



6405 - Clumpy Relics: The First Spectroscopic Confirmation of Globular Clusters at $z \sim 3$

Cycle: 3, Proposal Category: GO

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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	Clumps	NIRSpec IFU Spectroscopy	(1) UNCOVER35602-Clumps
	100	Clumps	NIRSpec IFU Spectroscopy	(1) UNCOVER35602-Clumps
	2	Host	NIRSpec IFU Spectroscopy	(4) Group UNCOVER35602-Host

ABSTRACT

With the discovery of "The Sparkler," JWST has opened up uncharted parameter space in the distant universe: remarkable high resolution views of ancient globular cluster (GC) candidates. There exists another fascinating galaxy in the Abell 2744 lensing cluster at even higher redshift that is littered with compact red and blue star-forming complexes - "The Relic". The Relic is a bright, quenched galaxy at $z=2.67$, merely a few billion years after the Big Bang. These clusters are potential GC candidates, with the red ones consistent with ancient relics, while the blue ones may be caught early in their formation (before possible disruption). However, these clumps will remain GC candidates until spectroscopically confirmed.

We propose a detailed spectroscopic follow-up using 20 hrs of NIRSpec IFU PRISM/CLEAR in order to:

- 1) confirm if the clusters are associated with the Relic,
- 2) robustly constrain the age, stellar mass, and other physical properties of the GC candidates
- 3) analyze clump survival timescales to inform theories of bulge formation that rely on infalling star-forming clumps.

Obtaining robust spectra for such faint objects will leverage the groundbreaking sensitivity and resolution of JWST, serving as proof-of-concept for a growing population of distant galaxies containing the first ancient relics of GCs.

OBSERVING DESCRIPTION

Our science goals are achievable with three pointings using the PRISM/CLEAR disperser-filter: (1) 0.5 hr in PRISM/CLEAR centered on the bright, main target grouped with (2) an identical 0.5 hr exposure of sky background, and (3) 14.5 hr in PRISM/CLEAR on the GC candidate pointing. We will use the NRSIRS2 readout pattern as it significantly reduces the correlated $1/f$ noise, important for obtaining the sky background. For the 14.5 hr pointing, we will observe with four integrations per exposure of 15 groups per integration. We are using a 12-point medium cycling dither pattern to have enough dithers to build robust background sky spectra excluding regions containing the main galaxy and clump candidates. For the 0.5 hr grouped pointings, we will observe in a 4-point small cycling dither pattern with a single integration per exposure and 8 groups per integration. The galaxy is extended mainly in one direction, hence we require two pointings at different depths in order to move along the semi-major axis, plus a third background pointing to keep a sufficient number of blank sky spaxels available. The medium cycling dither pattern for the deep exposure also ensures that all the clumps have uniform coverage during dithering. There is a bright star in Abell 2744 that could cause significant MSA leakage at certain position angles (PA). The ideal PA range to avoid this star is between 130 and 280 degrees. However, while the meteoroid safe zone is schedulable (2024-10-21 through 2024-12-16), the JWST General Target Visibility Tool states NIRSpec has a PA range between 31 and 65 degrees, which overlaps with the region of Abell 2744 where significant MSA leakage could occur. To avoid leakage from this bright star, we request a position angle constraint between 34-48 degrees, so that the star falls behind the solid metal plates of the MSA. We request blind pointing target acquisition which is good to 0.1", good enough to land the galaxy close to the center of the 3"x3" FoV.

The combined NIRCcam photometry and extract NIRSpec IFU observations for each clump (and the individual spaxels of the bright main target) will be fit with the public Prospector and Bagpipes SED fitting codes to robustly recover their physical properties (stellar mass, star formation rate, dust and metallicity). The NIRSpec PRISM mode is only one sufficient to obtain adequate SNR in the continuum (>3 per resolution element in the rest-optical). We will perform a joint spectrophotometric fit with 20-band JWST/NIRCcam broadband and medium-band photometry at the locations of each clump in order to constrain the continuum shape and measure the absorption line strengths. This is facilitated by the NRSIRS2 readout pattern, which reduces correlated noise in the spectrum. S/N estimates for PRISM/CLEAR are computed using the ETC, with the general program methodology modeled after the public APT file of the Sparkler IFU program (GO-2969). Similar lower spectral resolution data with more complexities in terms of background contamination have yielded robust ages from the spectrophotometric analysis of the rest-optical continuum and absorption features (Akhshik+2023), providing significant improvements on the derived physical parameters relative to photometry alone.

Proposal 6405 - Targets - Clumpy Relics: The First Spectroscopic Confirmation of Globular Clusters at z~3

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	UNCOVER35602-Clumps	RA: 00 14 6.5494 (3.5272892d) Dec: -30 22 2.52 (-30.36737d) Equinox: J2000	Proper Motion RA: 0 Proper Motion Dec: 0	
<i>Comments:</i> Category=Galaxy Description=[Elliptical galaxies] Extended=YES				
(2)	UNCOVER35602-Host-On	RA: 00 14 6.6542 (3.5277258d) Dec: -30 21 59.72 (-30.36659d) Equinox: J2000		
<i>Comments:</i> Category=Galaxy Description=[Elliptical galaxies]				
(3)	UNCOVER35602-Host-Off	RA: 00 14 7.0976 (3.5295733d) Dec: -30 22 0.81 (-30.36689d) Equinox: J2000		
<i>Comments:</i> Category=Galaxy Description=[Elliptical galaxies]				
(4)	Group UNCOVER35602-Host			
<i>Comments:</i> Target Selection=[2 UNCOVER35602-Host-On, 3 UNCOVER35602-Host-Off]				

Fixed Targets

Proposal 6405 - Observation 1 - Clumpy Relics: The First Spectroscopic Confirmation of Globular Clusters at z~3

Thu Nov 21 00:00:12 GMT 2024

Observation	<p>Proposal 6405, Observation 1: Clumps</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRSpec IFU Spectroscopy</p>											
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)	UNCOVER35602-Clumps	RA: 00 14 6.5494 (3.5272892d) Dec: -30 22 2.52 (-30.36737d) Equinox: J2000			Proper Motion RA: 0 Proper Motion Dec: 0						
	<p><i>Comments:</i> <i>Category=Galaxy</i> <i>Description=[Elliptical galaxies]</i> <i>Extended=YES</i></p>											
Template	TA Method											
	NONE											
Dithers	#	Dither Type		Size	Starting Point		Number of Points	Points				
	1	CYCLING		MEDIUM	1		12					
Spectral Elements	#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Ex p	Leakcal	Dither	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	PRISM/CLEAR	NRSIRS2	15	4	false	true	NONE	12	48	53220.271	169257.2
Special Requirements	Aperture PA Range 172.97164917 to 186.97164917 Degrees (V3 34.0 to 48.0)											

Proposal 6405 - Observation 100 - Clumpy Relics: The First Spectroscopic Confirmation of Globular Clusters at z~3

Thu Nov 21 00:00:12 GMT 2024

Observation	<p>Proposal 6405, Observation 100: Clumps</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRSpec IFU Spectroscopy</p>											
Diagnostics	(Visit 100:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.											
Fixed Targets	#	Name	Target Coordinates			Targ. Coord. Corrections			Miscellaneous			
	(1)	UNCOVER35602-Clumps	RA: 00 14 6.5494 (3.5272892d) Dec: -30 22 2.52 (-30.36737d) Equinox: J2000			Proper Motion RA: 0 Proper Motion Dec: 0						
	<p><i>Comments:</i> <i>Category=Galaxy</i> <i>Description=[Elliptical galaxies]</i> <i>Extended=YES</i></p>											
Template	TA Method											
	NONE											
Dithers	#	Dither Type		Size	Starting Point		Number of Points	Points				
	1	CYCLING		MEDIUM	1		12					
Spectral Elements	#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Ex p	Leakcal	Dither	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
	1	PRISM/CLEAR	NRSIRS2	15	4	false	true	NONE	12	48	53220.271	169257.2
Special Requirements	Aperture PA Range 206.47164917 to 220.97164917 Degrees (V3 67.5 to 82.0)											

Proposal 6405 - Observation 2 - Clumpy Relics: The First Spectroscopic Confirmation of Globular Clusters at z~3

Thu Nov 21 00:00:12 GMT 2024

Observation	<p>Proposal 6405, Observation 2: Host</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRSpec IFU Spectroscopy</p>											
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			
	(4)	Group UNCOVER35602-Host										
	<p><i>Comments:</i> <i>Target Selection=[2 UNCOVER35602-Host-On, 3 UNCOVER35602-Host-Off]</i></p>											
Template	TA Method											
	NONE											
Dithers	#	Dither Type		Size	Starting Point			Number of Points	Points			
	1	CYCLING		SMALL	1			4				
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	NRSIRS2	8	1	false	true	NONE	4	4	2392.578	169257.1
Special Requirements	Aperture PA Range 172.97164917 to 186.97164917 Degrees (V3 34.0 to 48.0)											