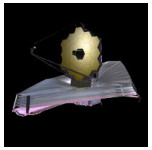

# 3507 - WHEN DOES THE INITIAL MASS FUNCTION BECOME BOTTOM-HEAVY?

Cycle: 2, Proposal Category: GO

**INVESTIGATORS**



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**OBSERVATIONS**

| *Folder* | *Observation* | *Label* | *Observing Template* | *Science Target* |
|---|---|---|---|---|
| Observation Folder | | | | |
| | 1 | AGEL0014_RED_EYEBROW | NIRSpec IFU Spectroscopy | (1) AGEL0014 |
| | 3 | SKY_BACKGROUND_AGEL0014_RED_EYEBROW | NIRSpec IFU Spectroscopy | (2) BACKGROUND-FOR-AGEL0014 |
| | 2 | AGEL1323_ROSETTA_STONES | NIRSpec IFU Spectroscopy | (3) AGEL1323 |

**ABSTRACT**

The stellar initial mass function (IMF) is a critical assumption underlying nearly every galaxy observable, yet it remains poorly constrained especially at high (z>0) redshifts. The low-mass end of the IMF (M < 0.4 Msun) significantly affects the mass-to-light ratio (M/L), and therefore measurements of key galaxy properties including the stellar mass, dark matter content, and supermassive black hole mass all depend on its assumed shape.

The problem is that measuring the low-mass end of the IMF is difficult due to how intrinsically faint these stars are. Additionally, low-mass stars have a similar surface temperature to evolved giant and supergiants yet are orders of magnitude fainter. Disentangling a large population of dwarf stars from a sprinkling of evolved giants requires both gravity sensitive spectral absorption features and an old, evolved stellar population. However, these gravity sensitive features only vary with the IMF at the 1% level, and therefore very high signal-to-noise (S/N>~150) spectra are required. As a result, measurements of the low-mass IMF using gravity sensitive features has never been done at z>1.

Here we propose to observe 2 strongly lensed massive quiescent galaxies at z~1 with JWST NIRSpec IFU which will allow for deep (integrated S/N>~150) coverage of multiple key IMF sensitive features. The two galaxies have well defined stellar population properties (age, metallicity, and alpha-abundance) from rest-frame optical spectroscopy, which are needed to disentangle chemical abundance patterns from IMF variations. These observations will be the first of their kind, and will provide a provide a key test for galaxy formation and evolution theories.

**OBSERVING DESCRIPTION**

This proposal requests deep NIRSpec IFU G235M/F170LP observations to target 2 strongly lensed massive quiescent galaxies at z~1 (z=1.016 for AGEL1323 and z=1.374 for AGEL0014). They are selected from a sample of spectroscopically confirmed gravitational lenses and have been followed up with deep ground-based rest-frame optical spectroscopy for stellar population modelling. These two galaxies are the ideal pair of targets to study the low-mass IMF due to their significantly different velocity dispersions and [Mg/Fe] abundances, which we expect to correlate with the IMF. However due to the atmospheric contamination in the near-infrared and the very high S/N requirements, until now it has been impossible to observe IMF variations past z~0.

By obtaining NIRSpec IFU spectroscopy between 1.66–3.17 μm we will obtain 6 different IMF sensitive features, including the Wing-Ford band (FeH). Combined with our on-hand rest-frame optical spectra, we will obtain the first ever measurement of the low-mass end of the IMF at z~1 using the gold-standard extragalactic techniques of z~0. Thanks to the magnification from lensing, both sources are relatively bright (K < 18). The larger of the two targets requires 3 hours 16 minutes on source with dedicated sky exposures, while the brighter, more compact target requires only 49 minutes on source to address our science goal.

# Proposal 3507 - Targets - WHEN DOES THE INITIAL MASS FUNCTION BECOME BOTTOM-HEAVY?

**Fixed Targets**

| # | Name | Target Coordinates | Targ. Coord. Corrections | Miscellaneous |
|---|---|---|---|---|
| (1) | AGEL0014 | RA: 00 14 24.2831 (3.6011796d)<br>Dec: +00 41 47.38 (.69649d)<br>Equinox: J2000 | | |
| *Comments:*<br>*Category=Galaxy*<br>*Description=[Einstein rings, Elliptical galaxies, Giant elliptical galaxies]*<br>*Extended=YES* | | | | |
| (2) | BACKGROUND-FOR-AGEL0014 | RA: 00 14 24.6111 (3.6025463d)<br>Dec: +00 41 43.28 (.69536d)<br>Equinox: J2000 | | |
| *Comments:*<br>*Category=Calibration*<br>*Description=[Telescope/sky background]* | | | | |
| (3) | AGEL1323 | RA: 13 23 4.3667 (200.7681946d)<br>Dec: +03 43 25.06 (3.72363d)<br>Equinox: J2000 | | |
| *Comments:*<br>*Category=Galaxy*<br>*Description=[Einstein rings, Elliptical galaxies]*<br>*Extended=YES* | | | | |

## Observation

**Proposal 3507, Observation 1: AGEL0014_RED_EYEBROW** Mon Apr 15 13:00:25 GMT 2024

**Diagnostic Status: Warning**

Observing Template: NIRSpec IFU Spectroscopy

Background Observations:[SKY_BACKGROUND_AGEL0014_RED_EYEBROW (Obs 3)]

## 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) | AGEL0014 | RA: 00 14 24.2831 (3.6011796d)<br>Dec: +00 41 47.38 (.69649d)<br>Equinox: J2000 | | |

*Comments:*
*Category=Galaxy*
*Description=[Einstein rings, Elliptical galaxies, Giant elliptical galaxies]*
*Extended=YES*

## Template

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

## Dithers

| # | Dither Type | Size | Starting Point | Number of Points | Points |
|---|---|---|---|---|---|
| 1 | CYCLING | SMALL | 1 | 8 | |

## 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 | G235M/F170LP | NRSIRS2 | 20 | 1 | false | true | NONE | 8 | 8 | 11787.823 | |

## Special Requirements

Sequence Observations 1, 3, Non-interruptible

## Observation

**Proposal 3507, Observation 3: SKY_BACKGROUND_AGEL0014_RED_EYEBROW** Mon Apr 15 13:00:25 GMT 2024

**Diagnostic Status: Warning**

Observing Template: NIRSpec IFU Spectroscopy

Background Observation For: [AGEL0014_RED_EYEBROW (Obs 1)]

## 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) | BACKGROUND-FOR-AGEL0014 | RA: 00 14 24.6111 (3.6025463d)<br>Dec: +00 41 43.28 (.69536d)<br>Equinox: J2000 | | |

*Comments:*
*Category=Calibration*
*Description=[Telescope/sky background]*

## Template

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

## Dithers

| # | Dither Type | Size | Starting Point | Number of Points | Points |
|---|---|---|---|---|---|
| 1 | CYCLING | SMALL | 1 | 8 | |

## 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 | G235M/F170LP | NRSIRS2 | 20 | 1 | false | true | NONE | 8 | 8 | 11787.823 | |

## Special Requirements

Sequence Observations 1, 3, Non-interruptible

## Observation

**Proposal 3507, Observation 2: AGEL1323_ROSETTA_STONES** Mon Apr 15 13:00:25 GMT 2024

**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 |
|---|---|---|---|---|
| (3) | AGEL1323 | RA: 13 23 4.3667 (200.7681946d)<br>Dec: +03 43 25.06 (3.72363d)<br>Equinox: J2000 | | |

*Comments:*
*Category=Galaxy*
*Description=[Einstein rings, Elliptical galaxies]*
*Extended=YES*

## Template

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

## Dithers

| # | Dither Type | Size | Starting Point | Number of Points | Points |
|---|---|---|---|---|---|
| 1 | 4-POINT-NOD | | | | |

## 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 | G235M/F170LP | NRSIRS2 | 10 | 1 | false | true | NONE | 4 | 4 | 2976.134 | |