17400 - Hunting for Black Holes with Astrometric Microlensing

Cycle: 31, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
Dr. Jessica Ryan Lu (PI) (Contact)	**University of California - Berkeley**
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Michael Medford (CoI)	University of California - Berkeley
Dr. Nathan Golovich (CoI)	Lawrence Livermore National Laboratory

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(2) OB230215	WFC3/UVIS	1	20-Feb-2025 15:00:56.0	yes
02	(2) OB230215	WFC3/UVIS	1	20-Feb-2025 15:00:57.0	yes

2 Total Orbits Used

ABSTRACT

Although there are likely 10^7 - 10^9 stellar mass black holes (BHs) in the Milky Way, only a handful have been detected in the Universe, all in X-ray binaries or BH-BH mergers; no isolated BHs have been definitively detected. A census of isolated BHs will provide important constraints on stellar evolution, the Milky Way BH mass function, supernovae physics, and BH/neutron star formation. Gravitational microlensing is ideal for finding isolated BHs, as properties of the lens can be inferred from changes in the brightness and position of a background star. By combining both the photometric and astrometric microlensing signal, we can directly determine the lens mass. We propose to use HST to measure the astrometric shift of 4 likely BH microlensing candidates. Combined with other ongoing measurements, this will allow us to constrain the number of BHs in the

Milky Way to better than 50%, a major improvement over the current orders of magnitude uncertainty. This will also enable the first constraints on the Milky Way BH mass function, binarity, and kick velocities.

OBSERVING DESCRIPTION

Four black hole candidates will be selected from photometric microlensing surveys for follow-up astrometric observations with HST WFC3-UVIS. The 4 targets will be non-disruptive ToOs and, once selected, 5 HST measurements will be obtained spread as evenly as possible over Cycle 29. The targets will be changing brightness, thus exposure times and number of exposures will be adjusted prior to each new observation. Further astrometric follow-up will be obtained in Cycles 30 and 31.

Each target observation consists of >5 dither positions (to maximize pixel phase coverage and thus astrometric precision) in a single orbit. The exposure times will be chosen in order to not saturate the source star or any bright neighbor stars within a few arcseconds. We will observing using 2k x 2k sub-array mode as the astrometric reference stars are those closest to the target and we would like to minimize the astrometric impacts of CTE.

In order to maximize observability and time sampling throughout the year, we have placed no restrictions on roll angle.

Visit

Proposal 17400, OB230215_vis1 (01), implementation Thu Feb 20 20:00:57 GMT 2025

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 268.2585D TO 268.2585 D; BETWEEN 01-FEB-2027 AND 04-APR-2027; TOO RESPONSE TIME 14.0D

Fixed Targets

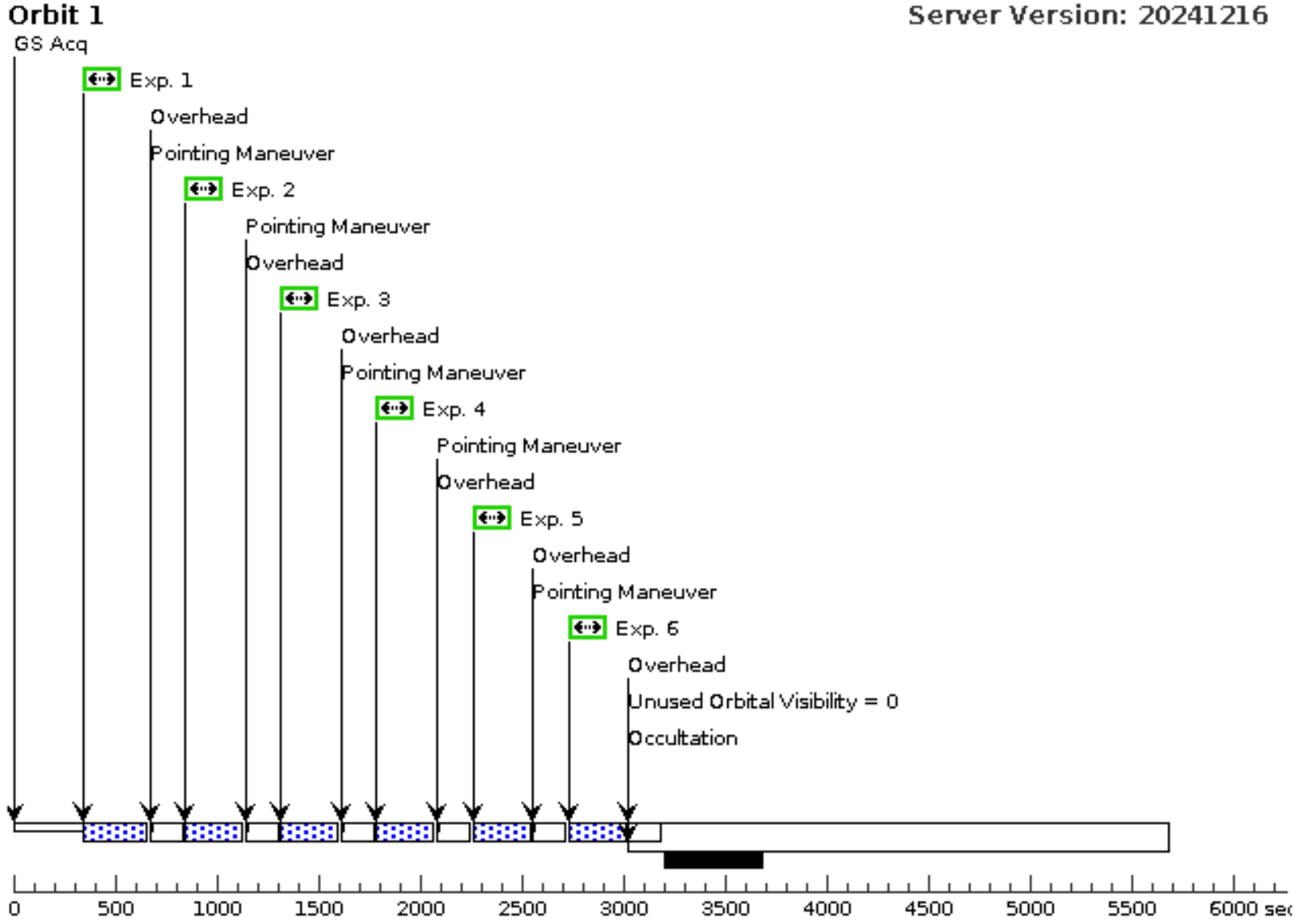
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	OB230215	RA: 18 20 20.3700 (275.0848750d) Dec: -21 35 14.90 (-21.58747d) Equinox: J2000		V=21.09+/-0.1 I-Mag 18.37	Reference Frame: ICRS

Comments:
Category=STELLAR CLUSTER
Description=[BULGE, GRAVITATIONAL LENS]
Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) OB230215	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=15	POS TARG 0.0000,0.0000		285 Secs (285 Secs) *[==>]*	*[1]*
2		(2) OB230215	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=15	POS TARG 0.0927,0.3376		285 Secs (285 Secs) *[==>]*	*[1]*
3		(2) OB230215	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=15	POS TARG 0.1851,0.1978		285 Secs (285 Secs) *[==>]*	*[1]*
4		(2) OB230215	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=15	POS TARG 0.2382,0.5130		285 Secs (285 Secs) *[==>]*	*[1]*
5		(2) OB230215	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=15	POS TARG 0.3305,0.3732		285 Secs (285 Secs) *[==>]*	*[1]*
6		(2) OB230215	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=15	POS TARG 0.5024,0.5171		285 Secs (285 Secs) *[==>]*	*[1]*

Orbit Structure



Visit

Proposal 17400, OB230215_vis2 (02), implementation Thu Feb 20 20:00:58 GMT 2025

Diagnostic Status: Informational

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 0D TO 0D FROM 01; AFTER_01 BY 30 D TO 180 D

Diagnostics

(OB230215_vis2 (02)) Informational (Form): The Visit Planner and Spike may produce different schedulability results.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	OB230215	RA: 18 20 20.3700 (275.0848750d) Dec: -21 35 14.90 (-21.58747d) Equinox: J2000		V=21.09+/-0.1 I-Mag 18.37	Reference Frame: ICRS

Comments:
Category=STELLAR CLUSTER
Description=[BULGE, GRAVITATIONAL LENS]
Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) OB230215	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=15	POS TARG 0.0000,0.0000		285 Secs (285 Secs) *[==>]*	 ***[1]***
2		(2) OB230215	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=15	POS TARG 0.0927,0.3376		285 Secs (285 Secs) *[==>]*	 ***[1]***
3		(2) OB230215	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=15	POS TARG 0.1851,0.1978		285 Secs (285 Secs) *[==>]*	 ***[1]***
4		(2) OB230215	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=15	POS TARG 0.2382,0.5130		285 Secs (285 Secs) *[==>]*	 ***[1]***
5		(2) OB230215	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=15	POS TARG 0.3305,0.3732		285 Secs (285 Secs) *[==>]*	 ***[1]***
6		(2) OB230215	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F814W	FLASH=15	POS TARG 0.5024,0.5171		285 Secs (285 Secs) *[==>]*	 ***[1]***

Orbit Structure