



# 4094 - A Galaxy-Scale Fountain of Multiphase Gas Pumped by a Black Hole: The power of JWST combined with ALMA, MUSE, Chandra, and HST

Cycle: 2, Proposal Category: GO

## INVESTIGATORS

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JWST Proposal 4094 (Created: Tuesday, July 2, 2024 at 2:01:18 PM Eastern Standard Time) - Overview

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Dr. William R. Forman (CoI)	Smithsonian Institution Astrophysical Observatory
Dr. Christine Jones (CoI)	Smithsonian Institution Astrophysical Observatory
Dr. Yuan Li (CoI)	University of North Texas
Dr. Meredith Powell (CoI)	Stanford University
Prof. Claudia Megan Urry (CoI)	Yale University
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Dr. Aurora Simionescu (CoI) (ESA Member)	Space Research Organization Netherlands
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Sideena Grace (CoI)	Hamline University
Dr. Yuanyuan Su (CoI)	University of Kentucky
Dr. Adrian Vantghem (CoI) (CSA Member)	University of Manitoba
Keduse Worku (CoI)	Yale University
Dr. Thomas Connor (CoI)	Smithsonian Institution Astrophysical Observatory

**OBSERVATIONS**

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
All Observations				
	1	A2597 NIRSpec IFU Mosaic	NIRSpec IFU Spectroscopy	(1) ABELL-2597-WITH-NO-BKG-NIRSPEC
	4	A2597 NIRSpec IFU Mosaic - REPEAT	NIRSpec IFU Spectroscopy	(1) ABELL-2597-WITH-NO-BKG-NIRSPEC

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
	2	MRS off-galaxy pointing	MIRI Medium Resolution Spectroscopy	(2) ABELL-2597-OFF-GALAXY
	3	A2597 MRS On-galaxy Mosaic	MIRI Medium Resolution Spectroscopy	(3) ABELL-2597-WITH-BKG-MIRI
	5	REPEAT MRS off-galaxy pointing	MIRI Medium Resolution Spectroscopy	(5) ABELL-2597-OFF-GALAXY-copy
	6	REPEAT A2597 MRS On-galaxy Mosaic	MIRI Medium Resolution Spectroscopy	(4) SHIFT-ABELL-2597-WITH-BKG-MIRI

## ABSTRACT

We propose short NIRSpec IFU and MIRI MRS observations of a galaxy-spanning fountain of multiphase gas "pumped" by a supermassive black hole. The data will demonstrate Webb's singular power to advance our understanding of the black hole feeding and feedback loop in the heart of galaxies, as well as showcase the IFU's exquisite multiwavelength synergy with archival data from Chandra, Spitzer, Herschel, ALMA, VLT/MUSE+SINFONI, and nearly every instrument aboard HST. The Abell 2597 BCG ( $z = 0.082$ ) is the perfect performance demonstration target for Webb's low redshift capabilities, hosting an efficiently mappable and spectacular example of chaotic cold accretion, which may trace processes fundamental to galaxy evolution at effectively all mass scales.

## OBSERVING DESCRIPTION

We use the NIRSpec IFU G235H gratings in a four-point dithered mosaic to cover the central  $6 \times 6$  arcsec<sup>2</sup> of the A2596 BCG at 1.7-4 microns with a resolution of 100 km/s. Background observations are not necessary for this bright target. We don't need leakcals since there are no extremely bright stars in the MSA footprint.

The MIRI MRS observations of A2597 use an extended source dither to better sample the PSF. We use all gratings to cover the full 5-27 micron spectrum. We link the source and dedicated off-background observations by an uninterrupted sequence special requirement, and constrain the PA of the off-background observation to gain MIRI MRS imager observations of A2597 in three filters, using the FULL array as saturation on the nucleus is not a concern.

Proposal 4094 - Targets - A Galaxy-Scale Fountain of Multiphase Gas Pumped by a Black Hole: The power of JWST combined with A...

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	ABELL-2597-WITH-NO-BKG-NIRSPEC	RA: 23 25 19.6900 (351.3320417d) Dec: -12 07 26.30 (-12.12397d) Equinox: J2000		
<p><i>Comments: This object was generated by the targetselector and retrieved from the NED database.</i>  <i>Category=Clusters of Galaxies</i>  <i>Description=[Abell clusters, Brightest cluster galaxies, Rich clusters]</i>  <i>Extended=YES</i></p>				
(2)	ABELL-2597-OFF-GALAXY	RA: 23 25 19.5600 (351.3315000d) Dec: -12 06 14.30 (-12.10397d) Equinox: J2000		
<p><i>Comments: This region was chosen to (a) be a relatively "blank" part of the sky (for background) while (b) placing the MIRI imager directly on top of the A2597 BCG - BUT BEWARE NEEDED ORIENT CONSTRAINT!</i>  <i>Category=Clusters of Galaxies</i>  <i>Description=[Abell clusters, Brightest cluster galaxies, Rich clusters]</i>  <i>Extended=YES</i></p>				
(3)	ABELL-2597-WITH-BKG-MIRI	RA: 23 25 19.6900 (351.3320417d) Dec: -12 07 26.30 (-12.12397d) Equinox: J2000		
<p><i>Comments: This object was generated by the targetselector and retrieved from the NED database.</i>  <i>Category=Clusters of Galaxies</i>  <i>Description=[Abell clusters, Brightest cluster galaxies, Rich clusters]</i>  <i>Extended=YES</i></p>				
(4)	SHIFT-ABELL-2597-WITH-BKG-MIRI	RA: 23 25 19.7210 (351.3321708d) Dec: -12 07 27.01 (-12.12417d) Equinox: J2000		
<p><i>Comments: This object was generated by the targetselector and retrieved from the NED database.</i>  <i>Category=Clusters of Galaxies</i>  <i>Description=[Abell clusters, Brightest cluster galaxies, Rich clusters]</i>  <i>Extended=YES</i></p>				
(5)	ABELL-2597-OFF-GALAXY-copy	RA: 23 25 19.5600 (351.3315000d) Dec: -12 06 14.30 (-12.10397d) Equinox: J2000		
<p><i>Comments: This region was chosen to (a) be a relatively "blank" part of the sky (for background) while (b) placing the MIRI imager directly on top of the A2597 BCG - BUT BEWARE NEEDED ORIENT CONSTRAINT!</i>  <i>Category=Clusters of Galaxies</i>  <i>Description=[Abell clusters, Brightest cluster galaxies, Rich clusters]</i>  <i>Extended=YES</i></p>				

Fixed Targets

Proposal 4094 - Observation 1 - A Galaxy-Scale Fountain of Multiphase Gas Pumped by a Black Hole: The power of JWST combined ...

Tue Jul 02 19:01:18 GMT 2024

<b>Observation</b>	<b>Proposal 4094, Observation 1: A2597 NIRSpec IFU Mosaic</b> <b>Diagnostic Status: Warning</b> Observing Template: NIRSpec IFU Spectroscopy											
	(Visit 1:1) Warning (Form): Data Excess over lower threshold (Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.											
<b>Diagnosics</b>												
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>			<b>Targ. Coord. Corrections</b>		<b>Miscellaneous</b>				
	(1)	ABELL-2597-WITH-NO-BKG-NIRSPEC	RA: 23 25 19.6900 (351.3320417d) Dec: -12 07 26.30 (-12.12397d) Equinox: J2000									
<i>Comments: This object was generated by the targetselector and retrieved from the NED database.</i> <i>Category=Clusters of Galaxies</i> <i>Description=[Abell clusters, Brightest cluster galaxies, Rich clusters]</i> <i>Extended=YES</i>												
<b>Template</b>	<b>TA Method</b>											
	NONE											
<b>Mosaic</b>	<b>Rows</b>	<b>Columns</b>	<b>Row Overlap %</b>	<b>Column Overlap %</b>	<b>Row shift (deg)</b>	<b>Column shift (deg)</b>	<b>Tile Order</b>					
	2	2	10.0	10.0	0.0	0.0	DEFAULT					
<b>Dithers</b>	<b>#</b>	<b>Dither Type</b>	<b>Size</b>	<b>Starting Point</b>		<b>Number of Points</b>	<b>Points</b>					
	1	4-POINT-DITHER										
<b>Spectral Elements</b>	<b>#</b>	<b>Grating/Filter</b>	<b>Readout Pattern</b>	<b>Groups/Int</b>	<b>Integrations/Exp</b>	<b>Leakcal</b>	<b>Dither</b>	<b>Autocal</b>	<b>Total Dithers</b>	<b>Total Integrations</b>	<b>Total Exposure Time</b>	<b>ETC Wkbk.Calc ID</b>
	1	G235H/F170LP	NRSIRS2RAPID	50	1	false	true	NONE	4	4	2976.134	

Proposal 4094 - Observation 4 - A Galaxy-Scale Fountain of Multiphase Gas Pumped by a Black Hole: The power of JWST combined ...

Tue Jul 02 19:01:18 GMT 2024

<b>Observation</b>	<b>Proposal 4094, Observation 4: A2597 NIRSpec IFU Mosaic - REPEAT</b> <b>Diagnostic Status: Warning</b> Observing Template: NIRSpec IFU Spectroscopy											
	(Visit 4:1) Warning (Form): Data Excess over lower threshold (Visit 4:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.											
<b>Diagnosics</b>												
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>			<b>Targ. Coord. Corrections</b>		<b>Miscellaneous</b>				
	(1)	ABELL-2597-WITH-NO-BKG-NIRSPEC	RA: 23 25 19.6900 (351.3320417d) Dec: -12 07 26.30 (-12.12397d) Equinox: J2000									
<i>Comments: This object was generated by the targetselector and retrieved from the NED database.</i> <i>Category=Clusters of Galaxies</i> <i>Description=[Abell clusters, Brightest cluster galaxies, Rich clusters]</i> <i>Extended=YES</i>												
<b>Template</b>	<b>TA Method</b>											
	NONE											
<b>Mosaic</b>	<b>Rows</b>	<b>Columns</b>	<b>Row Overlap %</b>	<b>Column Overlap %</b>	<b>Row shift (deg)</b>	<b>Column shift (deg)</b>	<b>Tile Order</b>					
	2	2	10.0	10.0	0.0	0.0	DEFAULT					
<b>Dithers</b>	<b>#</b>	<b>Dither Type</b>	<b>Size</b>	<b>Starting Point</b>		<b>Number of Points</b>	<b>Points</b>					
	1	4-POINT-DITHER										
<b>Spectral Elements</b>	<b>#</b>	<b>Grating/Filter</b>	<b>Readout Pattern</b>	<b>Groups/Int</b>	<b>Integrations/Exp</b>	<b>Leakcal</b>	<b>Dither</b>	<b>Autocal</b>	<b>Total Dithers</b>	<b>Total Integrations</b>	<b>Total Exposure Time</b>	<b>ETC Wkbk.Calc ID</b>
	1	G235H/F170LP	NRSIRS2RAPID	50	1	false	true	NONE	4	4	2976.134	

Proposal 4094 - Observation 2 - A Galaxy-Scale Fountain of Multiphase Gas Pumped by a Black Hole: The power of JWST combined ...

Tue Jul 02 19:01:18 GMT 2024

<b>Observation</b>	<b>Proposal 4094, Observation 2: MRS off-galaxy pointing</b> <b>Diagnostic Status: Warning</b> Observing Template: MIRI Medium Resolution Spectroscopy Background Observation For: [A2597 MRS On-galaxy Mosaic (Obs 3)] <i>Comments: The ORIENT constraint on PA is to ensure that the MIRI parallel image lands on the A2597 BCG</i>												
	(Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.												
<b>Fixed Targets</b>	#	Name	Target Coordinates				Targ. Coord. Corrections			Miscellaneous			
	(2)	ABELL-2597-OFF-GALAXY	RA: 23 25 19.5600 (351.3315000d) Dec: -12 06 14.30 (-12.10397d) Equinox: J2000										
<i>Comments: This region was chosen to (a) be a relatively "blank" part of the sky (for background) while (b) placing the MIRI imager directly on top of the A2597 BCG - BUT BEWARE NEEDED ORIENT CONSTRAINT!</i> Category=Clusters of Galaxies Description=[Abell clusters, Brightest cluster galaxies, Rich clusters] Extended=YES													
<b>Acquisition</b>	#	Target											
	1	NONE											
<b>Template</b>	AcqFilter	Primary Channel				Simultaneous Imaging			Imager Subarray		Grating Wheel Direction		
		All MRS				YES			FULL		NEUTRAL		
<b>Dithers</b>	#	Dither Type				Optimized For			Direction				
	1	4-Point				EXTENDED SOURCE			NEGATIVE				
<b>Spectral Elements</b>	#	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	FASTR1	50	1	1	Dither 1	4	4	555.008	
	1	LONG(C)	MRSLONG		FASTR1	50	1	1	Dither 1	4	4	555.008	
	1	LONG(C)	MRSSHORT		FASTR1	50	1	1	Dither 1	4	4	555.008	
	2		IMAGER	F770W	FASTR1	50	1	1	Dither 1	4	4	555.008	
	2	MEDIUM(B)	MRSLONG		FASTR1	50	1	1	Dither 1	4	4	555.008	
	2	MEDIUM(B)	MRSSHORT		FASTR1	50	1	1	Dither 1	4	4	555.008	
	3		IMAGER	F560W	FASTR1	50	1	1	Dither 1	4	4	555.008	
	3	SHORT(A)	MRSLONG		FASTR1	50	1	1	Dither 1	4	4	555.008	
	3	SHORT(A)	MRSSHORT		FASTR1	50	1	1	Dither 1	4	4	555.008	

Proposal 4094 - Observation 2 - A Galaxy-Scale Fountain of Multiphase Gas Pumped by a Black Hole: The power of JWST combined ...

Special Requirements

Aperture PA Range 22 to 76 Degrees (V3 22.0 to 76.0)

Sequence Observations 2, 3, Non-interruptible



Proposal 4094 - Observation 3 - A Galaxy-Scale Fountain of Multiphase Gas Pumped by a Black Hole: The power of JWST combined ...

Tue Jul 02 19:01:18 GMT 2024

<b>Observation</b>	<b>Proposal 4094, Observation 3: A2597 MRS On-galaxy Mosaic</b> <b>Diagnostic Status: Warning</b> Observing Template: MIRI Medium Resolution Spectroscopy Background Observations:[MRS off-galaxy pointing (Obs 2)]												
	(Visit 3:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.												
<b>Diagnosics</b>													
<b>Fixed Targets</b>	#	Name	Target Coordinates		Targ. Coord. Corrections				Miscellaneous				
	(3)	ABELL-2597-WITH-BKG-MIRI	RA: 23 25 19.6900 (351.3320417d) Dec: -12 07 26.30 (-12.12397d) Equinox: J2000										
Comments: This object was generated by the targetselector and retrieved from the NED database. Category=Clusters of Galaxies Description=[Abell clusters, Brightest cluster galaxies, Rich clusters] Extended=YES													
<b>Acquisition</b>	#	Target											
	1	NONE											
<b>Template</b>	AcqFilter	Primary Channel		Simultaneous Imaging			Imager Subarray		Grating Wheel Direction				
		All MRS		YES			FULL		NEUTRAL				
<b>Dithers</b>	#	Dither Type			Optimized For				Direction				
	1	4-Point			EXTENDED SOURCE				NEGATIVE				
<b>Spectral Elements</b>	#	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	FASTR1	50	1	1	Dither 1	4	4	555.008	
	1	LONG(C)	MRSLONG		FASTR1	50	1	1	Dither 1	4	4	555.008	
	1	LONG(C)	MRSSHORT		FASTR1	50	1	1	Dither 1	4	4	555.008	
	2		IMAGER	F770W	FASTR1	50	1	1	Dither 1	4	4	555.008	
	2	MEDIUM(B)	MRSLONG		FASTR1	50	1	1	Dither 1	4	4	555.008	
	2	MEDIUM(B)	MRSSHORT		FASTR1	50	1	1	Dither 1	4	4	555.008	
	3		IMAGER	F560W	FASTR1	50	1	1	Dither 1	4	4	555.008	
	3	SHORT(A)	MRSLONG		FASTR1	50	1	1	Dither 1	4	4	555.008	
	3	SHORT(A)	MRSSHORT		FASTR1	50	1	1	Dither 1	4	4	555.008	

Special Requirements

Sequence Observations 2, 3, Non-interruptible

Proposal 4094 - Observation 5 - A Galaxy-Scale Fountain of Multiphase Gas Pumped by a Black Hole: The power of JWST combined ...

Tue Jul 02 19:01:18 GMT 2024

<b>Observation</b>	<b>Proposal 4094, Observation 5: REPEAT MRS off-galaxy pointing</b> <b>Diagnostic Status: Warning</b> Observing Template: MIRI Medium Resolution Spectroscopy Background Observation For: [REPEAT A2597 MRS On-galaxy Mosaic (Obs 6)] <i>Comments: The ORIENT constraint on PA is to ensure that the MIRI parallel image lands on the A2597 BCG</i>																																																																																																																																														
	(REPEAT MRS off-galaxy pointing (Obs 5)) Warning (Form): Imager Filter overlap. (Visit 5:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.																																																																																																																																														
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Proposal 4094 - Observation 5 - A Galaxy-Scale Fountain of Multiphase Gas Pumped by a Black Hole: The power of JWST combined ...

Special Requirements

Aperture PA Range 22 to 76 Degrees (V3 22.0 to 76.0)

Sequence Observations 5, 6, Non-interruptible

Proposal 4094 - Observation 6 - A Galaxy-Scale Fountain of Multiphase Gas Pumped by a Black Hole: The power of JWST combined ...

Tue Jul 02 19:01:18 GMT 2024

<b>Observation</b>	<b>Proposal 4094, Observation 6: REPEAT A2597 MRS On-galaxy Mosaic</b> <b>Diagnostic Status: Warning</b> Observing Template: MIRI Medium Resolution Spectroscopy Background Observations:[REPEAT MRS off-galaxy pointing (Obs 5)]																																																																																																																																													
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