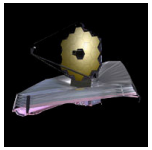

6809 - Observing the birth of a black hole in M31

Cycle: 3, Proposal Category: DD

INVESTIGATORS

Name	*Institution*
Dr. Kishalay De (PI)	**Massachusetts Institute of Technology**
Dr. Jacob Jencson (CoI)	California Institute of Technology
Dr. Ryan M Lau (CoI)	NOIRLab - (AZ)
Dr. Morgan MacLeod (CoI)	Smithsonian Institution Astrophysical Observatory

OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
M31-2014-DS1 MIRI				
	1	M31-2014-DS1/LRS	MIRI Low Resolution Spectroscopy	(1) M31-2014-DS1
	2	M31-2014-DS1 imaging	MIRI Imaging	(1) M31-2014-DS1
M31-2014-DS1 NIRSpec				
	3	M31-2014-DS1	NIRSpec Fixed Slit Spectroscopy	(1) M31-2014-DS1

ABSTRACT

Stellar mass black holes (BHs) form a corner stone of astrophysics; yet there remains no observational consensus on how they form. The majority are believed to form from the collapse of massive stellar cores that fail to explode as a supernova, and instead implode into a BH. However, identifying individual disappearing stars at extragalactic distances remains a daunting task. Using archival data from the NEOWISE survey, we have identified a faint mid-infrared (MIR) brightening of a massive supergiant in the Andromeda galaxy, which subsequently has faded dramatically in optical and bolometric luminosity. Modeling the exquisitely rich archival dataset, we identify a failed supernova as the most likely explanation. Here, we propose JWST DDT observations in support of a once-in-a-lifetime opportunity to study a failed SN in the nearest Milky Way-like galaxy, that will i) reveal the luminosity of the surviving remnant, thereby confirming a terminal event caused by the collapse of the core, ii) measure the energy and mass

ejected by the neutrino shock and iii) constrain the growth of the putative BH via direct detection of the fallback material. Capitalizing on recent ground-based observations that confirmed the disappearance, timely observations in Cycle 3 are necessary to catch the fading remnant dominated by IR emission, as it is expected to decay as a power-law in time (optimistically; it may be fainter if the accretion becomes radiatively inefficient approaching 10% of Eddington luminosity). These observations will set the benchmark for future follow-up for many decades, with the potential to become a foundation of our understanding of stellar mass black hole formation.

OBSERVING DESCRIPTION

The goal of the propsal is to obtain NIRSpec Fixed-Slit spectroscopy and MIRI LRS spectroscopy + longer wavelength image of a point source in the direction of M31. We propose to use a combination of MIRI/LRS spectroscopy and longer wavelength imaging in the F1500W, F1800W, F2100W and F2550W filters since it sufficies our goals to measure the dust continuum precisely. Target acquisition will be carried out directly on the source. For NIRSpec, we propose to use the G140H/F100LP, G235H/F170LP and G395H/F290LP gratings to get uniform coverage between $1.0\,\mu$m and $5.0\,\mu$m at $R \approx 2700$ for accurate comparisons against stellar photospheric models. Target acquistion will be carried out using an offset star since the science target is very faint and in a crowded field where direct acquistion may fail.

Proposal 6809 - Targets - Observing the birth of a black hole in M31

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	M31-2014-DS1	RA: 00 45 13.4751 (11.3061462d) Dec: +41 32 33.15 (41.54254d) Equinox: J2000	Proper Motion RA: 0 Proper Motion Dec: 0 Epoch of Position: 2000.0	
Comments: *Category=Star* *Description=[Red supergiants]* *Extended=NO*				
(2)	DMM2009-J004513.87+413227.2	RA: 00 45 13.8632 (11.3077633d) Dec: +41 32 27.01 (41.54084d) Equinox: J2000	Proper Motion RA: -22.051 mas/yr Proper Motion Dec: 3.508 mas/yr Parallax: 0.0017401" Epoch of Position: 2000	
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database. *SIMBAD listed proper motion for this target. When retrieving targets with PM from SIMBAD, APT requests the coordinates be calculated with an epoch of the year 2000. Do not modify this epoch. Always review coordinates using the Target Confirmation tool, which graphically displays the PM.* *Category=Star* *Description=[A stars]* *Extended=NO*				

Observation

Proposal 6809, Observation 1: M31-2014-DS1/LRS Wed Nov 06 01:00:10 GMT 2024

Diagnostic Status: Warning

Observing Template: MIRI Low Resolution 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)	M31-2014-DS1	RA: 00 45 13.4751 (11.3061462d) Dec: +41 32 33.15 (41.54254d) Equinox: J2000	Proper Motion RA: 0 Proper Motion Dec: 0 Epoch of Position: 2000.0	

Comments:
Category=Star
Description=[Red supergiants]
Extended=NO

Acquisition

#	Target	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	2 DMM2009-J004513.87+413227.2	F560W	FASTGRPAVG	4	1	1	44.401	210049

Template

Subarray	Obtain Verification Image?
FULL	true

Dithers

#	Dither Type	No. Spectral Steps	Spectral Step Offset	No. Spatial Steps	Spatial Step Offset
1	ALONG SLIT NOD				

Pointing Verification

#	PV Readout Pattern	PV Groups/Int	PV Integrations/Exp	PV Total Integrations	PV Exposures/Dith	PV Total Dithers	PV Total Exposure Time	PV ETC Wkbk.Calc ID	Filter
1	FASTR1	6	1	1	1	1	16.65		F560W

Spectral Elements

#	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Exposures/Dith	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	FASTR1	100	2	4	1	2	1115.566	210049

Observation

Proposal 6809, Observation 2: M31-2014-DS1 imaging

Wed Nov 06 01:00:10 GMT 2024

Diagnostic Status: Warning

Observing Template: MIRI Imaging

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)	M31-2014-DS1	RA: 00 45 13.4751 (11.3061462d) Dec: +41 32 33.15 (41.54254d) Equinox: J2000	Proper Motion RA: 0 Proper Motion Dec: 0 Epoch of Position: 2000.0	

Comments:
Category=Star
Description=[Red supergiants]
Extended=NO

Template

Subarray
FULL

Dithers

#	Dither Type	Starting Point	Number of Points	Points	Starting Set	Number of Sets	Optimized For	Direction	Pattern Size
1	CYCLING	1	4		1	1			LARGE

Spectral Elements

#	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Exposures/Dith	Dither	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	F1500W	FASTR1	5	1	1	Dither 1	4	4	55.501	
2	F1800W	FASTR1	5	1	1	Dither 1	4	4	55.501	
3	F2100W	FASTR1	10	1	1	Dither 1	4	4	111.002	
4	F2550W	FASTR1	15	8	1	Dither 1	4	32	1409.72	

Observation

Proposal 6809, Observation 3: M31-2014-DS1 Wed Nov 06 01:00:10 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRSpec Fixed Slit 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
(1)	M31-2014-DS1	RA: 00 45 13.4751 (11.3061462d) Dec: +41 32 33.15 (41.54254d) Equinox: J2000	Proper Motion RA: 0 Proper Motion Dec: 0 Epoch of Position: 2000.0	

Comments:
Category=Star
Description=[Red supergiants]
Extended=NO

Acquisition

#	Target	TA Method	Subarray	Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	2 DMM2009-J004513.87+413227.2	WATA	SUB32	F110W	NRSRAPID	3	1	1	0.08	210050

Template

Slit	Subarray
S200A1	SUBS200A1

Dithers

#	Primary Dither Positions	Sub-Pixel Pattern
1	3	NONE

Spectral Elements

#	Grating/Filter	Slit	Readout Pattern	Groups/Int	Integrations/Exp	#	Autocal	Total Dithers	Total Integrations	Total Exposure Time	ETC Wkbk.Calc ID
1	G140H/F100LP	S200A1	NRS	100	8	1	NONE	3	24	14994.684	
2	G235H/F170LP	S200A1	NRS	67	2	2	NONE	3	6	2514.735	
3	G395H/F290LP	S200A1	NRS	67	1	3	NONE	3	3	1257.367	