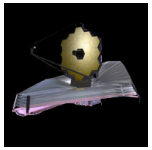

9327 - Confirmation of a direct-collapse supermassive black hole

Cycle: 3, Proposal Category: DD

INVESTIGATORS

Name	*Institution*
Prof. Pieter van Dokkum (PI)	**Yale University**
Dr. Gabriel Brammer (CoI) (ESA Member)	University of Copenhagen, Niels Bohr Institute
Imad Pasha (CoI)	Yale University
Ms. Josephine Frederika Willemijn Baggen (CoI)	Yale University

OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1		NIRSpec IFU Spectroscopy	(1) Infinity
	2		NIRSpec IFU Spectroscopy	(2) Background

ABSTRACT

The origin of supermassive black holes (SMBHs) is one of the most important open questions in astrophysics. The two leading theories are that they started out as remnants of individual Population III stars ("light seeds"), or formed through a direct runaway gravitational collapse of a massive gas cloud ("heavy seeds"). As both processes were thought to take place only at very high redshift (z~20), there was little hope to directly observe the formation of a SMBH, even with JWST. Against the odds, a candidate for a direct-collapse SMBH has now been identified in JWST images of the COSMOS field. It is in a galaxy at z=1.14 that consists of two massive, ringed nuclei. The SMBH is in between the nuclei, embedded in an extended distribution of Halpha+NII+SII emitting gas. The galaxy is a textbook example of a head-on collision of two disks, with the disk stars herded in collisional rings around the bulges. The ionized gas in between the nuclei was likely shocked and compressed at the collision site. The SMBH appears to have formed out of this dense, filamentary gas. We propose to test this by measuring the radial velocity of the ionized gas, using the NIRSpec IFU. If the SMBH formed out of this gas, the radial velocity of the SMBH and the gas should be the same. If it is a "wandering" black hole that is just passing through, the SMBH and gas velocities will be significantly different. Should the in-situ scenario be corroborated by the NIRSpec

observations, then this constitutes an empirical demonstration that direct-collapse formation of SMBHs can happen in the right circumstances - something that has so far only been seen in simulations and through indirect observations.

OBSERVING DESCRIPTION

Two linked sets of exposures will be obtained: one on the science target (Observation 1) and one on an offset sky position (Observation 2). Each of the sets consists of 4 exposures in a standard 4-point dither pattern. Each of the 4 exposures has 8 groups.

No acquistion is needed, given the size of the target and the pointing accuracy of JWST.

Proposal 9327 - Targets - Confirmation of a direct-collapse supermassive black hole

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	Infinity	RA: 10 00 14.2010 (150.0591708d) Dec: +02 13 11.66 (2.21991d) Equinox: J2000	Parallax: 0" Epoch of Position: 2000	
Comments: *Category=Galaxy* *Description=[Active galactic nuclei, Interacting galaxies]* *Extended=YES*				
(2)	Background	RA: 10 00 14.4000 (150.0600000d) Dec: +02 13 17.76 (2.22160d) Equinox: J2000	Parallax: 0" Epoch of Position: 2000	
Comments: *Category=Calibration* *Description=[Telescope/sky background]* *Extended=YES*				

Observation

Proposal 9327, Observation 1

Fri May 02 14:00:23 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Background Observations:[Observation 2]

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)	Infinity	RA: 10 00 14.2010 (150.0591708d) Dec: +02 13 11.66 (2.21991d) Equinox: J2000	Parallax: 0" Epoch of Position: 2000	

Comments:
Category=Galaxy
Description=[Active galactic nuclei, Interacting galaxies]
Extended=YES

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	G140H/F100LP	NRSIRS2RAPID	40	1	false	true	NONE	4	4	2392.578	247491

Special Requirements

Before Date 27-MAY-2025:00:00:00

Group Observations 1, 2, Non-interruptible

Observation

Proposal 9327, Observation 2 Fri May 02 14:00:23 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Background Observation For: [Observation 1]

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: 10 00 14.4000 (150.0600000d) Dec: +02 13 17.76 (2.22160d) Equinox: J2000	Parallax: 0" Epoch of Position: 2000	

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

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	G140H/F100LP	NRSIRS2RAPID	40	1	false	true	NONE	4	4	2392.578	

Special Requirements

Before Date 27-MAY-2025:00:00:00

Group Observations 1, 2, Non-interruptible