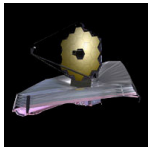

# 1712 - JWST beholds the multiple-merger assembly of the most luminous quasar

Cycle: 1, Proposal Category: GO

**INVESTIGATORS**


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**OBSERVATIONS**

| *Folder* | *Observation* | *Label* | *Observing Template* | *Science Target* |
|---|---|---|---|---|
| Observation Folder | | | | |
| | 1 | MIRI-BKG | MIRI Medium Resolution Spectroscopy | (3) W2246-0526-MIRI-MRS-BKG |
| | 2 | MIRI | MIRI Medium Resolution Spectroscopy | (1) W2246-0526-MIRI-MRS |
| | 3 | NIRSPEC | NIRSpec IFU Spectroscopy | (2) W2246-0526-NIRSPEC-IFU |

**ABSTRACT**

The most luminous quasars open a window to study the physics that govern the assembly of mass at the nodes of the cosmic web at a time when the Universe was ramping up to its period of peak activity. In particular, “cosmic morning” z ~ 3–5 obscured quasars may be signposting the locations at which the most super-massive black holes were being built via the accretion of in-falling galaxies, before emerging in a blast of radiation. While long-predicted by simulations, the detection of the tidal structures that could pinpoint the dynamics of these systems is at the limit of current facilities. Deep ALMA observations of the [CII] line in the most luminous galaxy known, W2246–0526, a hyper-luminous obscured quasar at z = 4.6 surrounded by multiple neighbor galaxies, have now revealed the complex kinematics of this merger system with unparalleled detail at this epoch. Companion galaxies, tidal streams, proto-spiral arms, gas clumps and bubbles, are all resolved spatially and spectrally. However, the [CII] emission does not allow for an unambiguous characterization of the ionizing sources, as it arises from virtually every interstellar medium phase. Here we request JWST NIRSpec IFU and MIRI MRS observations of the W2246–0526 system to identify the sources of gas ionization and heating, establish whether the multi-phase [CII] gas is kinematically coupled to the purely ionized phase, and reveal the transition between the starlight-dominated spectrum of W2246–0526's host and the hot dust continuum from the central obscured quasar. These observations will test the paradigm of galaxy-quasar feeding and feedback in this truly unique source, adding an early gem to the JWST legacy.

**OBSERVING DESCRIPTION**

This proposal aims to spatially and kinematically resolve the ionized gas phase in W2246-0526,  a hyper-luminous obscured quasar at z=4.6 that is part of multiple-merger system of galaxies. NIRSpec IFU observations of the H-alpha line will be obtained down to a SFR of ~ 2 Msun/yr/kpc^2, allowing the identification of emission in faint, tidal streamers connecting the members of the merger over a region of ~9"x6". Other rest-frame optical lines will be targeted (see below), allowing for a characterization of the ionizing sources in W2246-0526 and its companion galaxies via emission line diagnostics. In addition, a single 3"x3" pointing with MIRI MRS will map the transition from starlight-dominated to hot dust dominated emission in W2246-0526.

Two high-resolution spectral gratings will be used with NIRSpec, covering the rest-frame ~3000–9000A at a resolution of ~150 km/s, needed to kinematically resolve the components of the merger. The emission lines to be detected are [OII], H-beta, [OIII], H-alpha and [NII]. Since the quasar at the center of  W2246-0526 dominates the emission at observed-frame ~> 5um, all the spectral settings (A, B, C) of at least channels 1 and 2 of the MRS are needed in order to probe the transition between the continua from the host and the AGN.

The available V3PA ranges to observe W2246-0526 are limited to two ~20deg wide windows during the year, which narrowly sets the orientation the NIRSpec mosaic and allows us to define a more efficient 3x2 rectangular tiling instead of a more generic squared 3x3 tiling.

**Fixed Targets**

| # | Name | Target Coordinates | Targ. Coord. Corrections | Miscellaneous |
|---|---|---|---|---|
| (1) | W2246-0526-MIRI-MRS | RA: 22 46 7.5500 (341.5314583d)<br>Dec: -05 26 34.83 (-5.44301d)<br>Equinox: J2000 | | |
| *Comments:*<br>*Category=Galaxy*<br>*Description=[Infrared galaxies, Quasars, Starburst galaxies]*<br>*Extended=YES* | | | | |
| (2) | W2246-0526-NIRSPEC-IFU | RA: 22 46 7.6600 (341.5319167d)<br>Dec: -05 26 34.87 (-5.44302d)<br>Equinox: J2000 | | |
| *Comments:*<br>*Category=Galaxy*<br>*Description=[Infrared galaxies, Quasars, Starburst galaxies]*<br>*Extended=YES* | | | | |
| (3) | W2246-0526-MIRI-MRS-BKG | RA: 22 46 6.5000 (341.5270833d)<br>Dec: -05 27 38.63 (-5.46073d)<br>Equinox: J2000 | | |
| *Comments:*<br>*Category=Galaxy*<br>*Description=[Infrared galaxies, Quasars, Starburst galaxies]*<br>*Extended=YES* | | | | |

## Observation

**Proposal 1712, Observation 1: MIRI-BKG** Thu Jun 15 23:00:59 GMT 2023

**Diagnostic Status: Warning**

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observation For: [MIRI (Obs 2)]

## Diagnostics

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

(Visit 1:1) Informational (Form): Visit schedulable, but most scheduling windows are when JWST is pointed in direction of greatest micrometeoroid impact risk. This is likely due to scheduling special requirements.

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Miscellaneous |
|---|---|---|---|---|
| (3) | W2246-0526-MIRI-MRS-BKG | RA: 22 46 6.5000 (341.5270833d)<br>Dec: -05 27 38.63 (-5.46073d)<br>Equinox: J2000 | | |

*Comments:*
*Category=Galaxy*
*Description=[Infrared galaxies, Quasars, Starburst galaxies]*
*Extended=YES*

## Acquisition

| # | Target |
|---|---|
| 1 | NONE |

## Template

| AcqFilter | Primary Channel | Simultaneous Imaging | Imager Subarray | Grating Wheel Direction |
|---|---|---|---|---|
| | ALL | YES | FULL | NEUTRAL |

## Dithers

| # | Dither Type | Optimized For | Direction |
|---|---|---|---|
| 1 | 2-Point | EXTENDED SOURCE | NEGATIVE |

## Spectral Elements

| # | Wavelength Range | Detector | Filter | Readout Pattern | Groups/Int | Integrations/Exp | Exposures/Dith | Dither | Total Dithers | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | IMAGER | F1000W | SLOWR1 | 15 | 1 | 1 | Dither 1 | 2 | 2 | 716.698 | |
| 1 | LONG(C) | MRSLONG | | SLOWR1 | 15 | 1 | 1 | Dither 1 | 2 | 2 | 716.698 | |
| 1 | LONG(C) | MRSSHORT | | SLOWR1 | 15 | 1 | 1 | Dither 1 | 2 | 2 | 716.698 | |
| 2 | | IMAGER | F770W | SLOWR1 | 23 | 1 | 1 | Dither 1 | 2 | 2 | 1098.936 | |
| 2 | MEDIUM(B) | MRSLONG | | SLOWR1 | 23 | 1 | 1 | Dither 1 | 2 | 2 | 1098.936 | |
| 2 | MEDIUM(B) | MRSSHORT | | SLOWR1 | 23 | 1 | 1 | Dither 1 | 2 | 2 | 1098.936 | |
| 3 | | IMAGER | F560W | SLOWR1 | 31 | 1 | 1 | Dither 1 | 2 | 2 | 1481.175 | |
| 3 | SHORT(A) | MRSLONG | | SLOWR1 | 31 | 1 | 1 | Dither 1 | 2 | 2 | 1481.175 | |
| 3 | SHORT(A) | MRSSHORT | | SLOWR1 | 31 | 1 | 1 | Dither 1 | 2 | 2 | 1481.175 | |

| Special Requirements | |
|---|---|
| | Background Limited. Background no more than 10th percentile above minimum<br><br>2 After 1<br>Sequence Observations 1, 2, Non-interruptible<br>Group Observations 1, 2, 3 within 10 Days |

## Observation

**Proposal 1712, Observation 2: MIRI** Thu Jun 15 23:00:59 GMT 2023

**Diagnostic Status: Warning**

Observing Template: MIRI Medium Resolution Spectroscopy

Background Observations:[MIRI-BKG (Obs 1)]

## Diagnostics

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

(Visit 2:1) Informational (Form): Visit schedulable, but most scheduling windows are when JWST is pointed in direction of greatest micrometeoroid impact risk. This is likely due to scheduling special requirements.

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Miscellaneous |
|---|---|---|---|---|
| (1) | W2246-0526-MIRI-MRS | RA: 22 46 7.5500 (341.5314583d)<br>Dec: -05 26 34.83 (-5.44301d)<br>Equinox: J2000 | | |

*Comments:*
*Category=Galaxy*
*Description=[Infrared galaxies, Quasars, Starburst galaxies]*
*Extended=YES*

## Acquisition

| # | Target |
|---|---|
| 1 | NONE |

## Template

| AcqFilter | Primary Channel | Simultaneous Imaging | Imager Subarray | Grating Wheel Direction |
|---|---|---|---|---|
| | ALL | YES | FULL | NEUTRAL |

## Dithers

| # | Dither Type | Optimized For | Direction |
|---|---|---|---|
| 1 | 4-Point | EXTENDED SOURCE | NEGATIVE |

## Spectral Elements

| # | Wavelength Range | Detector | Filter | Readout Pattern | Groups/Int | Integrations/Exp | Exposures/Dith | Dither | Total Dithers | Total Integrations | Total Exposure Time | ETC Wkbk.Calc ID |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | IMAGER | F1000W | SLOWR1 | 15 | 1 | 1 | Dither 1 | 4 | 4 | 1433.395 | 56037 |
| 1 | LONG(C) | MRSLONG | | SLOWR1 | 15 | 1 | 1 | Dither 1 | 4 | 4 | 1433.395 | 56037 |
| 1 | LONG(C) | MRSSHORT | | SLOWR1 | 15 | 1 | 1 | Dither 1 | 4 | 4 | 1433.395 | 56037 |
| 2 | | IMAGER | F770W | SLOWR1 | 23 | 1 | 1 | Dither 1 | 4 | 4 | 2197.873 | 56037 |
| 2 | MEDIUM(B) | MRSLONG | | SLOWR1 | 23 | 1 | 1 | Dither 1 | 4 | 4 | 2197.873 | 56037 |
| 2 | MEDIUM(B) | MRSSHORT | | SLOWR1 | 23 | 1 | 1 | Dither 1 | 4 | 4 | 2197.873 | 56037 |
| 3 | | IMAGER | F560W | SLOWR1 | 31 | 1 | 1 | Dither 1 | 4 | 4 | 2962.35 | 56037 |
| 3 | SHORT(A) | MRSLONG | | SLOWR1 | 31 | 1 | 1 | Dither 1 | 4 | 4 | 2962.35 | 56037 |
| 3 | SHORT(A) | MRSSHORT | | SLOWR1 | 31 | 1 | 1 | Dither 1 | 4 | 4 | 2962.35 | 56037 |

| Special Requirements | |
|---|---|
| | Background Limited. Background no more than 10th percentile above minimum<br><br>2 After 1<br>Sequence Observations 1, 2, Non-interruptible<br>Group Observations 1, 2, 3 within 10 Days |

## Observation

**Proposal 1712, Observation 3: NIRSPEC**

Thu Jun 15 23:00:59 GMT 2023

**Diagnostic Status: Warning**

Observing Template: NIRSpec IFU Spectroscopy

## Diagnostics

(Visit 3:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Miscellaneous |
|---|---|---|---|---|
| (2) | W2246-0526-NIRSPEC-IFU | RA: 22 46 7.6600 (341.5319167d)<br>Dec: -05 26 34.87 (-5.44302d)<br>Equinox: J2000 | | |

*Comments:*
*Category=Galaxy*
*Description=[Infrared galaxies, Quasars, Starburst galaxies]*
*Extended=YES*

## Template

| TA Method |
|---|
| NONE |

## Mosaic

| Rows | Columns | Row Overlap % | Column Overlap % | Row shift (deg) | Column shift (deg) | Tile Order |
|---|---|---|---|---|---|---|
| 2 | 3 | 5.0 | 5.0 | 0.0 | 0.0 | DEFAULT |

## 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 | G235H/F170LP | NRSIRS2 | 15 | 1 | false | true | NONE | 4 | 4 | 4435.023 | 56097 |
| 2 | G235H/F170LP | NRSIRS2 | 15 | 1 | true | false | NONE | 1 | 1 | 1108.756 | |
| 3 | G395H/F290LP | NRSIRS2 | 6 | 1 | false | true | NONE | 4 | 4 | 1809.022 | 56097 |
| 4 | G395H/F290LP | NRSIRS2 | 6 | 1 | true | false | NONE | 1 | 1 | 452.256 | |

| Special Requirements | Group Observations 1, 2, 3 within 10 Days |
|---|---|