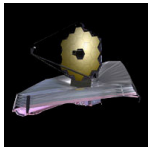

11883 - Opening a New Window on Globular Cluster Formation with Strong Lensing at z=2

Cycle: 5, Proposal Category: GO

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
MRG-M0138				
	1	MRG-M0138-IMAGING	NIRCam Imaging	(1) MRG-M0138-IMAGE
	2	MRG-M0138-IFU	NIRSpec IFU Spectroscopy	(2) MRG-M0138-IFU

ABSTRACT

Globular clusters (GCs) are ancient relics of galaxy formation, yet their origins remain elusive due to large age uncertainties, early disruption, and dynamical evolution over >10 Gyr. JWST now makes it possible to detect their progenitors directly at high redshift. We propose deep NIRSpec/IFU spectroscopy and complementary NIRCam imaging of the extremely magnified (mu>150) z=1.95 galaxy MRG-M0138 - the most powerful laboratory yet for probing GC formation. These observations will reach ~10^5 Msun clusters (an order of magnitude below previous limits) and deliver the first spectroscopic measurements of the ages and metallicities of typical GCs at cosmic noon. For the brightest few, we will search for abundance anomalies (e.g., nitrogen enhancement via CN/CH absorption bands). Intriguingly, MRG-M0138 also hosts an overabundance of “too-massive” (>10^7 Msun) compact clusters, reminiscent of similar JWST discoveries, whose nature - whether genuinely massive GCs, ultra-compact dwarfs, or younger systems with overestimated masses - remains unknown. New NIRCam rest-U and Pa-beta imaging will refine metallicity and age diagnostics across the full population. Together, this program will establish the first spectroscopic foundations for understanding both normal and extreme GC candidates at high redshift, anchoring future studies of cluster formation and evolution.

OBSERVING DESCRIPTION

We will obtain deep NIRSpec/IFU PRISM spectroscopy (19.6 hr) of 16 globular cluster (GC) candidates near the critical curve of the z=1.95 lensed quiescent galaxy MRG-M0138, plus NIRCam F090W/F360M imaging (7.1 hr).

A single IFU pointing using the PRISM grating with a 12-point MEDIUM CYCLING dither will provide uniform coverage over 0.6–5.3 micron,

assuming a medium background and using the NRSIRS2 readout pattern as it significantly reduces the correlated 1/f noise, important for obtaining the sky background. No dedicated background IFU observation is required here (Welch et al. 2023). PRISM mode is the only one sufficient to obtain adequate SNR in the continuum for this pilot study. The resulting spectra will achieve S/N>5 per resolution element for all targets (F444W = 25.8–28.2 AB); the brightest clusters (~26 AB) will reach S/N~40 per resolution element, enabling detection of CN and CH absorption features in stacks or possibly individually. Four 20 degree orientation windows ensure that all 16 targets fall within the IFU field of view. Blind target acquisition is sufficient given the 0.1 pointing accuracy.

NIRCam imaging will add rest-frame U coverage (F090W) to constrain metallicities and use F360M to detect Pa-beta excess and identify young clusters or contaminants, adopting the same RA and Dec as PID 2345. We use the INTRAMODULEBOX/DEEP8 dither strategy (4x8 groups, 4 dithers), ensuring uniform coverage and effective cosmic ray removal.

Together, these data enable spectroscopic measurements of GC ages, metallicities, and abundance anomalies, while improving photometric age–metallicity classification across the wider GC population.

All requested observations are supported by estimates computed in ETC Workbook 275152.

Proposal 11883 - Targets - Opening a New Window on Globular Cluster Formation with Strong Lensing at z=2

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	MRG-M0138-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, following PID 2345. *Category=Clusters of Galaxies* *Description=[Brightest cluster galaxies]* *Extended=YES*				
(2)	MRG-M0138-IFU	RA: 01 38 3.3840 (24.5141000d) Dec: -21 55 49.36 (-21.93038d) Equinox: J2000		
Comments: *Category=Galaxy* *Description=[Elliptical galaxies, High-redshift galaxies]*				

Observation

Proposal 11883, Observation 1: MRG-M0138-IMAGING

Fri Mar 13 22:04:10 GMT 2026

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

Diagnostics

(MRG-M0138-IMAGING (Obs 1)) Warning (Form): By selecting Target Placement = Module Gap the target coordinates will not fall on any detector unless an appropriate Mosaic, set of Dithers or Offset Special Requirement is specified.

(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)	MRG-M0138-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, following PID 2345.
Category=Clusters of Galaxies
Description=[Brightest cluster galaxies]
Extended=YES

Template

Module	Subarray	Target Placement
ALL	FULL	Module gap (large extended source)

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	Optional ETC ID
1	F090W	F360M	DEEP8	8	4	16	4	25553.513	275152

Observation

Proposal 11883, Observation 2: MRG-M0138-IFU

Fri Mar 13 22:04:10 GMT 2026

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

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
(2)	MRG-M0138-IFU	RA: 01 38 3.3840 (24.5141000d) Dec: -21 55 49.36 (-21.93038d) Equinox: J2000		

Comments:
Category=Galaxy
Description=[Elliptical galaxies, High-redshift galaxies]

Template

TA Method	HFF Readout Mode
NONE	false

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	CYCLING	MEDIUM	1	12	

Spectral Elements

#	Grating/Filter	Readout Pattern	Groups/Int	Integrations/Exp	Leakcal	Dither	Autocal	Total Dithers	Total Integrations	Total Exposure Time	Optional ETC ID
1	PRISM/CLEAR	NRSIRS2	20	4	false	true	NONE	12	48	70726.939	275152

Special Requirements

Aperture PA Range 60 to 80 Degrees (V3 281.02835083 to 301.02835083)
Aperture PA Range 150 to 170 Degrees (V3 11.02835083 to 31.02835083)
Aperture PA Range 240 to 260 Degrees (V3 101.02835083 to 121.02835083)
Aperture PA Range 330 to 350 Degrees (V3 191.02835083 to 211.02835083)