16782 - Discovering Isolated Stellar-Mass Black Holes Using Astrometric Microlensing

Cycle: 29, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. Kailash C. Sahu (PI) (Contact)	**Space Telescope Science Institute**	**ksahu@stsci.edu**
Dr. Jay Anderson (CoI)	Space Telescope Science Institute	jayander@stsci.edu
Dr. Andrea Bellini (CoI)	Space Telescope Science Institute	bellini@stsci.edu
Dr. Howard E. Bond (CoI)	The Pennsylvania State University	heb11@psu.edu
Dr. Thomas M. Brown (CoI)	Space Telescope Science Institute	tbrown@stsci.edu
Dr. Annalisa Calamida (CoI)	Space Telescope Science Institute	calamida@stsci.edu
Dr. Stefano Casertano (CoI)	Space Telescope Science Institute	stefano@stsci.edu
Dr. Andrzej Udalski (CoI) (ESA Member)	Warsaw University	udalski@astrouw.edu.pl

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(8) OGLE-2017-BLG-0302	WFC3/UVIS	1	31-Jan-2023 07:00:17.0	yes
02	(7) OGLE-2019-BLG-1080	WFC3/UVIS	1	31-Jan-2023 07:00:19.0	yes

2 Total Orbits Used

ABSTRACT

There should be ~100 million black holes (BHs) in our Galaxy, of which the majority should be single. Yet there has been no unambiguous detection of a solitary BH--not surprisingly, since they emit essentially no radiation. Astrometric microlensing--the relativistic deflection of light from a

background star--is the only technique that can detect isolated BHs. HST has demonstrated its capability to measure such tiny deflections.

A multi-year HST program of precision astrometry of long-duration microlensing events in the Galactic bulge is underway, aimed at the first detection of isolated BHs. This program has achieved clear detections of deflections in two events, consistent with non-luminous massive lenses. However, the timing of the observations was sub-optimal due to some guide-star failures and the HST gyro failure in 2018. As a result, there remains a degeneracy between deflection, parallax, and proper motion; an unusually slow-moving low-mass lens remains a possibility. One more observation of these two targets will resolve this degeneracy. Observations of another event had to be abandoned when HST revealed a blended source. Because of the 2018 HST gyro failure, initiation of two new events had to be delayed until 2019. These events are still ongoing and need a total of five orbits for completion. One of the BH candidate sources is extremely red, which can be best explained by a shell around the putative BH. A 1-orbit STIS spectrum, and a final WFC3 image in Cycle 29, will test this hypothesis. Thus a total of 9 orbits (7 in Cycle 28 and 2 in Cycle 29) are needed to achieve the original objectives of the program, and to confirm the potentially exciting findings.

OBSERVING DESCRIPTION

WFC3 imaging to measure astrometric deflections. We will employ an observational strategy similar to that used in the GO-15318 program. We will image each field using WFC3/UVIS, primarily with the F814W filter, but also with F606W.

In a rich stellar field such as the Galactic bulge, there is always a large number of reference stars available in the WFC3 field, even with the subarrays that we will use to avoid buffer dumps. This allows the highest possible astrometric accuracy.

For the astrometric analysis, we will basically use procedures described in previous HST studies, including Anderson & King (2004) and Bellini (2014). Very similar techniques were used by Sahu et al. (2017) to detect the relativistic deflection of a background star by the nearby white dwarf Stein2051B, leading to a mass determination for this isolated object.

STIS spectroscopy of OGLE-2017-BLG-328. We will use G750L with a 0.2" slit to obtain a classification spectrum of the source. This setting covers a wavelength range of 5240-10265 A. The STIS ETC indicates that a one-orbit exposure will reach a S/N per resolution element of ~22 at 7500 A, which is more than adequate for spectral classification and inference of the intrinsic color.

As indicated in phase-I, we may have to re-adjust the orbit distribution for the targets based on the results from the first few observations. So the targets in vists 5 and 6 are specified as "DUMMY", which will be replaced with specific targets later on.

Visit

Proposal 16782, Visit 01 Tue Jan 31 12:00:19 GMT 2023

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: ORIENT 251.93D TO 251.93 D; BETWEEN 15-MAR-2023 AND 29-MAR-2023

Fixed Targets

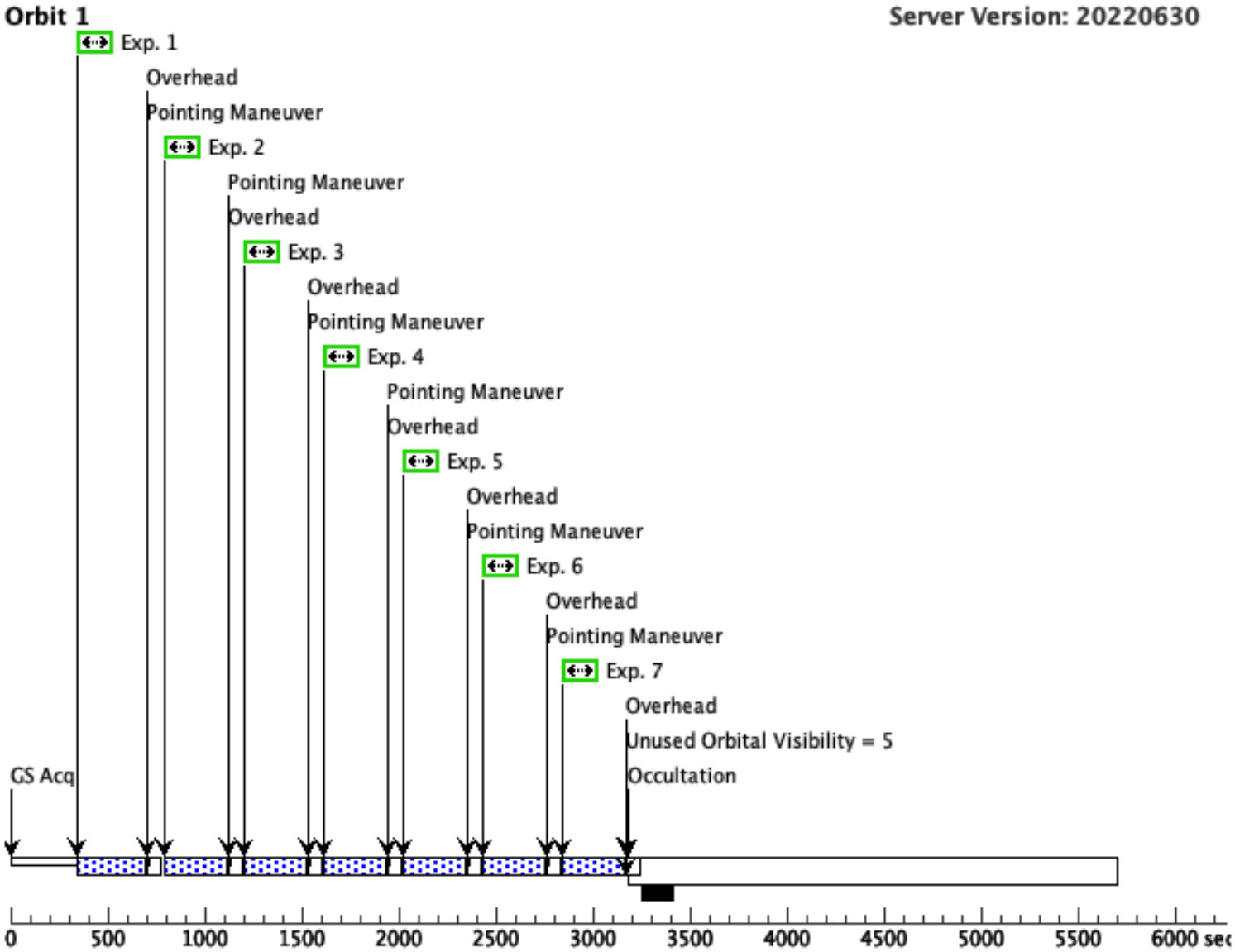
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(8)	OGLE-2017-BLG-0302	RA: 17 41 35.9300 (265.3997083d) Dec: -34 33 19.30 (-34.55536d) Equinox: J2000		V=19.25+/-2	Reference Frame: ICRS

Comments:
Category=EXT-STAR
Description=[A0-A3 III-I]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(8) OGLE-2017-BLG-0302	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=11	POS TARG 0,0; GS ACQ SCENARIO BASE1B3		318 Secs (318 Secs) *[==>]*	 ***[1]***
2		(8) OGLE-2017-BLG-0302	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=11	POS TARG 3.95,0		318 Secs (318 Secs) *[==>]*	 ***[1]***
3		(8) OGLE-2017-BLG-0302	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=11	POS TARG 1.97,3.42		318 Secs (318 Secs) *[==>]*	 ***[1]***
4		(8) OGLE-2017-BLG-0302	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=11	POS TARG -1.98,3.42		318 Secs (318 Secs) *[==>]*	 ***[1]***
5		(8) OGLE-2017-BLG-0302	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=11	POS TARG -3.95,-0.02		318 Secs (318 Secs) *[==>]*	 ***[1]***
6		(8) OGLE-2017-BLG-0302	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=11	POS TARG -1.96,-3.43		318 Secs (318 Secs) *[==>]*	 ***[1]***
7		(8) OGLE-2017-BLG-0302	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=11	POS TARG 2.00,-3.41		318 Secs (318 Secs) *[==>]*	 ***[1]***

Orbit Structure



Visit

Proposal 16782, Visit 02, completed Tue Jan 31 12:00:19 GMT 2023

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(7)	OGLE-2019-BLG-1080	RA: 18 10 4.4700 (272.5186250d) Dec: -27 52 1.40 (-27.86706d) Equinox: J2000		V=19.25+/-2	Reference Frame: ICRS

Comments:
Category=EXT-STAR
Description=[A0-A3 III-I]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(7) OGLE-2019-BLG-1080	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	CR-SPLIT=NO; FLASH=12			216 Secs (216 Secs) *[==>]*	 ***[1]***
2		(7) OGLE-2019-BLG-1080	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	CR-SPLIT=NO; FLASH=12			216 Secs (216 Secs) *[==>]*	 ***[1]***
3		(7) OGLE-2019-BLG-1080	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	CR-SPLIT=NO; FLASH=12	POS TARG 3.95,0.1		216 Secs (216 Secs) *[==>]*	 ***[1]***
4		(7) OGLE-2019-BLG-1080	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	CR-SPLIT=NO; FLASH=12	POS TARG 2.79,2.79		216 Secs (216 Secs) *[==>]*	 ***[1]***
5		(7) OGLE-2019-BLG-1080	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	CR-SPLIT=NO; FLASH=12	POS TARG 0,3.95		216 Secs (216 Secs) *[==>]*	 ***[1]***
6		(7) OGLE-2019-BLG-1080	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	CR-SPLIT=NO; FLASH=12	POS TARG 0,3.95		216 Secs (216 Secs) *[==>]*	 ***[1]***
7		(7) OGLE-2019-BLG-1080	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	CR-SPLIT=NO; FLASH=12	POS TARG -2.79,2.8		216 Secs (216 Secs) *[==>]*	 ***[1]***
8		(7) OGLE-2019-BLG-1080	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	CR-SPLIT=NO; FLASH=12	POS TARG -3.95,0		216 Secs (216 Secs) *[==>]*	 ***[1]***
9		(7) OGLE-2019-BLG-1080	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	CR-SPLIT=NO; FLASH=12	POS TARG -2.68,-2.79		216 Secs (216 Secs) *[==>]*	 ***[1]***

Orbit Structure