14067 - Searching for a Supermassive Black Hole in the Brightest Ultracompact Dwarf Galaxy

Cycle: 23, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) M59-UCD3	WFC3/UVIS	1	19-Apr-2016 21:00:49.0	yes

1 Total Orbits Used

ABSTRACT

We request a single orbit of HST time to image the most luminous ultracompact dwarf galaxy (UCD), M59-UCD3, suspected to be the tidally stripped nucleus of a massive galaxy. We will combine these data with adaptive optics kinematic data from Gemini/NIFS to test for the presence of a supermassive black hole (SMBH) in this object. HST imaging will resolve the inner surface brightness profile of this very compact object, which is necessary creating dynamical models and in determining the PSF of the kinematic observations. Due to M59-UCD3's brightness, we expect to be able to detect the signature of any black hole above a few million solar masses; significantly smaller than the 21 million solar mass black hole

recently found by our team in the slightly less luminous UCD, M60-UCD1. There is indirect evidence that supermassive black holes in UCDs, like the one in M60-UCD1, may represent a significant new population of supermassive black holes. M59-UCD3 provides an important test of this hypothesis.

OBSERVING DESCRIPTION

The purpose of our observations is to enable dynamical modeling of M59-UCD3, the brightest known UCD. Specically, we need to determine the surface brightness profile and constrain the presence of any stellar population gradients within this object. Given the compactness of the object (reff 0.25" estimated from ground-based observations), a detailed surface brigthness profile and color information within the UCD can only be obtained with HST. Therefore, we propose WFC3 images in both the F475W and F814W filters. We chose these filters to provide maximum sensitivity and a wide color-baseline; the F850LP filter used in the ACS Virgo Cluster Survey is not suitable due to a significant color dependence of the PSF. We choose to use WFC3 over ACS/WFC to provide good spatial resolution while still maintaining high signal-to-noise (S/N).

Because M59-UCD3 is ~0.3 mags brighter than M60-UCD1 with a similar effective radius, we use M60-UCD1's surface brightness profile to estimate our signal-to-noise estimates (Strader et al., 2013). Short exposures in these two bands will provide sufficient signal-to-noise to examine the central surface brightness and color gradient near the center (F475W ~15 and F475W - F814W = 1.2). We will obtain 3 dithered exposures in each filter in a single orbit with full frame exposures and total exposure time of 1440s in F475W, and C1K1C subarray exposures with a total exposure time of 720s in F814W. These data will yield an accurate surface brightness profile out to a radius of ~2", about the radius where M59-UCD3's surface brightness profile is expected to fall below that of the envelope of M59 (F475W~25). This is ~3x further out than we will obtain kinematics from our Gemini/NIFS observations, which is sufficient for accurately modeling the stellar mass in the system without additional data. At a radius of ~2", we estimate that summing together pixels in a 6 pixel annulus will yield S/N of 10 in both filters.

The surface brightness profile will be fitted to models in 2D including PSF convolution using TinyTim PSFs and a standard star within the image. We will use a short, 5s exposure to ensure we get the PSF core cleanly, while the longer exposures will be used to get the outer parts of the PSF at high S/N. These models will then be deprojected for use in dynamical modeling using a multi-gaussian expansion (MGE) method (Cappellari, 2002). This MGE model will then be combined with our kinematic data to conduct both Jeans modeling (Cappellari, 2008), and Schwarzschild modeling (van den Bosch et al., 2008). We will search for any possible stellar population gradients by creating 2D color maps using both Lucy-Richardson deconvolved images and comparing the fitted surface brightness profiles in the two bands. If stellar population gradients exist, we will model the range of M/L gradients consistent with these colors and include these in our dynamical modeling (see Methods section of Seth et al., 2014).

For determining a PSF of our Gemini/NIFS kinematic data we will use the deconvolved F814W image and then convolve this to match our observed K band profile (Seth et al., 2010). We have used this procedure successfully in the past, but corrections may be needed in fitting the PSF if a significant color gradient is found.

Visit

Proposal 14067, Visit 01, implementation Wed Apr 20 01:00:50 GMT 2016

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

Diagnostics

(Exposure 1 (Pattern 1, Exps 1-1 in Visit 01)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

(Exposure 3 (Pattern 1, Exps 3-3 in Visit 01)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-LINE-3PT Purpose=DITHER Number Of Points=3 Point Spacing=0.135 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(1), (3)

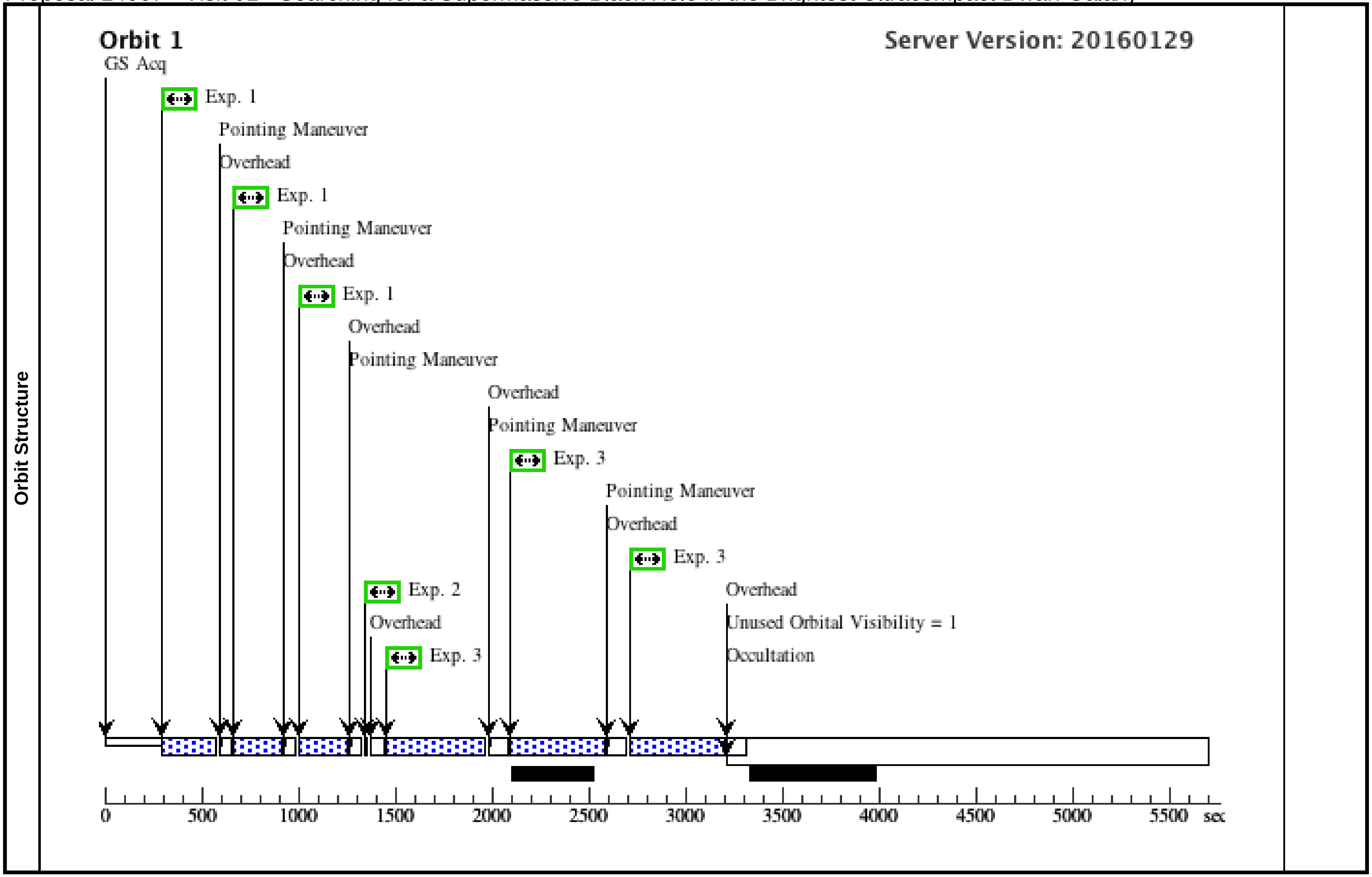
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	M59-UCD3	RA: 12 42 10.9253 (190.5455221d) Dec: +11 38 43.13 (11.64531d) Equinox: J2000		V=16.34+/-0.05 g-i=1.2	Reference Frame: ICRS

Comments: Extended=YES

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) M59-UCD3	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=5	GS ACQ SCENARIO BASE1B3	Pattern 1, Exps 1-1 in Visit 01 (1)	249 Secs (747 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	***[1]***
2		(1) M59-UCD3	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F814W	FLASH=12			10 Secs (10 Secs) *[==>]*	***[1]***
3		(1) M59-UCD3	WFC3/UVIS, ACCUM, UVIS2-C1K1C-CTE	F475W			Pattern 1, Exps 3-3 in Visit 01 (1)	490 Secs (1470 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]*	***[1]***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GS Acq
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Pointing Maneuver
Overhead
Exp. 1
Pointing Maneuver
Overhead
Exp. 1
Overhead
Pointing Maneuver
Overhead
Pointing Maneuver
Exp. 3
Pointing Maneuver
Overhead
Exp. 3
Exp. 2
Overhead
Exp. 3
Overhead
Unused Orbital Visibility = 1
Occultation
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sec