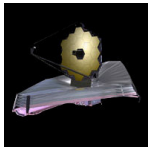

4877 - The Host Galaxy, Environment, and Hot Dust Emission of the First Known Extremely-Luminous Obscured AGN at z>6

Cycle: 3, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
COS-87259				
	1	MIRI	MIRI Imaging	(1) COS-87259
	4	NIRCam grism	NIRCam Wide Field Slitless Spectroscopy	(1) COS-87259
	6	IFU	NIRSpec IFU Spectroscopy	(1) COS-87259

ABSTRACT

The existence of billion solar mass black holes within the first 750 Myr of cosmic history poses a major challenge for models of early supermassive black hole (SMBH) formation. A major obstacle towards furthering our understanding of early SMBH growth is that all known extremely luminous AGN at z>6 fall in the category of type 1 quasars. Several recent studies have hinted that early SMBHs frequently grew as obscured AGN, stressing the importance of identifying and characterizing these objects. Here, we will take steps towards this goal by characterizing the hot dust emission, host galaxy, and environment of a newly discovered obscured AGN at z_spec = 6.853. This AGN is extremely luminous (with L_bol comparable to the brightest z~7 quasars thus implying M_BH ~ 10^9 Msol) and has multiple ALMA line detections proving its high redshift. Remarkably this object was found in a relatively small (1.5 deg^2) field, consistent with a scenario in which obscured z~7 AGN are far more abundant than similarly-luminous quasars. We will 1) deliver the first clear and detailed study of a galaxy hosting a rapidly-growing SMBH at z~7; 2) finely sample the rest near-IR SED to characterize the hot dust emission and deliver the first empirical mid-IR SED template of an obscured z>6 AGN, assisting efforts to identify similar objects with MIRI data; 3) locate the AGN relative to the resolved radio synchrotron, infrared starburst, and unobscured stellar emission to begin characterizing the interplay between the AGN and host; and 4) measure the galaxy environment of this object to better place it in context of type 1 quasars at very similar redshifts for a first glimpse into its halo rarity.

OBSERVING DESCRIPTION

To most efficiently achieve our science goals, we will utilize MIRI imaging, NIRSpec IFU spectroscopy, and NIRCam wide field slitless spectroscopy (WFSS). The NIRCam WFSS mode has now proven to be highly efficient at detecting rest-optical [OIII] line emission from normal star-forming z~7 galaxies from Cycle 1 programs without the need for deep pre-imaging, thereby allowing us to characterize the environment of our target at minimal observing time cost.

We design our observing strategy in accordance with the ETC to ensure all requisite sensitivities are achieved, as well as with the recommended observing strategies provided on the JWST User Documentation webpages. Our MIRI observations are conducted with the 4-POINT-SETS dither pattern with the number of groups and integrations/exposure set to reach the needed sensitivities while also avoiding saturation. For the NIRCam WFSS observations, we follow the strategy of ASPIRE and use the INTRAMODULEX-3 primary dither pattern with 2 sub-pixel positions. This yields full coverage of the short-wavelength detector gaps and provides a sufficient number of overlapping exposures to flag artifacts (e.g., `snowballs'). We achieve our requisite line flux sensitivity with a SHALLOW4, 10 groups/integration readout. We will apply the proven median-filtering deconfusion and galaxy identification techniques developed by previous studies (Kashino et al. 2023) to efficiently conduct our observations with the Grism R orientation. This setting has been most commonly utilized thus far and hence has the best understood spectral tracing and wavelength calibration. To achieve optimum sensitivity to the UV continuum of neighboring galaxies, we follow ASPIRE and pair the F200W filter with the grism observations and pair with F115W for the direct imaging observations.

Finally, for the NIRSpec IFU observations we adopt a 4-point dither pattern to obtain sufficient background sampling and to improve spatial and spectral sampling. Following Cycle 1 GTO programs (e.g. program IDs 1215 and 1264) we utilize a single `leakcal' exposure for our target object to mitigate contaminating light from failed open MSA shutters. A single leakcal exposure is sufficient since our target does not lie in a crowded field. We reach our requisite sensitivity with 75 groups/int using the NRSIRS2RAPID readout pattern.

We apply offsets of X = -100 and Y = 10 arcsec to the NIRCam observations to place our target z=6.853 AGN near the middle of the more sensitive Module A while also avoiding the short-wavelength detector gaps for all exposures.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	COS-87259	RA: 09 58 58.2720 (149.7428000d) Dec: +01 39 20.00 (1.65556d) Equinox: J2000		

Comments:
Category=Galaxy
Description=[Active galactic nuclei, High-redshift galaxies, Radio galaxies, Ultraluminous infrared galaxies]

Observation

Proposal 4877, Observation 1: MIRI

Tue Jan 28 17:00:10 GMT 2025

Diagnostic Status: Warning

Observing Template: MIRI Imaging

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)	COS-87259	RA: 09 58 58.2720 (149.7428000d) Dec: +01 39 20.00 (1.65556d) Equinox: J2000		

Comments:
Category=Galaxy
Description=[Active galactic nuclei, High-redshift galaxies, Radio galaxies, Ultraluminous infrared galaxies]

Template

Subarray
FULL

Dithers

#	Dither Type	Starting Point	Number of Points	Points	Starting Set	Number of Sets	Optimized For	Direction	Pattern Size
1	CYCLING	1	4		1	1			LARGE

Spectral Elements

#	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F560W	FASTR1	20	1	1	Dither 1	4	4	222.003	
2	F770W	FASTR1	20	1	1	Dither 1	4	4	222.003	
3	F1000W	FASTR1	20	1	1	Dither 1	4	4	222.003	
4	F1130W	FASTR1	20	2	1	Dither 1	4	8	455.107	
5	F1280W	FASTR1	15	1	1	Dither 1	4	4	166.502	
6	F1500W	FASTR1	10	1	1	Dither 1	4	4	111.002	
7	F1800W	FASTR1	11	1	1	Dither 1	4	4	122.102	
8	F2100W	FASTR1	11	1	1	Dither 1	4	4	122.102	
9	F2550W	FASTR1	12	2	1	Dither 1	4	8	277.504	

Observation

Proposal 4877, Observation 4: NIRCam grism Tue Jan 28 17:00:10 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRCam Wide Field Slitless Spectroscopy

Diagnostics

(NIRCam grism (Obs 4)) Warning (Form): For Module=ALL the default target location is in the gap between the modules.

(NIRCam grism (Obs 4)) 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 4:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	COS-87259	RA: 09 58 58.2720 (149.7428000d) Dec: +01 39 20.00 (1.65556d) Equinox: J2000		

Comments:
Category=Galaxy
Description=[Active galactic nuclei, High-redshift galaxies, Radio galaxies, Ultraluminous infrared galaxies]

Template

Module	Subarray	Grism (Long Wavelength)
ALL	FULL	GRISMR

Dithers

#	Primary Dither Type	Primary Dithers	Subpixel Positions
1	INTRAMODULEBOX	3	2-Point

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	F115W	F410M	SHALLOW4	10	1	1	526.102		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	F200W	F410M	SHALLOW4	10	1	6	3156.61		GRISMR	Grism (Long Wavelength)	6
2	F115W	F410M	SHALLOW4	10	1	2	1052.203			Out of Field	2

Special Requirements	Offset -100.0 arcsec, 10.0 arcsec

Observation

Proposal 4877, Observation 6: IFU

Tue Jan 28 17:00:10 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Diagnostics

(Visit 6:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	COS-87259	RA: 09 58 58.2720 (149.7428000d) Dec: +01 39 20.00 (1.65556d) Equinox: J2000		

Comments:
Category=Galaxy
Description=[Active galactic nuclei, High-redshift galaxies, Radio galaxies, Ultraluminous infrared galaxies]

Template

TA Method	HFF Readout Mode
NONE	false

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	PRISM/CLEAR	NRSIRS2RAPID	75	1	false	true	NONE	4	4	4435.023	
2	PRISM/CLEAR	NRSIRS2RAPID	75	1	true	false	NONE	1	1	1108.756	