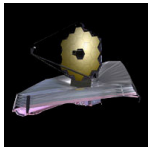

6777 - Finding Black Holes through Gravitational Microlensing

Cycle: 3, Proposal Category: DD

INVESTIGATORS

Name	*Institution*
Dr. Jessica Ryan Lu (PI)	**University of California - Berkeley**
Dr. Macy Huston (CoI) (CoPI)	University of California - Berkeley
Natasha Abrams (CoI)	University of California - Berkeley
Casey Lam (CoI)	Carnegie Institution of Washington
Dr. Sean Terry (CoI)	University of Maryland
Dr. Matthew Hosek Jr. (CoI)	University of California - Los Angeles

OBSERVATIONS

Folder	*Observation*	*Label*	*Observing Template*	*Science Target*
NIRCam				
	1	2024_fall	NIRCam Imaging	(1) OB240062
	2	2025_spring	NIRCam Imaging	(1) OB240062

ABSTRACT

The deaths of massive stars and the black hole remnants they leave behind are not well understood. Within the Milky Way, the stellar population is well studied; but very few black holes have ever been found. Specifically, 30 out of 31 black holes that have been detected are in binaries. Although nearly all massive stars are in binaries or higher-order multiple systems at birth, it is expected that the vast majority of black holes are isolated, due to supernovae kicks, mass loss, or stellar mergers. Only a single isolated black hole has been discovered, OGLE-2011-BLG-0462, using the technique of gravitational microlensing with long-duration photometry and high-precision astrometry to measure the mass of the lens and prove it was a black hole. We have identified a new, high-probability black hole microlensing event using ground-based photometry. The lightcurve peaked in 2024 June and the duration (tE > 200 days) and microlensing parallax (piE ~ 0.12) were determined more precisely just in the last week. These parameters mark this event as a strong black hole candidate. We propose to obtain time-critical JWST NIRCam images of this event during 2024 Fall and 2025 Spring

to measure the transient astrometric microlensing signal. If this candidate is discovered to be a black hole, it will double the sample size of isolated black holes with mass measurements, improve estimates of the total number of black holes in the Milky Way by 30%, and allow us to probe whether black holes get kicks when they are formed.

OBSERVING DESCRIPTION

We propose to obtain NIRCam imaging of a new microlensing event (OB240062) identified from ground-based OGLE data that is a good candidate to be a black hole lens. A microlensing event occurs when a foreground lens passes in front of a background source star. The target is located towards the crowded Galactic Bulge region.

The JWST observations will provide precision astrometric measurements needed to measure an astrometric microlensing signal over time and thus measure the mass of the lens object. JWST photometry in multiple epochs is also needed to determine the brignthess of the source star and the lens object. Taken together, the few-epoch astrometric and photometric signals from JWST will be combined with the OGLE light-curve to confirm whether the lens is a black hole.

The NIRCam imaging includes 2 filters (F250M, F090W) in the first measurement, which needs to be taken in the 2024 Fall observing window when the astrometric microlensing signal is near a minimum and the photometric microlensing signal is still detectable. A second NIRCam imaging epoch of just F250M will be taken in 2025 Spring when the astrometric signal peaks. The two epochs may be rotated with respect to each other; however, the target should always be centered in the B4 corner of the B-module to minimize distortions for the target and the 100s of stars surrounding it within 30" radius that are used as astrometric standards to establish a precise astrometric reference frame.

NIRCam configurations and filters were chosen to maximize SNR while not saturating the target or nearby neighbor stars. SNR>1000 is needed to achieve astrometric precisions of ~0.1 mas per epoch. SNR > 300 is needed for photometric measurements. The filters were also chosen to yield color-magnitude diagrams that can be used to determine the luminosity distance of the source star.

Proposal 6777 - Targets - Finding Black Holes through Gravitational Microlensing

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	OB240062	RA: 17 49 11.1151 (267.2963129d) Dec: -21 10 19.95 (-21.17221d) Equinox: J2000	Epoch of Position: 2000	

Comments:
Category=Star
Description=[Black holes, Multiple stars]
Extended=NO

Observation

Proposal 6777, Observation 1: 2024_fall

Wed Sep 04 20:00:39 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

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)	OB240062	RA: 17 49 11.1151 (267.2963129d) Dec: -21 10 19.95 (-21.17221d) Equinox: J2000	Epoch of Position: 2000	

Comments:
Category=Star
Description=[Black holes, Multiple stars]
Extended=NO

Template

Module	Subarray	Target Placement
ALL	FULL	Module B (B4 corner)

Dithers

#	Primary Dither Type	Primary Dithers	Subpixel Dither Type	Dither Size	Subpixel Positions
1	INTRAMODULEBOX	4	STANDARD		3

Spectral Elements

#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	F210M	F460M	BRIGHT2	5	1	12	12	1288.412	
2	F090W	F335M	BRIGHT2	2	1	12	12	515.365	

Special Requirements

Between Dates 05-AUG-2024:00:00:00 and 25-SEP-2024:00:00:00
Offset -18.0 arcsec, 23.0 arcsec
Fiducial Point Override NRCBS_FULL

2 After 1 by 60 Days to 220 Days

Observation

Proposal 6777, Observation 2: 2025_spring Wed Sep 04 20:00:39 GMT 2024

Diagnostic Status: Warning

Observing Template: NIRCam Imaging

Diagnostics

(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.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Miscellaneous
(1)	OB240062	RA: 17 49 11.1151 (267.2963129d) Dec: -21 10 19.95 (-21.17221d) Equinox: J2000	Epoch of Position: 2000	

Comments:
Category=Star
Description=[Black holes, Multiple stars]
Extended=NO

Template

Module	Subarray	Target Placement
ALL	FULL	Module B (B4 corner)

Dithers

#	Primary Dither Type	Primary Dithers	Subpixel Dither Type	Dither Size	Subpixel Positions
1	INTRAMODULEBOX	4	STANDARD		3

Spectral Elements

#	Short Filter	Long Filter	Readout Pattern	Groups/Int	Integrations/Exp	Total Integrations	Total Dithers	Total Exposure Time	ETC Wkbk.Calc ID
1	F210M	F460M	BRIGHT2	5	1	12	12	1288.412	

Special Requirements

Between Dates 13-MAR-2025:00:00:00 and 02-MAY-2025:00:00:00
Offset -18.0 arcsec, 23.0 arcsec
Fiducial Point Override NRCBS_FULL

2 After 1 by 60 Days to 220 Days