



# 2913 - Dissecting the Monsters: Resolved IFU Spectroscopy of the Most Massive Quiescent Galaxies at $z > 3$

Cycle: 2, Proposal Category: GO

## INVESTIGATORS

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## OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Observation Folder				
	1	NIRSPec IFU 1120	NIRSpec IFU Spectroscopy	(1) XMM-VID3-1120
	2	NIRSPec IFU 2457	NIRSpec IFU Spectroscopy	(2) XMM-VID3-2457
	3	NIRSPec IFU 2075	NIRSpec IFU Spectroscopy	(3) XMM-VID1-2075

## ABSTRACT

Recent deep and wide near-IR surveys have led to the discovery of massive quiescent galaxies at  $3 < z < 4$  at abundances approximately ten times those predicted by simulations. Understanding the mechanisms behind their quenching is key to reproducing their number densities in models. We propose deep NIRSpec/IFU G235M/F170LP observations of 3 ultramassive ( $\log M/M_{\text{sun}} \sim 11.5$ ) quiescent galaxies spectroscopically confirmed at  $z \sim 3.5$ , resulting in the first spatially resolved spectroscopic study of ultra-massive quiescent galaxies in the first 2 billion years of cosmic history. These rest-frame optical data will allow us to:

- 1) Measure spatially resolved stellar population ages from features such as Dn(4000) and Hdelta, the latter of which is not observable from the ground at  $z=3.5$ , to probe when the stars in these systems formed,
- 2) Constrain residual dust-corrected star formation across the face of the target galaxies to within  $1 M_{\text{sun}}/\text{yr}$  using Balmer-decrement corrected Halpha, which is also not observable from the ground at this epoch, to measure how uniformly quenched these systems are,
- 3) Look for evidence of galaxy rotation, allowing for accurate characterizations of velocity dispersion and dynamical mass, and
- 4) Probe AGN activity through rest-frame optical line ratios (Hbeta, [OIII], Halpha, [NII]) as a possible quenching mechanism.

Together, these insights will shed light on the assembly of stellar mass and quenching processes in these extreme and mysterious distant galaxies which must have formed stars at incredibly high rates and then halted their star formation activity equally abruptly.

## OBSERVING DESCRIPTION

We propose for deep JWST NIRSPEC IFU G235M/F170LP observations of 3 of the most massive spectroscopically confirmed quiescent galaxies at  $z > 3$ .

In the tight redshift window of the targets ( $3.45 < z < 3.52$ ), the G235 grating will be sensitive to rest-frame optical wavelengths from [OII]3727 to [SII]6732, many of which are not observable from the ground at this epoch, and also removes bright sky line contamination seen in ground-based observations.

This will allow for the study of spatially resolved residual star formation and stellar population ages, AGN activity, and galaxy rotation, allowing us to constrain models of extreme galaxy evolution.

All targets are bright enough ( $m_K < 21.7$ ) to preclude the need for target acquisition strategies, and also small enough ( $r_e \sim 0.25''$ ) to preclude the need for off-scene nods.

We request a 4 point nod pattern to subtract in-field background flux and account for detector effects.

The Groups/Integration and Integrations/Exposure are chosen to reduce the effects of cosmic rays.

The NRSIRS2 readout pattern is requested to keep the data volume within the designated limits.

The total science exposure time is 14.27 hours while the total charged time, including overheads, is 19.41 hours.

Proposal 2913 - Targets - Dissecting the Monsters: Resolved IFU Spectroscopy of the Most Massive Quiescent Galaxies at  $z>3$

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	XMM-VID3-1120	RA: 02 27 10.0800 (36.7920000d) Dec: -04 34 44.99 (-4.57916d) Equinox: J2000	Proper Motion RA: 0 Proper Motion Dec: 0 Epoch of Position: 2000	
<i>Comments:</i> Category=Galaxy Description=[High-redshift galaxies] Extended=YES				
(2)	XMM-VID3-2457	RA: 02 26 56.0400 (36.7335000d) Dec: -04 32 11.64 (-4.53657d) Equinox: J2000	Proper Motion RA: 0 Proper Motion Dec: 0 Epoch of Position: 2000	
<i>Comments:</i> Category=Galaxy Description=[High-redshift galaxies] Extended=YES				
(3)	XMM-VID1-2075	RA: 02 17 32.8560 (34.3869000d) Dec: -05 28 57.39 (-5.48261d) Equinox: J2000	Proper Motion RA: 0 Proper Motion Dec: 0 Epoch of Position: 2000	
<i>Comments:</i> Category=Galaxy Description=[High-redshift galaxies] Extended=YES				

Fixed Targets

Proposal 2913 - Observation 1 - Dissecting the Monsters: Resolved IFU Spectroscopy of the Most Massive Quiescent Galaxies at  $z>3$

Mon Jun 03 18:00:19 GMT 2024

<b>Observation</b>	<p><b>Proposal 2913, Observation 1: NIRSPec IFU 1120</b></p> <p><b>Diagnostic Status: Warning</b></p> <p>Observing Template: NIRSpec IFU Spectroscopy</p>											
<b>Diagnostics</b>	(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.											
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>			<b>Targ. Coord. Corrections</b>			<b>Miscellaneous</b>			
	(1)	XMM-VID3-1120	RA: 02 27 10.0800 (36.7920000d) Dec: -04 34 44.99 (-4.57916d) Equinox: J2000			Proper Motion RA: 0 Proper Motion Dec: 0 Epoch of Position: 2000						
	<p><i>Comments:</i>  <i>Category=Galaxy</i>  <i>Description=[High-redshift galaxies]</i>  <i>Extended=YES</i></p>											
<b>Template</b>	<b>TA Method</b>											
	NONE											
<b>Dithers</b>	<b>#</b>	<b>Dither Type</b>		<b>Size</b>	<b>Starting Point</b>			<b>Number of Points</b>	<b>Points</b>			
	1	4-POINT-DITHER										
<b>Spectral Elements</b>	<b>#</b>	<b>Grating/Filter</b>	<b>Readout Pattern</b>	<b>Groups/Int</b>	<b>Integrations/Exp</b>	<b>Leakcal</b>	<b>Dither</b>	<b>Autocal</b>	<b>Total Dithers</b>	<b>Total Integrations</b>	<b>Total Exposure Time</b>	<b>ETC Wkbk.Calc ID</b>
	1	G235M/F170LP	NRSIRS2	10	5	false	true	NONE	4	20	14880.668	138725.1

Proposal 2913 - Observation 2 - Dissecting the Monsters: Resolved IFU Spectroscopy of the Most Massive Quiescent Galaxies at z>3

Mon Jun 03 18:00:19 GMT 2024

<b>Observation</b>	<p>Proposal 2913, Observation 2: NIRSPec IFU 2457</p> <p><b>Diagnostic Status: Warning</b></p> <p>Observing Template: NIRSpec IFU Spectroscopy</p>											
<b>Diagnostics</b>	(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.											
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>			<b>Targ. Coord. Corrections</b>			<b>Miscellaneous</b>			
	(2)	XMM-VID3-2457	RA: 02 26 56.0400 (36.7335000d)			Proper Motion RA: 0						
			Dec: -04 32 11.64 (-4.53657d)			Proper Motion Dec: 0						
			Equinox: J2000			Epoch of Position: 2000						
	<p><i>Comments:</i></p> <p><i>Category=Galaxy</i></p> <p><i>Description=[High-redshift galaxies]</i></p> <p><i>Extended=YES</i></p>											
<b>Template</b>	<b>TA Method</b>											
	NONE											
<b>Dithers</b>	<b>#</b>	<b>Dither Type</b>		<b>Size</b>	<b>Starting Point</b>			<b>Number of Points</b>	<b>Points</b>			
	1	4-POINT-DITHER										
<b>Spectral Elements</b>	<b>#</b>	<b>Grating/Filter</b>	<b>Readout Pattern</b>	<b>Groups/Int</b>	<b>Integrations/Exp</b>	<b>Leakcal</b>	<b>Dither</b>	<b>Autocal</b>	<b>Total Dithers</b>	<b>Total Integrations</b>	<b>Total Exposure Time</b>	<b>ETC Wkbk.Calc ID</b>
	1	G235M/F170LP	NRSIRS2	15	6	false	true	NONE	4	24	26610.135	

Proposal 2913 - Observation 3 - Dissecting the Monsters: Resolved IFU Spectroscopy of the Most Massive Quiescent Galaxies at  $z > 3$

<b>Observation</b>	Proposal 2913, Observation 3: NIRSpec IFU 2075 <span style="float: right;">Mon Jun 03 18:00:19 GMT 2024</span> Diagnostic Status: Warning Observing Template: NIRSpec IFU Spectroscopy											
	(Visit 3:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.											
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>			<b>Targ. Coord. Corrections</b>			<b>Miscellaneous</b>			
	(3)	XMM-VID1-2075	RA: 02 17 32.8560 (34.3869000d) Dec: -05 28 57.39 (-5.48261d) Equinox: J2000			Proper Motion RA: 0 Proper Motion Dec: 0 Epoch of Position: 2000						
Comments: Category=Galaxy Description=[High-redshift galaxies] Extended=YES												
<b>Template</b>	<b>TA Method</b>											
	NONE											
<b>Dithers</b>	<b>#</b>	<b>Dither Type</b>		<b>Size</b>	<b>Starting Point</b>			<b>Number of Points</b>	<b>Points</b>			
	1	4-POINT-DITHER										
<b>Spectral Elements</b>	<b>#</b>	<b>Grating/Filter</b>	<b>Readout Pattern</b>	<b>Groups/Int</b>	<b>Integrations/Ex p</b>	<b>Leakcal</b>	<b>Dither</b>	<b>Autocal</b>	<b>Total Dithers</b>	<b>Total Integrations</b>	<b>Total Exposure Time</b>	<b>ETC Wkbk.Calc ID</b>
	1	G235M/F170LP	NRSIRS2	9	4	false	true	NONE	4	16	10737.423	138725.1