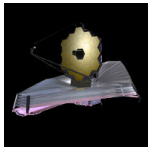

3384 - Testing the Jet Origin of the Mysterious Infrared Excess in Quiescent Black Hole Binaries

Cycle: 2, Proposal Category: GO

INVESTIGATORS

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OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
V404 Observations				
	1		MIRI Imaging	(1) V404-CYG
	2		MIRI Imaging	(1) V404-CYG
	3		MIRI Imaging	(1) V404-CYG

ABSTRACT

We will observe the quiescent black hole X-ray binary V404 Cyg with JWST/MIRI and ALMA. This is a prototype of the class of 'electromagnetic black holes' with normal stellar companions, in contrast to binary stellar mass black holes identified by LIGO. V404 Cyg exhibits an IR excess in Spitzer observations above that expected from either the secondary star or the accretion disk. Two explanations are proposed. Either it originates from synchrotron emission from a relativistic jet that persists into quiescence or from a large, cool circumbinary disk. We will discriminate between these possibilities by using the large throughput and sensitivity of JWST coupled with simultaneous ALMA observations of the radio jet to search for mid-IR variability and multiwavelength correlation and measure the mid-IR-mm spectral energy distribution. No short timescale variability is expected from a circumbinary disk so variability, especially if correlated with ALMA, would falsify the disk model and confirm mid-IR jet emission. On the other hand, if ALMA sees variability but JWST does not, this will support the circumbinary disk interpretation with profound implications for compact binary evolution. Joint JWST-ALMA observations of the jet would probe jet formation close to the black hole at extremely low accretion rates, and would be compared to predicted multiwavelength lightcurves from models of internal shocks in jets. These observations when compared to observations from V404 Cyg in outburst would allow a study of jets spanning five orders of magnitude dynamic range in luminosity.

OBSERVING DESCRIPTION

We will perform time-series observations with JWST supported by ALMA of the quiescent black hole binary V404 Cyg to search for infrared and mm variability expected from a jet together with multicolor photometry to measure its mid-IR spectral energy distribution. Based on radio

observations we expect flares on timescales of minutes, but also anticipate shorter timescale variability will be present at shorter wavelengths.

We will use MIRI imaging in Time Series Observation mode to obtain two uninterrupted series of images over two hours each (matched to ALMA two hour observing blocks). Sub-array (SUB64) mode will be used as these are single point-sources and we wish to maximize time-resolution. We use 64 groups per integration to permit well-calibrated 5.45 second resolution lightcurves, and will also examine individual groups to search for higher time-resolution information.

V404 Cyg has a luminous sub-giant companion, so we work primarily in the mid-IR using the F2100W filter with which we expect a large contrast with a jet or circumbinary disk. We include a sequence of observations spanning the F1280W to F2550W filters to measure the shape of the spectral energy distribution. We anticipate that these can be scheduled at the end of the second time-series rather than as a self-contained observation.

Joint ALMA observations should be scheduled simultaneously, with one two hour block matched to each of Observations 1 and 2. V404 Cyg is a northern target so it is likely that ALMA will require scheduling these on different nights, but we would prefer to observe them back to back if ALMA can match that and that would save on slew time.

Proposal 3384 - Targets - Testing the Jet Origin of the Mysterious Infrared Excess in Quiescent Black Hole Binaries

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	V404-CYG	RA: 20 24 3.8181 (306.0159087d)	Proper Motion RA: -5.177 mas/yr	
		Dec: +33 52 1.84 (33.86718d)	Proper Motion Dec: -7.778 mas/yr	
		Equinox: J2000	Parallax: 0.0003024"	
			Epoch of Position: 2016.0	

Comments: Coordinates are taken from Gaia DR3
Category=Star
Description=[Black holes, Compact binary systems, Low-mass X-ray binary stars, X-ray binary stars, X-ray transients]
Extended=NO

Observation

Proposal 3384, Observation 1

Wed Sep 13 21:01:21 GMT 2023

Diagnostic Status: Warning

Observing Template: MIRI Imaging

Comments: The BETWEEN requirement results from communicaiton between Tony Roman, JWST LRP staff, the PI, ALMA science operations staff, and Chandra science operations staff to determine when ALMA, Chandra, and JWST may observe simultaneously.

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)	V404-CYG	RA: 20 24 3.8181 (306.0159087d)	Proper Motion RA: -5.177 mas/yr	
		Dec: +33 52 1.84 (33.86718d)	Proper Motion Dec: -7.778 mas/yr	
		Equinox: J2000	Parallax: 0.0003024"	
			Epoch of Position: 2016.0	

Comments: Coordinates are taken from Gaia DR3
Category=Star
Description=[Black holes, Compact binary systems, Low-mass X-ray binary stars, X-ray binary stars, X-ray transients]
Extended=NO

Template

Subarray
SUB256

Spectral Elements

#	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F2100W	FASTR1	20	1185	1	None	1	1185	7453.256	147290.7

Special Requirements

Between Dates 14-OCT-2023:19:30:00 and 14-OCT-2023:20:30:00
Time Series Observation
No Parallel Attachments
No Parallel Attachments

Sequence Observations 1, 2, 3, Non-interruptible

Observation

Proposal 3384, Observation 2

Wed Sep 13 21:01:21 GMT 2023

Diagnostic Status: Warning

Observing Template: MIRI Imaging

Comments: This observation is to be simultaneous with our second two hour ALMA observation. Since V404 Cyg is in the northern hemisphere, ALMA nightly visibility is limited and it may not be possible to accomodate all four hours of requested ALMA time in a single night. We have therefore inserted the AFTER 1 DAY special requirement so that the slew time for the second observation is properly accounted for. This requirement can be removed if ALMA are able to schedule our observations within a single night.

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
(1)	V404-CYG	RA: 20 24 3.8181 (306.0159087d)	Proper Motion RA: -5.177 mas/yr	
		Dec: +33 52 1.84 (33.86718d)	Proper Motion Dec: -7.778 mas/yr	
		Equinox: J2000	Parallax: 0.0003024"	
			Epoch of Position: 2016.0	

Comments: Coordinates are taken from Gaia DR3
Category=Star
Description=[Black holes, Compact binary systems, Low-mass X-ray binary stars, X-ray binary stars, X-ray transients]
Extended=NO

Template

Subarray
SUB256

Spectral Elements

#	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F2100W	FASTR1	20	1185	1	None	1	1185	7453.256	55898.1

Special Requirements

Time Series Observation
No Parallel Attachments

Sequence Observations 1, 2, 3, Non-interruptible

Observation

Proposal 3384, Observation 3

Wed Sep 13 21:01:21 GMT 2023

Diagnostic Status: Warning

Observing Template: MIRI Imaging

Comments: This observation should be taken immediately after Observation 2 to minimize the impact of long-term variability on our ALMA-JWST SED and our comparison of spectral and timing characteristics. This also avoids superfluous slew-time.

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
(1)	V404-CYG	RA: 20 24 3.8181 (306.0159087d)	Proper Motion RA: -5.177 mas/yr	
		Dec: +33 52 1.84 (33.86718d)	Proper Motion Dec: -7.778 mas/yr	
		Equinox: J2000	Parallax: 0.0003024"	
			Epoch of Position: 2016.0	

Comments: Coordinates are taken from Gaia DR3
Category=Star
Description=[Black holes, Compact binary systems, Low-mass X-ray binary stars, X-ray binary stars, X-ray transients]
Extended=NO

Template

Subarray
SUB256

Dithers

#	Dither Type	Starting Point	Number of Points	Points	Starting Set	Number of Sets	Optimized For	Direction	Pattern Size
1	4-Point-Sets				1	1	POINT SOURCE	POSITIVE	DEFAULT

Spectral Elements

#	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F1280W	FASTR1	5	1	1	Dither 1	4	4	5.99	147290.8
2	F1500W	FASTR1	5	1	1	Dither 1	4	4	5.99	147290.9
3	F1800W	FASTR1	7	1	1	Dither 1	4	4	8.387	147290.10
4	F2100W	FASTR1	11	1	1	Dither 1	4	4	13.179	147290.11
5	F2550W	FASTR1	100	3	1	Dither 1	4	12	361.82	147290.12

Special Requirements

Sequence Observations 1, 2, 3, Non-interruptible