star formation history. Confirmation of either solution with our proposed observations would set the most stringent constraints and challenges to existing galaxy formation/evolution models at cosmic dawn, which is crucial for designing more detailed observations of similar objects in the upcoming JWST Cycle 4 and future Cycles.

OBSERVING DESCRIPTION

We propose to obtain NIRSpec IFU spectroscopy and MIRI F770W, F1000W, and F1280W imaging to derive unambiguous redshift and robust spatially-resolved star formation history of the COSMOS-GL-1 source. We will use the PRISM/CLEAR grating to cover the entire wavelength range of NIRSpec (0.6–5.3 m) and to detect the stellar continuum redwards 2.3 m (corresponding to rest-frame ~34004000 Å for the low-z solution) under conservative assumptions. Our program is very time efficient, with a total exposure time of 2 hours for NIRSpec IFU spectroscopy and 45 mins for MIRI imaging.

NIRSpec IFU Spectroscopy

We will use the NRSIRS2RAPID readout pattern and the 5-point-small-cycling dither pattern for NIRSpec IFU PRISM spectroscopy to mitigate detector effects, to improve background subtraction, and to improve spatial and spectral sampling. With a total exposure time of 2 hours, we will be able to detect the stellar continuum with an S/N of ~10 at 2.3 m and S/N ~> 20 redwards 2.5 m within the region-of-interest, such that we will also have good spatial information of the source at the same time.

The adopted 5-point-small-cycling dither pattern includes an additional dither position at the target center compared to the four-point-dither pattern. This enhancement improves outlier rejection performance, as well as spatial and spectral sampling, without sacrificing S/N, given the same total exposure time.

No dedicated background exposures are needed because plenty of background pixels are available, which are free from target emission.

No target acquisition is needed for NIRSpec IFU observation, as the absolute pointing accuracy of direct pointing (0.1") is enough to ensure that the

target is well centered in the FoV of NIRSpec IFU.

No MSA lekeage exposure is needed as we have verified that no very bright stars will enter the FoV of MSA during the schedulable window.

MIRI imaging

We will adopt the FASTR1 readout pattern and the 4-Point Extended-Source dither pattern for MIRI imaging to mitigate detector effects and to improve background subtraction. We request a total exposure time of ~15 mins for each filter to ensure S/N > 15 to perform robust lens modeling and source flux measurement.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	COSMOS-GL-1	RA: 09 59 17.1740 (149.8215583d) Dec: +01 54 25.19 (1.90700d) Equinox: J2000	Epoch of Position: 2023	

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

Observation

Proposal 6595, Observation 1

Fri Apr 26 13:00:35 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

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)	COSMOS-GL-1	RA: 09 59 17.1740 (149.8215583d) Dec: +01 54 25.19 (1.90700d) Equinox: J2000	Epoch of Position: 2023	

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

Template

TA Method
NONE

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	CYCLING	SMALL	1	5	

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	PRISM/CLEAR	NRSIRS2RAPID	98	1	false	true	NONE	5	5	7221.501	

Observation

Proposal 6595, Observation 2

Fri Apr 26 13:00:35 GMT 2024

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)	COSMOS-GL-1	RA: 09 59 17.1740 (149.8215583d) Dec: +01 54 25.19 (1.90700d) Equinox: J2000	Epoch of Position: 2023	

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

Template

Subarray
FULL

Dithers

#	Dither Type	Starting Point	Number of Points	Points	Starting Set	Number of Sets	Optimized For	Direction	Pattern Size
1	4-Point-Sets				5	1	EXTENDED SOURCE	POSITIVE	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	F770W	FASTR1	82	1	1	Dither 1	4	4	910.213	
2	F1000W	FASTR1	82	1	1	Dither 1	4	4	910.213	
3	F1280W	FASTR1	82	1	1	Dither 1	4	4	910.213	