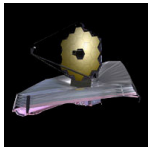

# 7049 - A Unique Opportunity to Probe Lensing-Magnified Star Clusters in a Low-Mass Galaxy at z_spec=8.3 with JWST

Cycle: 4, Proposal Category: GO

**INVESTIGATORS**


| *Name* | *Institution* |
|---|---|
| **Lamiya Mowla (PI)** | **Wellesley College** |
| Kartheik Iyer (CoI) (CoPI) (Contact) | Columbia University in the City of New York |
| Guillaume Desprez (CoI) (ESA Member) | Kapteyn Astronomical Institute |
| Nusrath Jahan (CoI) | Shahjalal University of Science and Technology |
| Prof. Marusa Bradac (CoI) | University of Ljubljana, Dept. of Physics |
| Dr. Gabriel Brammer (CoI) (ESA Member) | University of Copenhagen, Niels Bohr Institute |
| Dr. Marcin Sawicki (CoI) (CSA Member) | Saint Mary's University |
| Dr. Yoshihisa Asada (CoI) (CSA Member) | University of Toronto |
| Dr. Nicholas Martis (CoI) | University of Ljubljana, Dept. of Physics |
| Vivian Yun Yan Tan (CoI) (CSA Member) | York University |
| Dr. Camilla Pacifici (CoI) | Space Telescope Science Institute |
| Prof. Roberto G. Abraham (CoI) (CSA Member) | University of Toronto |
| Gregor Rihtarsic (CoI) | University of Ljubljana, Dept. of Physics |
| Maya Merchant (CoI) (ESA Member) | University of Copenhagen, Niels Bohr Institute |
| Dr. Adam Muzzin (CoI) (CSA Member) | York University |
| Dr. Roberta Tripodi (CoI) (ESA Member) | INAF - Osservatorio Astronomico di Roma |
| Dr. Jacqueline Antwi-Danso (CoI) (CSA Member) | University of Toronto |
| Dr. Anishya Harshan (CoI) | University of Ljubljana, Dept. of Physics |
| Dr. Vicente Estrada-Carpenter (CoI) | Arizona State University |
| Dr. Vladan Markov (CoI) | University of Ljubljana, Dept. of Physics |
| Dr. Gaia Gaspar (CoI) (CSA Member) | Saint Mary's University |

| *Name* | *Institution* |
|---|---|
| Ms. Cassandra Withers (CoI) (CSA Member) | York University |
| Mr. Visal Sok (CoI) (CSA Member) | York University |
| Prof. Greg Bryan (CoI) (US Admin CoI) | Columbia University in the City of New York |


**OBSERVATIONS**

| *Folder* | *Observation* | *Label* | *Observing Template* | *Science Target* |
|---|---|---|---|---|
| Observation Folder | | | | |
| | 1 | | NIRSpec IFU Spectroscopy | (1) Firefly |


**ABSTRACT**

We propose for high signal-to-noise spatially resolved spectroscopic observations of the Firefly Sparkle (FS), a highly magnified galaxy at z$_{spec} = 8.3$, using NIRSpec/PRISM IFU to obtain spectra of the individual star clusters.
These observations are only possible due to NIRSpec's unparalleled sensitivity, making it uniquely capable of resolving the spatially resolved ISM conditions within and around the star clusters in a lensing magnified low-mass galaxy at cosmic dawn.

These timely observations coincide with JWST's groundbreaking ability to directly observe globular cluster (GC) formation, and provide a bridge between the old stellar populations that we see in GCs today and the young clusters they are thought to form from. Our key science goals are to: (i) characterize the extreme ISM conditions in the clusters, (ii) determine whether they form in a single burst or show extended star formation, (iii) investigate the potential evidence for an excess of massive stars expected in early star formation using Nitrogen abundances, and (iv) evaluate the possibility of a clumpy CGM by spatially resolving the Lyman-break. These observations will significantly advance our understanding of the birth of the first stellar systems in a low-mass galaxy at extreme redshifts, probe the connection between massive star clusters in young galaxies and future globular clusters, and provide synergies with upcoming ALMA measurements.


**OBSERVING DESCRIPTION**

We will use NIRSpec/IFU with CLEAR/PRISM to observe the galaxy for 41.5 hours. This will provide a continuum SNR per pixel of $\sim 5-15$ for the star clusters and $\sim 2-3$ at $2 \, \mu$m for the diffuse galaxy body. The entire FS fits diagonally within the IFU field of view (FoV). We will use a 4-point dither pattern centered at four locations along the galaxy. This 16-point dither ensures robust background spectra free from contamination by the nearby bright cluster galaxy, while covering all star clusters of interest. The central brightest clusters, crucial for ISM studies, will remain in the FoV for all 16 pointings, achieving an SNR of 20 for the continuum and 40-80 for emission lines. The outermost clusters, with the

lowest magnification, will be in the FoV for half the pointings, allowing us to determine their stellar properties. We will use the NRSIRS2 readout pattern, which reduces correlated 1/f noise, crucial for sky background acquisition. Each pointing will include 32 groups and 4 integrations. To avoid leakage through the MSA, we request a V3PA constraint of 191 to 216 and 296 to 112 degrees, ensuring that bright stars and cluster galaxies are behind the MSA’s solid metal plates. Blind pointing target acquisition, accurate to 0.1", will position the galaxy near the center of the $3" \times 3"$ FoV.

**Fixed Targets**

| # | Name | Target Coordinates | Targ. Coord. Corrections | Miscellaneous |
|---|---|---|---|---|
| (1) | Firefly | RA: 14 23 46.1747 (215.9423946d)<br>Dec: +24 04 10.74 (24.06965d)<br>Equinox: J2000 | Epoch of Position: 2000 | |

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

## Observation

**Proposal 7049, Observation 1**

Mon Jul 14 15:00:18 GMT 2025

**Diagnostic Status: Warning**

Observing Template: NIRSpec IFU Spectroscopy

## Diagnostics

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

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

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Miscellaneous |
|---|---|---|---|---|
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*Comments:*
*Category=Galaxy*
*Description=[High-redshift galaxies, Protogalaxies]*
*Extended=YES*

## Template

| TA Method | HFF Readout Mode |
|---|---|
| NONE | false |

## 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 | PRISM/CLEAR | NRSIRS2 | 32 | 4 | false | true | NONE | 4 | 16 | 37580.981 | |
| 2 | PRISM/CLEAR | NRSIRS2 | 32 | 4 | false | true | NONE | 4 | 16 | 37580.981 | |
| 3 | PRISM/CLEAR | NRSIRS2 | 32 | 4 | false | true | NONE | 4 | 16 | 37580.981 | |
| 4 | PRISM/CLEAR | NRSIRS2 | 32 | 4 | false | true | NONE | 4 | 16 | 37580.981 | |

## Special Requirements

Group Visits within 53.0 Days
Aperture PA Range 74.97164917 to 250.97164917 Degrees (V3 296.0 to 112.0)
Aperture PA Range 329.97164917 to 354.97164917 Degrees (V3 191.0 to 216.0)
Visits Same PA