



4574 - Dissecting the kinematics of the central region of a $z \sim 6$ QSO with ALMA and JWST

Cycle: 2, Proposal Category: GO

INVESTIGATORS

<i>Name</i>	<i>Institution</i>
Ms. Roberta Tripodi (PI) (ESA Member)	Universita degli Studi di Trieste
Dr. Chiara Feruglio (CoI) (ESA Member)	INAF, Osservatorio Astronomico di Trieste
Dr. Federico Lelli (CoI) (ESA Member)	INAF - Osservatorio Astrofisico di Arcetri
Dr. Sandro Tacchella (CoI) (ESA Member)	University of Cambridge
Dr. Jan Scholtz (CoI) (ESA Member)	University of Cambridge, Kavli Institute for Cosmology
Dr. Hannah Uebler (CoI) (ESA Member)	University of Cambridge
Prof. Roberto Maiolino (CoI) (ESA Member)	University of Cambridge
Dr. Luca Zappacosta (CoI) (ESA Member)	INAF, Osservatorio Astronomico di Roma
Dr. Enrico Piconcelli (CoI) (ESA Member)	INAF, Osservatorio Astronomico di Roma
Mr. Francesco Salvestrini (CoI) (ESA Member)	Universita di Bologna
Dra. Federica Ricci (CoI) (ESA Member)	Universita degli Studi Roma Tre
Prof. Fabio La Franca (CoI) (ESA Member)	Universita' degli Studi Roma Tre
Dr. Francesca Civano (CoI) (US Admin CoI)	NASA Goddard Space Flight Center
Dr. Maria Vittoria Zanchettin (CoI) (ESA Member)	Scuola Internazionale Superiore di Studi Avanzati
Dr. Manuela Bischetti (CoI) (ESA Member)	Universita degli Studi di Trieste
Dr. Valentina D'Odorico (CoI) (ESA Member)	INAF, Osservatorio Astronomico di Trieste
Dr. Fabrizio Fiore (CoI) (ESA Member)	INAF, Osservatorio Astronomico di Roma

OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
	NIRCam Imaging of J2310+1855			

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
	1	Imaging J2310+1855	NIRCam Imaging	(1) J2310+1855

ABSTRACT

The goal of this ALMA-JWST joint proposal is to investigate the innermost region of the QSO host galaxy SDSS J2310+1855 at $z \sim 6$, during the Epoch of Reionization, in order to unveil the host-galaxy stellar distribution, determining the possible presence and characteristics of a bulge-like component, and to constrain the black hole (BH) mass from gas kinematics. We propose to target the [CII] emission of J2310+1855 in order to analyse the rotation curve of the QSO's host-galaxy down to 100 physical pc scales and to investigate the properties of the host galaxy. We aim at pushing dynamical studies to high- z using for the first time very high resolution ALMA observations jointly with JWST-NIRCam, which probes the stellar mass of the host galaxy. This will give us a more accurate and less-biased estimate of BH mass in comparison to those currently obtained via the virial relation and the broad lines (both UV and optical rest frame) alone. This pilot programme will be used to design and optimise future ALMA observations of a larger sample of high- z QSOs to test the reliability of black holes mass estimates and explore the early quasar-galaxy coevolution in a statistical sound manner.

OBSERVING DESCRIPTION

Observational feasibility of JWST-NIRCam: The QSO-host galaxy decomposition has been proven to be feasible with JWST-NIRCam for QSOs at $z > 6$ (Ding+22). We need NIRCam observations in order to determine the properties of the stellar component in QSO J2310+1855, such as the stellar mass, the effective radius and Sérsic index of the stellar distribution. Images will be taken in two filters (F150W and F410M), with a wide and medium wavelength coverage respectively, in order to constrain the stellar mass and size. We choose F410M as red filter since it has a very good PSF (comparable with that of F356W) and we do not expect to find any bright emission lines that can contaminate our measure, given the redshift of the target QSO ($z = 6.0031$). This is the only red filter that ensure the latter condition. F150W, as blue filter, has very good PSF, comparable with the required resolution of the ALMA observation. The detection of the underlying host galaxy requires a careful decomposition of the two-dimensional light distribution to separate the point-like quasar from its host galaxy. This will be performed by JWST experts in our team, using refined software tools (e.g., galight, <https://galight.readthedocs.io/en/latest>; ForcePho, <https://github.com/bd-j/forcepho>). This decomposition will give us

results on the stellar properties. Using the JWST ETC, to ensure an high S/N detection we require a total exposure of 3200 seconds in the two filters (F150W and F410M), that can be obtained simultaneously. We estimated the magnitude of the host galaxy assuming a stellar mass of $\sim 1e10 M_{\text{sun}}$ and a star formation rate history with an age of 10 Myr, typical of high- z galaxies. This leads to an AB magnitude in band H of ~ 22 . The rough estimate for the stellar mass is based on the estimates of the dynamical mass, BH mass, and gas mass already available for J2310+1855, and given the results of the dynamical modelling of Tripodi+22 (A&A, 665, A107). A 4x4 primary and sub-pixel dithering pattern is employed to mitigate

JWST Proposal 4574 (Created: Monday, September 18, 2023 at 11:03:04 AM Eastern Standard Time) - Overview

cosmic ray hits and bad pixels in the detector and to ensure sub-pixel resampling during the stacking step. We used the BRIGHT1 read-out mode and we avoided saturation. The total exposure time corresponds to 32 total integrations, with 5 group per integration, 2 integrations per exposure, and 16 exposures for specification (as also done in Ding+22). We have verified that there are no duplicate JWST observations, using the MAST Data Discovery Portal.

Proposal 4574 - Targets - Dissecting the kinematics of the central region of a z~6 QSO with ALMA and JWST

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(1)	J2310+1855	RA: 23 10 38.8800 (347.6620000d) Dec: +18 55 19.70 (18.92214d) Equinox: J2000		
<i>Comments: z = 6.003</i> <i>Category=Galaxy</i> <i>Description=[Active galactic nuclei, High-redshift galaxies, Quasars]</i> <i>Extended=NO</i>					

Proposal 4574 - Observation 1 - Dissecting the kinematics of the central region of a z~6 QSO with ALMA and JWST

Mon Sep 18 16:03:04 GMT 2023

Observation	<p>Proposal 4574, Observation 1: Imaging J2310+1855</p> <p>Diagnostic Status: Warning</p> <p>Observing Template: NIRCam Imaging</p>									
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)	J2310+1855	RA: 23 10 38.8800 (347.6620000d) Dec: +18 55 19.70 (18.92214d) Equinox: J2000							
	<p><i>Comments: z = 6.003</i></p> <p><i>Category=Galaxy</i></p> <p><i>Description=[Active galactic nuclei, High-redshift galaxies, Quasars]</i></p> <p><i>Extended=NO</i></p>									
Template	Module		Subarray			Target Placement				
	B		FULL			Module Gap				
Dithers	#	Primary Dither Type		Primary Dithers	Subpixel Dither Type		Dither Size	Subpixel Positions		
	1	INTRAMODULEBOX		4	STANDARD			4		
Spectral Elements	#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
	1	F150W	F410M	BRIGHT1	5	2	32	16	3263.978	155971
Special Requirements	Offset 35.0 arcsec, -42.0 arcsec									