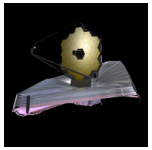

# 2279 - Where Cosmic Dawn Breaks First: Mapping the Primordial Overdensity Powering a z~9 Ionized Bubble

Cycle: 1, Proposal Category: GO

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**OBSERVATIONS**

| *Folder* | *Observation* | *Label* | *Observing Template* | *Science Target* |
|---|---|---|---|---|
| F444W-Grism | | | | |
| | 1 | NIRCam Grism | NIRCam Wide Field Slitless Spectroscopy | (1) EGSZ8P7-BUBBLE |

**ABSTRACT**

Models of cosmic reionization predict that the earliest star-forming systems develop in primordial overdensities which, in turn, create ionized bubbles. With time, these bubbles grow and coalesce until the intergalactic medium is fully ionized. Since Lyman-alpha photons originating in these protoclusters can propagate freely through ionized gas, the highest redshift Lyman Alpha emitters (LAEs) act as valuable tracers of early ionized bubbles. We present evidence that the highest redshift LAE, EGSz8p7 (z=8.68), is likely embedded in such an overdensity. Collectively, in all of HST's deep fields, blank fields and gravitationally-lensed fields spanning >1000 arcmin^2 there are ~30 photometric candidates at z~9, yet a third lie within 3.75' (10 cMpc) of EGSz8p7. To confirm and exploit this extraordinary early overdensity we seek systemic redshifts and diagnostic features only JWST can provide. We propose blind, grism spectroscopy to map the ionized bubble around EGSz8p7 using the [OIII] doublet. A blind survey is optimal for determining a complete census of EGSz8p7's physical neighbors. Spitzer/IRAC color excesses at z>8 imply extreme [OIII] EWs (~6000 A) ensuring efficient use of JWST. Stellar population modeling of the sources around EGSz8p7 may give us the strongest constraints yet on when star-formation first commenced after the Big Bang (i.e., cosmic dawn). Our spectra will likewise constrain the ionizing photon production efficiency, a key unknown in reionization calculations. Our observing strategy is designed for maximum legacy value with a footprint overlapping the CEERS ERS survey and use of the wide F444W grism that will guarantee additional 1<z<9 science.

**OBSERVING DESCRIPTION**

Our goal is to reach a 6-sigma emission-line sensitivity for NIRCam/grism observations of 3.3x10^{-18} erg/s/cm^2, which is the expected, average [OIII]5007 flux of the faintest neighboring sources around EGSz8p7 identified in HST imaging (with H=27.5mag). Based on the ETC, we can reach such lines in 8x880s (MEDIUM2, Ngroups=9, Nint=1) in the F444W filter. We will obtain two pointings, offset by 1150 pixels in order to reach full coverage of the [OIII]5007 line at z=8.68 (at 4.85micron) over two areas of 2.2x2.6arcmin^2. The orient requirement is set to cover the spectroscopicallly confirmed source EGSz8p7 in one detector and the very luminous z~9 galaxy candidate EGS910-3 in the other. Background-limited exposures are required, as the achieved S/N of our emission line spectra changes by >10% at ~4micron between low and high background. These constraints have only limited impact on the scheduling, which is still possible over 51 days.

We will only use one dispersion direction, GrismR, given that the GrismC results in disproportional overheads (due to the very large offsets required

for the out-of field images). Additionally, creating the required area with full wavelength coverage would result in further extra costs. We will build on the community's expertise with the WFC3/IR grisms and public toolsets to fully model the contamination of all galaxies within the field of view. We will obtain our exposures with 4-point large scale dithers, but no sub-pixel dithering. Direct images are taken after the last grism exposures. At the same time, we will take short-wavelength imaging over the same field. Images are taken with the SHALLOW4 and MEDIUM2 readout modes (6 and 9 groups) for the direct images and grism exposures, respectively.

The direct and out-of-field image exposure times are set such that we will detect every source in imaging at 5sigma if it shows a 5sigma line in the grism spectrum. This amounts to a 15min exposure only. The total request is therefore 7.1 hours, of which 4.4hrs are science time.

No parallels are requested.

**Fixed Targets**

| # | Name | Target Coordinates | Targ. Coord. Corrections | Miscellaneous |
|---|---|---|---|---|
| (1) | EGSZ8P7-BUBBLE | RA: 14 19 53.4106 (214.9725442d)<br>Dec: +52 54 13.79 (52.90383d)<br>Equinox: J2000 | | |

*Comments:*
*Category=Unidentified*
*Description=[Blank field]*

## Observation

**Proposal 2279, Observation 1: NIRCam Grism** Tue Mar 30 20:08:36 GMT 2021

**Diagnostic Status: Warning**

Observing Template: NIRCam Wide Field Slitless Spectroscopy

## Diagnostics

(NIRCam Grism (Obs 1)) Warning (Form): Use of only one of GRISMR or GRISMC may result in spectral overlap from multiple sources that can't be corrected. Users should address this issue in their proposal text.

(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=Unidentified*
*Description=[Blank field]*

## Template

| Module | Subarray | Grism (Long Wavelength) |
|---|---|---|
| ALL | FULL | GRISMR |

## Mosaic

| Rows | Columns | Row Overlap % | Column Overlap % | Row shift | Column shift | Tile Order |
|---|---|---|---|---|---|---|
| 1 | 2 | 3.0 | 76.0 | 0.0 | 0.0 | DEFAULT |

## Dithers

| # | Primary Dither Type | Primary Dithers | Subpixel Positions |
|---|---|---|---|
| 1 | INTRAMODULEBOX | 4 | NONE |

## Direct Image

| # | Short Filter | Long Filter | Readout Pattern | Groups/Int | Integrations/Exp | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID | Grism (Long Wavelength) | Exposure Type | Total Dithers |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | F210M | F444W | SHALLOW4 | 6 | 1 | 1 | 311.366 | | GRISMR | Direct Image | 1 |

## Spectral Elements

| # | Short Filter | Long Filter | Readout Pattern | Groups/Int | Integrations/Exp | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID | Grism (Long Wavelength) | Exposure Type | Total Dithers |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | F182M | F444W | MEDIUM2 | 9 | 1 | 4 | 3521.661 | | GRISMR | Grism (Long Wavelength) | 4 |
| 2 | F210M | F444W | MEDIUM2 | 9 | 1 | 4 | 3521.661 | | GRISMR | Grism (Long Wavelength) | 4 |
| 3 | F210M | F444W | SHALLOW4 | 6 | 1 | 2 | 622.733 | | | Out of Field | 2 |

| Special Requirements | |
|---|---|
| | Group Visits within 53.0 Days<br>Aperture PA Range 173 to 216 Degrees (V3 173.0 to 216.0)<br>Visits Same PA<br>Background Limited. Background no more than 10% above minimum |