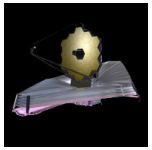

2345 - Resolved Studies of a Unique Lensed Quiescent Galaxy at z=2: Testing Models of Assembly History, Quenching, and IMF Variations

Cycle: 1, Proposal Category: GO

INVESTIGATORS

Name	*Institution*
Dr. Andrew B. Newman (PI)	**Carnegie Institution of Washington**
Prof. Sirio Belli (CoI) (ESA Member)	Universita di Bologna
Prof. Richard S. Ellis (CoI) (ESA Member)	University College London
Prof. Mariska Kriek (CoI) (ESA Member)	Leiden Observatory
Prof. Karl Glazebrook (CoI)	Swinburne University of Technology
Dr. Themiya Nanayakkara (CoI)	Swinburne University of Technology
Dr. Marziye Jafariyazani (CoI)	Caltech/IPAC
Dr. Shannon Patel (CoI)	Carnegie Institution of Washington

OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
MRG-M0138				
	1	M0138-OnSource-G140M	NIRSpec IFU Spectroscopy	(1) MRGM0138-IFU
	11	M0138-OnSource-G140M- Repeat 1	NIRSpec IFU Spectroscopy	(1) MRGM0138-IFU
	2	M0138-OffSource-G140M	NIRSpec IFU Spectroscopy	(2) MRGM0138-BKG
	12	M0138-OffSource-G140M-Repeat 2	NIRSpec IFU Spectroscopy	(2) MRGM0138-BKG
	3	M0138-OnSource-G235M	NIRSpec IFU Spectroscopy	(1) MRGM0138-IFU

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
	4	M0138-OffSource-G235M	NIRSpec IFU Spectroscopy	(2) MRGM0138-BKG
	5	M0138-Imaging	NIRCam Imaging	(3) MRGM0138-IMAGE

ABSTRACT

Observations of quiescent galaxies at redshifts z~2 have yielded many surprises, often upending contemporary models. JWST will undoubtedly provide further unexpected discoveries regarding the properties and progenitors of this key galaxy population. However, it will remain a challenge to study their internal structures and resolved stellar populations. We propose NIRSpec IFU observations of a strongly lensed massive quiescent galaxy that is, by far, the brightest high-redshift example. Studying this unique object will enable us to dissect a z=1.95 massive galaxy, seen ~1 Gyr after quenching, at a level of detail unprecedented beyond the local universe and impractical for any other known z~2 source. We will (1) spatially resolve detailed star formation histories and stellar chemical abundances of the bulge and inner and outer disk, revealing key formation events to test proposed connections between a central gas-rich starburst and galaxy-wide quenching; (2) produce the first 2D stellar kinematic map of any high-z galaxy, enabling us to assess whether the quenching process was linked to kinematic transformations; (3) produce the first 2D map of neutral gas in a high-z quiescent galaxy via ISM absorption and determine whether this gas sustains low-level star formation; and (4) probe the possible origins of the initial mass function (IMF) variations claimed in local early-type galaxies by comparing the IMFs of stars born in the bulge and disk. These detailed insights into the spatially resolved formation history of a massive quiescent galaxy are only possible for this unique target combined with the resolution, sensitivity, and wavelength coverage of JWST.

OBSERVING DESCRIPTION

We propose NIRSpec IFU observations of a lensed quiescent galaxy at z=1.95 using both the G140M and G235M grisms. The WATA mode will be used for acquisition. The offset target is either a star or a very compact galaxy based on HST imaging. Because of the angular extent of the target, equal exposures of a nearby background field are needed for subtraction. In order to mitigate any flux from other objects in the field (either in stuck open shutters or bleeding through the MSA), we will perform the standard 4-point dither pattern before moving to the background field and repeating the same pattern. We request a V3PA range of 30-60 deg for optimal placement of the target along the IFU diagonal. The precise IFU pointing may need to be refined (at the sub-arcsecond level) once the PA is set in the long-range plan. We also request that data with the two grisms be taken at a common PA, ensuring complete spectral coverage in each spaxel, and that the target and background exposures for each grism be taken non-interruptibly following the APT recommendation. Finally, we also request a brief NIRCam image using a standard 4-point dither pattern.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	MRGM0138-IFU	RA: 01 38 3.1700 (24.5132083d) Dec: -21 55 47.73 (-21.92993d) Equinox: J2000		
Comments: *Category=Galaxy* *Description=[High-redshift galaxies]* *Extended=YES*				
(2)	MRGM0138-BKG	RA: 01 38 3.5900 (24.5149583d) Dec: -21 55 46.60 (-21.92961d) Equinox: J2000		
Comments: *Category=Calibration* *Description=[Telescope/sky background]* *Extended=YES*				
(3)	MRGM0138-IMAGE	RA: 01 38 3.7500 (24.5156250d) Dec: -21 55 31.50 (-21.92542d) Equinox: J2000		
Comments: Coordinates specify the BCG of the lensing cluster, which will be offset to the B4 detector. *Category=Clusters of Galaxies* *Description=[Brightest cluster galaxies]* *Extended=YES*				
(5)	MRGM0138-OFFSET	RA: 01 38 2.8540 (24.5118917d) Dec: -21 55 51.16 (-21.93088d) Equinox: J2000	Epoch of Position: 2016.6	
Comments: WATA offset source. It is a galaxy with F160W mag = 21.1 AB, effective radius 0.3 arcsec, Sersic n = 2.5 based on HST image. Since it seems compact and featureless at HST resolution, I think this should be an acceptable offset source. Coordinates come from HST aligned to GAIA DR3. *Category=Galaxy* *Description=[Compact galaxies]* *Extended=YES*				

Observation

Proposal 2345, Observation 1: M0138-OnSource-G140M Tue Nov 28 22:00:30 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Background Observations:[M0138-OffSource-G140M (Obs 2)]

Diagnostics

(M0138-OnSource-G140M (Obs 1)) Warning (Form): The slew between the acquisition exposure and the farthest science exposure is 38.004 Arcsec (larger than the recommended limit of 38.000 Arcsec) and may result in reduced or no schedulability. See more information in the diagnostic browser.

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

(M0138-OnSource-G140M (Obs 1)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	MRGM0138-IFU	RA: 01 38 3.1700 (24.5132083d) Dec: -21 55 47.73 (-21.92993d) Equinox: J2000		

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

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	5 MRGM0138-OFFSET	WATA	SUB2048	F140X	NRSRAPIDD6	3	1	1	14.452	82104

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	4-POINT-DITHER				

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	G140M/F100LP	NRSIRS2	28	1	false	true	NONE	4	4	8228.134	55313

Special Requirements

Aperture PA Range 168.892975 to 198.892975 Degrees (V3 29.92044082 to 59.92044082)

Sequence Observations 1, 2, Non-interruptible
Same Aperture PA 1, 2, 3, 4

Observation

Proposal 2345, Observation 11: M0138-OnSource-G140M- Repeat 1 Tue Nov 28 22:00:30 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Background Observations:[M0138-OffSource-G140M-Repeat 2 (Obs 12)]

Diagnostics

(M0138-OnSource-G140M- Repeat 1 (Obs 11)) Warning (Form): The slew between the acquisition exposure and the farthest science exposure is 38.004 Arcsec (larger than the recommended limit of 38.000 Arcsec) and may result in reduced or no schedulability. See more information in the diagnostic browser.

(Visit 11:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

(M0138-OnSource-G140M- Repeat 1 (Obs 11)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	MRGM0138-IFU	RA: 01 38 3.1700 (24.5132083d) Dec: -21 55 47.73 (-21.92993d) Equinox: J2000		

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

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	5 MRGM0138-OFFSET	WATA	SUB2048	F140X	NRSRAPIDD6	3	1	1	14.452	82104

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	4-POINT-DITHER				

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	G140M/F100LP	NRSIRS2	28	1	false	true	NONE	4	4	8228.134	55313

Special Requirements

Aperture PA Range 168.892975 to 198.892975 Degrees (V3 29.92044082 to 59.92044082)

Sequence Observations 11, 12, Non-interruptible
Same Aperture PA 11, 12

Observation

Proposal 2345, Observation 2: M0138-OffSource-G140M Tue Nov 28 22:00:30 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Background Observation For: [M0138-OnSource-G140M (Obs 1)]

Diagnostics

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

(M0138-OffSource-G140M (Obs 2)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(2)	MRGM0138-BKG	RA: 01 38 3.5900 (24.5149583d) Dec: -21 55 46.60 (-21.92961d) Equinox: J2000		

Comments:
Category=Calibration
Description=[Telescope/sky background]
Extended=YES

Template

TA Method
NONE

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	4-POINT-DITHER				

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	G140M/F100LP	NRSIRS2	28	1	false	true	NONE	4	4	8228.134	

Special Requirements

Sequence Observations 1, 2, Non-interruptible
Same Aperture PA 1, 2, 3, 4

Observation

Proposal 2345, Observation 12: M0138-OffSource-G140M-Repeat 2 Tue Nov 28 22:00:30 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Background Observation For: [M0138-OnSource-G140M- Repeat 1 (Obs 11)]

Diagnostics

(Visit 12:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

(M0138-OffSource-G140M-Repeat 2 (Obs 12)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(2)	MRGM0138-BKG	RA: 01 38 3.5900 (24.5149583d) Dec: -21 55 46.60 (-21.92961d) Equinox: J2000		

Comments:
Category=Calibration
Description=[Telescope/sky background]
Extended=YES

Template

TA Method
NONE

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	4-POINT-DITHER				

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	G140M/F100LP	NRSIRS2	28	1	false	true	NONE	4	4	8228.134	

Special Requirements

Sequence Observations 11, 12, Non-interruptible
Same Aperture PA 11, 12

Observation

Proposal 2345, Observation 3: M0138-OnSource-G235M Tue Nov 28 22:00:30 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Background Observations:[M0138-OffSource-G235M (Obs 4)]

Diagnostics

(M0138-OnSource-G235M (Obs 3)) Warning (Form): The slew between the acquisition exposure and the farthest science exposure is 38.004 Arcsec (larger than the recommended limit of 38.000 Arcsec) and may result in reduced or no schedulability. See more information in the diagnostic browser.

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

(M0138-OnSource-G235M (Obs 3)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	MRGM0138-IFU	RA: 01 38 3.1700 (24.5132083d) Dec: -21 55 47.73 (-21.92993d) Equinox: J2000		

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

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	5 MRGM0138-OFFSET	WATA	SUB2048	F140X	NRSRAPIDD6	3	1	1	14.452	82104

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	4-POINT-DITHER				

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	G235M/F170LP	NRSIRS2	26	1	false	true	NONE	4	4	7644.578	55313

Special Requirements

Aperture PA Range 168.89297485 to 198.89297485 Degrees (V3 29.92044067 to 59.92044067)

Sequence Observations 3, 4, Non-interruptible
Same Aperture PA 1, 2, 3, 4

Observation

Proposal 2345, Observation 4: M0138-OffSource-G235M Tue Nov 28 22:00:30 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Background Observation For: [M0138-OnSource-G235M (Obs 3)]

Diagnostics

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

(M0138-OffSource-G235M (Obs 4)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(2)	MRGM0138-BKG	RA: 01 38 3.5900 (24.5149583d) Dec: -21 55 46.60 (-21.92961d) Equinox: J2000		

Comments:
Category=Calibration
Description=[Telescope/sky background]
Extended=YES

Template

TA Method
NONE

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	4-POINT-DITHER				

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	G235M/F170LP	NRSIRS2	26	1	false	true	NONE	4	4	7644.578	

Special Requirements

Sequence Observations 3, 4, Non-interruptible
Same Aperture PA 1, 2, 3, 4

Observation

Proposal 2345, Observation 5: M0138-Imaging Tue Nov 28 22:00:30 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

Comments: Centering target in the B3 detector with offset.

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
(3)	MRGM0138-IMAGE	RA: 01 38 3.7500 (24.5156250d) Dec: -21 55 31.50 (-21.92542d) Equinox: J2000		

Comments: Coordinates specify the BCG of the lensing cluster, which will be offset to the B4 detector.
Category=Clusters of Galaxies
Description=[Brightest cluster galaxies]
Extended=YES

Template

Module	Subarray	Target Placement
ALL	FULL	Module Gap

Dithers

#	Primary Dither Type	Primary Dithers	Subpixel Dither Type	Dither Size	Subpixel Positions
1	INTRAMODULEBOX	4	STANDARD		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	F150W	F444W	BRIGHT2	9	1	4	4	773.047	60311

Special Requirements

Offset 55.0 arcsec, 35.0 arcsec