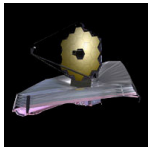

5716 - Precision Tests of Black Hole Mass Measurements in Massive Elliptical Galaxies

Cycle: 3, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
Observation Folder				
	1	NGC 315	NIRSpec IFU Spectroscopy	(1) NGC-0315
	2	NGC 3258	NIRSpec IFU Spectroscopy	(2) NGC-3258
	3	NGC 4261	NIRSpec IFU Spectroscopy	(3) NGC-4261

ABSTRACT

About 100 supermassive black hole (BH) masses have been dynamically measured in nearby galaxies. The local BH census, however, is highly incomplete, and questions about the slope, scatter, and even the shape of the BH-host galaxy relations remain, especially at the high-mass end. Moreover, only a handful of studies have made direct comparisons of BH masses using different dynamical tracers or under different modeling assumptions. Recently, ALMA has enabled the mapping of molecular gas (CO) within the BH's gravitational sphere of influence (r_soi). CO is a far superior tracer of the potential compared to the traditionally used ionized gas, and there has been a large uptick in the number of ALMA BH masses.

Concurrently, substantial advancements have been made to stellar-dynamical models, including new/updated triaxial codes and modern search strategies to simultaneously determine mass and intrinsic shape parameters for each galaxy. With the new CO BH masses and the exciting improvements to stellar-dynamical models, the time is right for a systematic study of BH masses from CO emission versus stars. We will use the NIRSpec IFU to acquire the best high angular resolution spectra to date at the center of three massive elliptical galaxies that have superb ALMA observations and some of the most precise CO BH masses. We will extract reliable stellar kinematics deep within r_soi, matching the resolution of ALMA, and apply state-of-the-art models to obtain robust stellar-dynamical BH masses. The three galaxies are the best targets for such analysis and will allow us to assess the consistency of these two main methods and the subsequent effects on the upper end of the BH relations.

OBSERVING DESCRIPTION

We will observe the center of NGC 315, NGC 3258, and NGC 4261 using NIRSpec in IFU mode with the G235H/F170LP grating and filter. The wavelength range will cover the K-band CO bandheads, from which we will measure the stellar kinematics as a function of spatial location. We will obtain dithered NIRSpec exposures using the cycling pattern and small extent, thereby improving the sampling of the NIRSpec point spread function. We select the NRSIRS2 readout mode to reduce correlated noise and increase sensitivity for long exposures, while keeping the data volume low to ensure schedulability.

Our work requires high signal-to-noise (S/N) spectra in order to fully characterize the stellar line-of-sight velocity distribution. We will measure not only the velocity and velocity dispersion, but also higher order moments (h_3, h_4, and beyond) that quantify the distribution's asymmetric and symmetric deviations from a Gaussian. Using the JWST ETC and the surface brightness profiles from multi-Gaussian expansions from Boizelle et al. 2019 and Boizelle et al. 2021, we estimate that ~9.6 hrs, ~6.9 hrs, and ~6.1 hrs (including all overheads) are needed to reach a S/N ~ 100 at 2.3 microns in a circular aperture with a radius of 0.014" located 0.15" from the nucleus of NGC 315, NGC 3258, and NGC 4261, respectively. The aperture was selected to mimic a single spaxel with our dithering strategy. We will construct spatial bins in the outer regions of the NIRSpec IFU to reach a similarly high S/N. We will use 20 groups (each consisting of 5 frames with our readout mode) for NGC 315, 13 groups for NGC 3258, and 11 groups for NGC 4261, each with 1 integration and 16 (dithered) exposures.

We will obtain a LeakCal exposure composed of the same number of groups as the science exposure for the given galaxy, with the NRIRS2 readout mode at the first science dither position. This exposure will be used to remove MSA leakage. Since we expect the background to be fairly uniform over the small extent of the dither pattern, we chose not to obtain LeakCal exposures at every dither position. We also will perform a target acquisition to ensure precise centering on the galaxy nucleus.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	NGC-0315	RA: 00 57 48.8832 (14.4536800d) Dec: +30 21 8.82 (30.35245d) Equinox: J2000		
Comments: This object was generated by the targetselector and retrieved from the NED database. *Category=Galaxy* *Description=[Elliptical galaxies, Galaxy nuclei]* *Extended=YES*				
(2)	NGC-3258	RA: 10 28 53.5704 (157.2232100d) Dec: -35 36 19.91 (-35.60553d) Equinox: J2000		
Comments: This object was generated by the targetselector and retrieved from the NED database. *Category=Galaxy* *Description=[Elliptical galaxies, Galaxy nuclei]* *Extended=YES*				
(3)	NGC-4261	RA: 12 19 23.2160 (184.8467333d) Dec: +05 49 29.69 (5.82491d) Equinox: J2000		
Comments: This object was generated by the targetselector and retrieved from the NED database. *Category=Galaxy* *Description=[Elliptical galaxies, Galaxy nuclei]* *Extended=YES*				

Observation

Proposal 5716, Observation 1: NGC 315

Fri Mar 07 14:00:10 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

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)	NGC-0315	RA: 00 57 48.8832 (14.4536800d) Dec: +30 21 8.82 (30.35245d) Equinox: J2000		

Comments: This object was generated by the targetselector and retrieved from the NED database.
Category=Galaxy
Description=[Elliptical galaxies, Galaxy nuclei]
Extended=YES

Template

TA Method	HFF Readout Mode
NONE	false

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	CYCLING	SMALL	1	16	

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	G235H/F170LP	NRSIRS2	20	1	false	true	NONE	16	16	23575.646	176398
2	G235H/F170LP	NRSIRS2	20	1	true	false	NONE	1	1	1473.478	

Observation

Proposal 5716, Observation 2: NGC 3258

Fri Mar 07 14:00:10 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

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)	NGC-3258	RA: 10 28 53.5704 (157.2232100d) Dec: -35 36 19.91 (-35.60553d) Equinox: J2000		

Comments: This object was generated by the targetselector and retrieved from the NED database.
Category=Galaxy
Description=[Elliptical galaxies, Galaxy nuclei]
Extended=YES

Template

TA Method	HFF Readout Mode
NONE	false

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	CYCLING	SMALL	1	16	

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	G235H/F170LP	NRSIRS2	13	1	false	true	NONE	16	16	15405.868	176397
2	G235H/F170LP	NRSIRS2	13	1	true	false	NONE	1	1	962.867	

Observation

Proposal 5716, Observation 3: NGC 4261

Fri Mar 07 14:00:10 GMT 2025

Diagnostic Status: Warning

Observing Template: NIRSpec IFU Spectroscopy

Diagnostics

(Visit 3:1) Warning (Form): Overheads are provisional until the Visit Planner has been run.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(3)	NGC-4261	RA: 12 19 23.2160 (184.8467333d) Dec: +05 49 29.69 (5.82491d) Equinox: J2000		

Comments: This object was generated by the targetselector and retrieved from the NED database.
Category=Galaxy
Description=[Elliptical galaxies, Galaxy nuclei]
Extended=YES

Template

TA Method	HFF Readout Mode
NONE	false

Dithers

#	Dither Type	Size	Starting Point	Number of Points	Points
1	CYCLING	SMALL	1	16	

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	G235H/F170LP	NRSIRS2	11	1	false	true	NONE	16	16	13071.645	176399
2	G235H/F170LP	NRSIRS2	11	1	true	false	NONE	1	1	816.978	