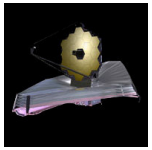

1794 - 100% gain in precision and accuracy of H0 measurement from JWST stellar kinematics of a lens galaxy

Cycle: 1, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1	RXJ1131.1231-obs	NIRSpec IFU Spectroscopy	(1) RXJ1131-1231.LENSGALAXY
	2	background-obs	NIRSpec IFU Spectroscopy	(2) BACKGROUND

ABSTRACT

Gravitationally lensed quasars provide an independent way to measure the Hubble constant (H0) that is crucial for assessing the current H0 tension and possible new physics beyond LCDM. The dominant source of uncertainty is the radial mass profile of the lens galaxy that cannot be constrained by lensing data alone without model assumptions. Stellar kinematic measurement of the foreground lens galaxy breaks the mass-sheet degeneracy and provides a vital mass profile constraint. We propose to observe the strongly lensed quasar RXJ1131-1231 with the NIRSpec IFU to obtain spatially resolved stellar kinematic maps of the foreground lens galaxy, that has been impossible to obtain using ground-based facilities. Given the small (~1") image separation between the multiple quasar images and the lens galaxy, the high-spatial and spectral resolution of JWST will resolve and separate the spectra of the foreground lens and the background quasar. With our proposed NIRSpec data on this one lens system alone, we will reduce the relative uncertainty on H0 from 8% to 4% in combination with our current lens sample in flat LCDM cosmology, i.e., a 100% gain in precision, with minimal mass profile assumptions. The proposed observations will further enable the study of the stellar initial mass function and dark matter distribution in the lens galaxy, and of the supermassive black hole-host connection of the gravitationally lensed background galaxy. The proposed data set of spatially resolved kinematic measurements of the lens galaxy will be a crucial step in our roadmap to obtain a 1% H0 measurement from time delays.

OBSERVING DESCRIPTION

We propose for deep spectroscopic observations with the NIRSpec IFU to acquire spatially resolved kinematic data of the foreground lens and background quasar host galaxy, aiming for a S/N of ~35 per pixel at the center of the lens. For this purpose, we will employ the G140M/F100LP disperser/filter set-up to target the Ca II triplet features, which are shifted into the near-infrared given the lens and source redshift of 0.295 and 0.654 respectively. To cover the lens and background host galaxy, we will enlarge NIRSpec's FOV by adopting a 2x2 mosaic mapping pattern, with an overlap of 1" between the individual tiles. This results in a coverage of 5"x5" and enables us to obtain spectroscopic data of the lens-source system, independent of the detector orientation. In each tile, we will use a small cycle dither pattern with subarcsecond shifts, consisting of 4 dither positions, to allow for the identification and removal of cosmic rays and detector defects. The low surface brightness wings demand improved noise performance, which will be accomplished by employing the IRS2 readout mode with the NRSIRS2 readout pattern. For each of the 4 dither positions, we will expose for a total of 1050.4 s, with 2 integrations and 7 groups to avoid any saturation by even the brightest quasar images. The 4 dither positions per tile are followed up by one MSA leakage calibration of 1050.4 s. The mosaic will be accompanied by a background observation, with the same exposure time as a single science exposure followed by a MSA leakage calibration, to mitigate possible stray light contamination. Summed over all 4 tiles and background, the observing strategy amounts to a total of 6.2 h (9.5h including overheads).

Target: RXJ1131-1231

Target Coordinates: RA 11:31:51.449 DEC -12:31:58.33

Target visibility: 2 May 2022 - 25 June, 2022 and 15 December 2022 - 3 February 2023

Instrument: NIRSPEC IFU

Filter: G140M/F100LP

Mosaic Properties: 2x2 Mosaic with 1” overlap.

Dither: Small cycle with 4 positions.

Exposure time per cycle position: 1050.4 s

Detector readout pattern: 2 integrations, 7 groups.

MSA leakage calibration at the end of small cycle. Exposure time per leakage calibration: 1050.4 s.

Background: same exposure time as a single science exposure and one MSA leakage calibration

Proposal 1794 - Targets - 100% gain in precision and accuracy of H0 measurement from JWST stellar kinematics of a lens galaxy

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	RXJ1131-1231.LENSGALAXY	RA: 11 31 51.4490 (172.9643708d) Dec: -12 31 58.33 (-12.53287d) Equinox: J2000		
Comments: *Category=Galaxy* *Description=[Elliptical galaxies]* *Extended=YES*				
(2)	BACKGROUND	RA: 11 31 52.2670 (172.9677792d) Dec: -12 32 24.77 (-12.54021d) Equinox: J2000		
Comments: *Category=Calibration* *Description=[Telescope/sky background]*				

Observation

Proposal 1794, Observation 1: RXJ1131.1231-obs Wed Mar 01 23:01:41 GMT 2023

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

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)	RXJ1131-1231.LENSGALAXY	RA: 11 31 51.4490 (172.9643708d) Dec: -12 31 58.33 (-12.53287d) Equinox: J2000		

Comments:
Category=Galaxy
Description=[Elliptical galaxies]
Extended=YES

Template

TA Method
NONE

Mosaic

Rows	Columns	Row Overlap %	Column Overlap %	Row shift	Column shift	Tile Order
2	2	33.0	33.0	0.0	0.0	DEFAULT

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	CYCLING	SMALL	1	4	

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	G140M/F100LP	NRSIRS2	7	2	false	true	NONE	4	8	4201.6	
2	G140M/F100LP	NRSIRS2	7	2	true	false	NONE	1	2	1050.4	

Observation

Proposal 1794, Observation 2: background-obs Wed Mar 01 23:01:41 GMT 2023

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)	BACKGROUND	RA: 11 31 52.2670 (172.9677792d) Dec: -12 32 24.77 (-12.54021d) Equinox: J2000		

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

Template

TA Method
NONE

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	NONE				

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	G140M/F100LP	NRSIRS2	7	2	false	false	NONE	1	2	1050.4	
2	G140M/F100LP	NRSIRS2	7	2	true	false	NONE	1	2	1050.4	