



# 8358 - Revealing the True Nature of Little Red Dots with Deep Continuum Observations of an IR-Bright LRD at $z=3.1$

Cycle: 4, Proposal Category: GO

## INVESTIGATORS

<i>Name</i>	<i>Institution</i>
<b>Dr. Guillermo Barro (PI)</b>	<b>University of the Pacific</b>
Prof. Pablo G. Perez-Gonzalez (CoI) (ESA Member) (CoPI)	Centro de Astrobiologia - CAB
Prof. Jonathan R Trump (CoI)	University of Connecticut
Prof. Dale D. Kocevski (CoI)	Colby College
Dr. Elizabeth McGrath (CoI)	Colby College
Dr. Gene C K Leung (CoI)	Massachusetts Institute of Technology
Prof. Rachel S. Somerville (CoI)	Simons Foundation Center for Computational Astrophysics
Dr. L. Y. Aaron Yung (CoI)	Space Telescope Science Institute

## OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
MIRI + NIRSpec				
	1	NIRSpec-IFU	NIRSpec IFU Spectroscopy	(1) JADES-191056
	2	MRS	MIRI Medium Resolution Spectroscopy	(1) JADES-191056
	3	MRS - repeat	MIRI Medium Resolution Spectroscopy	(1) JADES-191056
	4	MRS - second repeat	MIRI Medium Resolution Spectroscopy	(1) JADES-191056

## ABSTRACT

The first 3 JWST cycles have revealed a surprising population of Little Red Dots (LRDs) at  $z\sim 3-9$ , characterized by compact sizes, broad emission lines, and peculiar, V-shaped spectral energy distributions (SEDs) with blue UV emission and very red optical and NIR colors unlike any typical galaxy or active galactic nuclei (AGN). Are LRDs compact, dust-obscured starbursts with UV leaks, or blue, low-mass galaxies hosting obscured

AGNs?. Current photometric models are strongly degenerated and follow up spectroscopy, aimed at detecting the emission lines, is typically shallow and can not reveal the true nature of the LRD continuum emission.

High resolution ( $R=1000$ ) continuum spectroscopy provides a definitive answer. Our  $\sim 20$ h, deep NIRSpec/IFU and MIRI/MRS spectroscopic program targeting a typical LRD at  $z=3.1386$  with bright IR emission will a) reveal the galaxy or AGN nature of the optical continuum emission, and NIR dust emission by targeting multiple stellar absorption lines, and, for the first time, a PAH emission at  $3.3\mu\text{m}$ , b) show the true (emission-line free) spatial distribution of the optical and NIR continuum providing another axis to distinguish between galaxy or AGN, and c) obtain precise, black hole masses and attenuations from multiple, narrow, and broad emission lines.

## **OBSERVING DESCRIPTION**

This program aims to obtain deep, spatially-resolved continuum spectroscopy of a representative LRD at  $z = 3.1386$  using a combination of NIRSpec and MIRI/MRS observations. The observations are designed to distinguish the stellar and AGN contributions to the continuum, as well as the properties of warm dust in the mid-IR.

### **NIRSpec Observations:**

We will utilize the NIRSpec Integral Field Unit (IFU) with Prism, G235M, and G395M gratings. The Prism mode will provide low-resolution coverage from  $0.6$  to  $5\mu\text{m}$  to measure the overall shape of the continuum, focusing on the Balmer break at  $4000\text{ \AA}$ , while the higher resolution G235M and G395M modes will target key absorption and emission lines. The  $R=1000$  is crucial for resolving absorption lines a model the broad and narrow components of the emission lines. For G235M and G395M we use the NRSIRS2 readout mode given the long required integration times and data-rate limitations. The 8 dithers are following a Medium cycling pattern that offer an optimal compromise between a large enough step size to mitigate microshutter failures, while ensuring good sub-pixel sampling and a large FoV  $\sim 2.5'' \times 2.5''$  that has the full exposure time.

### **MIRI/MRS Observations:**

In the mid-IR, we will use MIRI/MRS in the Medium (B) configuration. Since we know the spectroscopic redshift we verify that this configuration can target both the CO band heads, enabling us to probe stellar populations and the  $3.3\mu\text{m}$  PAH line to differentiate between ISM dust and AGN torus emission.

### **Exposure Times:**

We estimate 20 hours of total observing time split across NIRSpec and MIRI. The NIRSpec Prism observations will reach a  $\text{SNR} \sim 3$  for continuum

detection, with higher SNR achieved for line measurements by collapsing the spectra in regions free of strong emission lines. The MIRI observations are designed to achieve an SNR = 5, ensuring reliable detection of the 3.3  $\mu\text{m}$  PAH feature and the continuum emission.

Proposal 8358 - Targets - Revealing the True Nature of Little Red Dots with Deep Continuum Observations of an IR-Bright LRD at z=3.1

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(1)	JADES-191056	RA: 03 32 39.5549 (53.1648121d) Dec: -27 50 13.09 (-27.83697d) Equinox: J2000		
<i>Comments:</i> <i>Category=Galaxy</i> <i>Description=[Active galactic nuclei, Emission line galaxies, Quasars]</i>					

Proposal 8358 - Observation 1 - Revealing the True Nature of Little Red Dots with Deep Continuum Observations of an IR-Bright LRD ...

Fri Feb 06 17:00:21 GMT 2026

<b>Observation</b>	<p><b>Proposal 8358, Observation 1: NIRSpec-IFU</b></p> <p><b>Diagnostic Status: Warning</b></p> <p>Observing Template: NIRSpec IFU Spectroscopy</p>											
<b>Diagnostics</b>	(Visit 1:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.											
<b>Fixed Targets</b>	<b>#</b>	<b>Name</b>	<b>Target Coordinates</b>			<b>Targ. Coord. Corrections</b>			<b>Miscellaneous</b>			
	(1)	JADES-191056	RA: 03 32 39.5549 (53.1648121d) Dec: -27 50 13.09 (-27.83697d) Equinox: J2000									
	<p><i>Comments:</i>  <i>Category=Galaxy</i>  <i>Description=[Active galactic nuclei, Emission line galaxies, Quasars]</i></p>											
<b>Template</b>	<b>TA Method</b>						<b>HFF Readout Mode</b>					
	NONE						false					
<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	CYCLING		MEDIUM	1		8					
<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>Optional ETC ID</b>
	1	PRISM/CLEAR	NRSIRS2RAPID	28	1	false	true	NONE	8	8	3384.622	
	2	G235M/F170LP	NRSIRS2	25	1	false	true	NONE	8	8	14705.601	
	3	G395M/F290LP	NRSIRS2	7	1	false	true	NONE	8	8	4201.6	

Proposal 8358 - Observation 2 - Revealing the True Nature of Little Red Dots with Deep Continuum Observations of an IR-Bright LRD ...

Fri Feb 06 17:00:21 GMT 2026

<b>Observation</b>	Proposal 8358, Observation 2: MRS Diagnostic Status: Warning Observing Template: MIRI Medium Resolution Spectroscopy												
	(Visit 2:1) 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			
	(1)	JADES-191056	RA: 03 32 39.5549 (53.1648121d) Dec: -27 50 13.09 (-27.83697d) Equinox: J2000										
Comments: Category=Galaxy Description=[Active galactic nuclei, Emission line galaxies, Quasars]													
<b>Acquisition</b>	#	Target											
	1	NONE											
<b>Template</b>	AcqFilter	Primary Channel				Simultaneous Imaging		Imager Subarray		Grating Wheel Direction			
		All MRS				YES		FULL		Allow Auto Reorder			
<b>Dithers</b>	#	Dither Type				Optimized For				Direction			
	1	4-Point				POINT SOURCE				POSITIVE			
	2	4-Point				POINT SOURCE				NEGATIVE			
<b>Spectral Elements</b>	#	Wavelength Range	Detector	Filter	Readout Pattern	Groups/Int	Integrations/E xp	Exposures/Dit h	Dither	Total Dithers	Total Integrations	Total Exposure Time	Optional ETC ID
	1		IMAGER	F1000W	FASTR1	60	15	1	Dither 1	4	60	10145.546	
	1	MEDIUM(B)	MRSLONG		SLOWR1	22	5	1	Dither 1	4	20	10893.804	
	1	MEDIUM(B)	MRSSHORT		SLOWR1	22	5	1	Dither 1	4	20	10893.804	
	2		IMAGER	F1000W	FASTR1	60	15	1	Dither 2	4	60	10145.546	
	2	MEDIUM(B)	MRSLONG		SLOWR1	22	5	1	Dither 2	4	20	10893.804	
	2	MEDIUM(B)	MRSSHORT		SLOWR1	22	5	1	Dither 2	4	20	10893.804	
	3		IMAGER	F1000W	FASTR1	60	15	1	Dither 1	4	60	10145.546	
	3	MEDIUM(B)	MRSLONG		SLOWR1	22	5	1	Dither 1	4	20	10893.804	
	3	MEDIUM(B)	MRSSHORT		SLOWR1	22	5	1	Dither 1	4	20	10893.804	

Proposal 8358 - Observation 3 - Revealing the True Nature of Little Red Dots with Deep Continuum Observations of an IR-Bright LRD ...

Fri Feb 06 17:00:21 GMT 2026

<b>Observation</b>	Proposal 8358, Observation 3: MRS - repeat Diagnostic Status: Warning Observing Template: MIRI Medium Resolution Spectroscopy												
	(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			
	(1)	JADES-191056	RA: 03 32 39.5549 (53.1648121d) Dec: -27 50 13.09 (-27.83697d) Equinox: J2000										
Comments: Category=Galaxy Description=[Active galactic nuclei, Emission line galaxies, Quasars]													
<b>Acquisition</b>	#	Target											
	1	NONE											
<b>Template</b>	AcqFilter	Primary Channel				Simultaneous Imaging			Imager Subarray		Grating Wheel Direction		
		All MRS				YES			FULL		Allow Auto Reorder		
<b>Dithers</b>	#	Dither Type				Optimized For				Direction			
	1	4-Point				POINT SOURCE				POSITIVE			
	2	4-Point				POINT SOURCE				NEGATIVE			
<b>Spectral Elements</b>	#	Wavelength Range	Detector	Filter	Readout Pattern	Groups/Int	Integrations/E xp	Exposures/Dit h	Dither	Total Dithers	Total Integrations	Total Exposure Time	Optional ETC ID
	1		IMAGER	F1000W	FASTR1	60	15	1	Dither 1	4	60	10145.546	
	1	MEDIUM(B)	MRSLONG		SLOWR1	22	5	1	Dither 1	4	20	10893.804	
	1	MEDIUM(B)	MRSSHORT		SLOWR1	22	5	1	Dither 1	4	20	10893.804	
	2		IMAGER	F1000W	FASTR1	60	15	1	Dither 2	4	60	10145.546	
	2	MEDIUM(B)	MRSLONG		SLOWR1	22	5	1	Dither 2	4	20	10893.804	
	2	MEDIUM(B)	MRSSHORT		SLOWR1	22	5	1	Dither 2	4	20	10893.804	
	3		IMAGER	F1000W	FASTR1	60	15	1	Dither 1	4	60	10145.546	
	3	MEDIUM(B)	MRSLONG		SLOWR1	22	5	1	Dither 1	4	20	10893.804	
	3	MEDIUM(B)	MRSSHORT		SLOWR1	22	5	1	Dither 1	4	20	10893.804	

Proposal 8358 - Observation 4 - Revealing the True Nature of Little Red Dots with Deep Continuum Observations of an IR-Bright LRD ...

Fri Feb 06 17:00:21 GMT 2026

<b>Observation</b>	Proposal 8358, Observation 4: MRS - second repeat Diagnostic Status: Warning Observing Template: MIRI Medium Resolution Spectroscopy												
	(Visit 4:1) 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			
	(1)	JADES-191056	RA: 03 32 39.5549 (53.1648121d) Dec: -27 50 13.09 (-27.83697d) Equinox: J2000										
Comments: Category=Galaxy Description=[Active galactic nuclei, Emission line galaxies, Quasars]													
<b>Acquisition</b>	#	Target											
	1	NONE											
<b>Template</b>	AcqFilter	Primary Channel			Simultaneous Imaging			Imager Subarray		Grating Wheel Direction			
		All MRS			YES			FULL		Allow Auto Reorder			
<b>Dithers</b>	#	Dither Type				Optimized For				Direction			
	1	4-Point				POINT SOURCE				POSITIVE			
	2	4-Point				POINT SOURCE				NEGATIVE			
<b>Spectral Elements</b>	#	Wavelength Range	Detector	Filter	Readout Pattern	Groups/Int	Integrations/E xp	Exposures/Dit h	Dither	Total Dithers	Total Integrations	Total Exposure Time	Optional ETC ID
	1		IMAGER	F1000W	FASTR1	60	15	1	Dither 1	4	60	10145.546	
	1	MEDIUM(B)	MRSLONG		SLOWR1	22	5	1	Dither 1	4	20	10893.804	
	1	MEDIUM(B)	MRSSHORT		SLOWR1	22	5	1	Dither 1	4	20	10893.804	
	2		IMAGER	F1000W	FASTR1	60	15	1	Dither 2	4	60	10145.546	
	2	MEDIUM(B)	MRSLONG		SLOWR1	22	5	1	Dither 2	4	20	10893.804	
	2	MEDIUM(B)	MRSSHORT		SLOWR1	22	5	1	Dither 2	4	20	10893.804	
	3		IMAGER	F1000W	FASTR1	60	15	1	Dither 1	4	60	10145.546	
	3	MEDIUM(B)	MRSLONG		SLOWR1	22	5	1	Dither 1	4	20	10893.804	
	3	MEDIUM(B)	MRSSHORT		SLOWR1	22	5	1	Dither 1	4	20	10893.804	