



2439 - Resolving the Cooling Flow at the Center of the Phoenix Cluster

Cycle: 1, Proposal Category: GO

INVESTIGATORS

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Dr. Massimo Gaspari (CoI)	Princeton University
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Dr. Alexandro Saro (CoI) (ESA Member)	Universita degli Studi di Trieste

OBSERVATIONS

<i>Folder</i>	<i>Observation</i>	<i>Label</i>	<i>Observing Template</i>	<i>Science Target</i>
Observation Folder				
	1	OnBCG-ChABC	MIRI Medium Resolution Spectroscopy	(1) PHOENIX-CLUSTER-BCG
	2	OffBCG-ChABC	MIRI Medium Resolution Spectroscopy	(2) PHOENIX-CLUSTER-BG

ABSTRACT

The centers of galaxy clusters represent an ideal laboratory to study black hole feeding and feedback. In nearly every cluster that has been observed, cooling of the intracluster medium (ICM) appears to be well-regulated by a mechanically-efficient, radio-loud AGN within the central giant elliptical galaxy. This mechanical power appears to offset cooling of the ICM over long (~ 10 Gyr) timescales, allowing only $\sim 1\%$ of the hot ICM to cool to low enough temperatures to form stars and fuel the AGN. This precise balance prevents the overcooling of the ICM, keeps central cluster galaxies red and dead, and keeps central AGN in a low (mechanically-efficient) accretion state. The Phoenix cluster ($z=0.597$) represents an exception to this paradigm, with a starburst (~ 800 Msun/yr) central galaxy and a rapidly-accreting central quasar. This system appears to be fulfilling many of the early “cooling flow” predictions, with evidence from X-ray spectroscopy that the hot ($>10^7$ K) gas in the core is cooling at nearly the maximal rate. We propose MIRI IFU spectroscopy to image the core of this unique cluster. In particular, we will utilize the NeVI emission line, which probes gas at 300,000K, to map out the intermediate temperature gas both spatially and kinematically, and determine whether a cooling flow is indeed fueling the observed starburst. The full mid-IR spectrum will allow new insights into the cooling flow, ICM turbulence, the central QSO, and the cold gas reservoir.

OBSERVING DESCRIPTION

The goal of this program is to observe the core of the Phoenix cluster with the MIRI MRS IFU. This requires a single pointing of the IFU, with three separate observations to utilize the three gratings. We opt for a deep exposure in the "Short (A)" grating, and shallow exposures in the B,C gratings. The former allows the detection of the very faint NeVI line (rest frame 7.6 μ m redshifted to 12.14 μ m) against the bright continuum. The other two setups will be observed at sufficient depth to achieve $S/N > 5$ in all spectral elements. Our source is extended, so we will perform small dithers to optimize the field-of-view. We split the 'A' grating observation into two visits in order to keep the data volume per visit under the 58GB limit. Wherever possible, we optimize the observing program for the Ch3-A setup, where we require maximal S/N and coverage.

Proposal 2439 - Targets - Resolving the Cooling Flow at the Center of the Phoenix Cluster

Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
	(1)	PHOENIX-CLUSTER-BCG	RA: 23 44 43.8885 (356.1828688d) Dec: -42 43 12.88 (-42.72024d) Equinox: J2000 <i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i> <i>Category=Galaxy</i> <i>Description=[Emission line galaxies, Giant elliptical galaxies, Radio loud quasars, Starburst galaxies, Ultraluminous infrared galaxies]</i> <i>Extended=YES</i>	Epoch of Position: 2015.5	
(2)	PHOENIX-CLUSTER-BG	RA: 23 44 46.1009 (356.1920871d) Dec: -42 42 46.21 (-42.71284d) Equinox: J2000 <i>Comments:</i> <i>Category=Calibration</i> <i>Description=[Telescope/sky background]</i>			

Proposal 2439 - Observation 1 - Resolving the Cooling Flow at the Center of the Phoenix Cluster

Thu Jul 13 22:02:28 GMT 2023

Observation	Proposal 2439, Observation 1: OnBCG-ChABC Diagnostic Status: Warning Observing Template: MIRI Medium Resolution Spectroscopy Background Observations:[OffBCG-ChABC (Obs 2)]																																																																																																																																																																																				
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Proposal 2439 - Observation 1 - Resolving the Cooling Flow at the Center of the Phoenix Cluster

Special Requirements

Aperture PA Range 285 to 300 Degrees (V3 285.0 to 300.0)

Sequence Observations 1, 2, Non-interruptible

Proposal 2439 - Observation 2 - Resolving the Cooling Flow at the Center of the Phoenix Cluster

Thu Jul 13 22:02:28 GMT 2023

Observation	Proposal 2439, Observation 2: OffBCG-ChABC Diagnostic Status: Warning Observing Template: MIRI Medium Resolution Spectroscopy Background Observation For: [OnBCG-ChABC (Obs 1)]												
	(OffBCG-ChABC (Obs 2)) Warning (Form): Imager Filter overlap. (OffBCG-ChABC (Obs 2)) Warning (Form): Imager Filter overlap. (OffBCG-ChABC (Obs 2)) Warning (Form): Imager Filter overlap. (Visit 2:1) Warning (Form): Overheads are provisional until the Visit Planner has been run. (Visit 2:1) Informational (Form): Visit schedulable, but most scheduling windows are when JWST is pointed in direction of greatest micrometeoroid impact risk. This is likely due to scheduling special requirements.												
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Comments: Category=Calibration Description=[Telescope/sky background]													
Acquisition	#	Target											
	1	NONE											
Template	AcqFilter	Primary Channel				Simultaneous Imaging			Imager Subarray		Grating Wheel Direction		
	F1000W	CHANNEL3				YES			FULL		NEUTRAL		
Dithers	#	Dither Type				Optimized For				Direction			
	1	2-Point				EXTENDED SOURCE				NEGATIVE			
Spectral Elements	#	Wavelength Range	Detector	Filter	Readout Pattern	Groups/Int	Integrations/E xp	Exposures/Dit h	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
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	1	SHORT(A)	MRSLONG		SLOWR1	10	3	1	Dither 1	2	6	1528.955	58169
	1	SHORT(A)	MRSSHORT		SLOWR1	10	3	1	Dither 1	2	6	1528.955	58169
	2		IMAGER	F1500W	SLOWR1	10	3	1	Dither 1	2	6	1528.955	
	2	SHORT(A)	MRSLONG		SLOWR1	10	3	1	Dither 1	2	6	1528.955	
	2	SHORT(A)	MRSSHORT		SLOWR1	10	3	1	Dither 1	2	6	1528.955	
	3		IMAGER	F1000W	SLOWR1	10	2	1	Dither 1	2	4	1003.377	
	3	MEDIUM(B)	MRSLONG		SLOWR1	10	2	1	Dither 1	2	4	1003.377	
	3	MEDIUM(B)	MRSSHORT		SLOWR1	10	2	1	Dither 1	2	4	1003.377	
	4		IMAGER	F1280W	SLOWR1	10	3	1	Dither 1	2	6	1528.955	
	4	LONG(C)	MRSLONG		SLOWR1	10	3	1	Dither 1	2	6	1528.955	
	4	LONG(C)	MRSSHORT		SLOWR1	10	3	1	Dither 1	2	6	1528.955	

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