



## 15263 - The Host Galaxy of the Low Mass Black Hole in UGC 06728

Cycle: 25, Proposal Category: GO

(Availability Mode: SUPPORTED)

### INVESTIGATORS

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### VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(1) UGC-6728	WFC3/IR WFC3/UVIS	2	12-Jul-2017 17:09:37.0	yes

2 Total Orbits Used

### ABSTRACT

We propose to obtain high-resolution, multicolor imaging of the host-galaxy of UGC 06728, a nearby ( $z=0.0065$ ) low-luminosity Seyfert. A recent reverberation-mapping campaign has constrained the black hole mass to  $7 \times 10^5 M_{\text{sun}}$ , but little is currently known about the host galaxy due to the lack of spatial resolution in existing, seeing-limited images. Based on the black hole mass and the bulge stellar velocity dispersion, it is likely that a black hole mass could also be derived from modeling the nuclear stellar dynamics of UGC 06728. The number of galaxies where comparison of stellar dynamics and reverberation mapping is possible is very small ( $<10$ ) due to their non-overlapping technical requirements, so UGC 06728 is an important target for testing the consistencies of black hole masses from different techniques. The proposed images will allow us to characterize the host-galaxy features and morphology for the first time. They will also allow us to determine the central stellar surface brightness for follow-up AO-

assisted near-IR integral field spectroscopy, accurately constrain the stellar mass-to-light ratio of the galaxy, and correct the AGN luminosity for starlight contamination (to include UGC 06728 at the low end of the AGN R-L relationship). We will also investigate the globular cluster population around the galaxy and the potential to determine its distance using the globular cluster luminosity function method. The proposed observations will facilitate the direct comparison of masses from reverberation mapping and stellar dynamics, which is critical to ensure that all black holes, from Local Group galaxies to  $z \sim 7$  quasars, are on the same mass scale.

## **OBSERVING DESCRIPTION**

We will obtain multi-color high-resolution imaging of the host galaxy of the nearby reverberation-mapped Seyfert UGC06728. We will use WFC3 in the following configurations: UVIS channel with filters F547M (medium V ) and F814W (I), and IR channel with the F160W (H) filter.

The images will allow us to investigate the properties of the host galaxy, such as its basic morphological classification and the presence of bars, rings, nuclear spirals, and dust lanes. We will carry out detailed two-dimensional surface brightness decompositions of the images, allowing us to constrain the background sky contribution and separate the bright unresolved AGN from the faint, resolved host galaxy.

The F160W filter will provide high spatial-resolution maps of the central stellar surface brightness that we need to plan our observations for constraining the black hole mass through AO-assisted near-IR integral field spectroscopy of the nuclear stellar dynamics. The F547M and F814W filters together will allow us to determine the stellar mass-to-light ratio through a commonly-used color, V-I (e.g., Bell & de Jong 2001). Furthermore, Into & Portinari (2013) find that the V-I color is least affected by dust extinction internal to a galaxy, which will be important for UGC06728 as it is inclined to our line of sight. The F547M and F160W filters will provide a second, separate probe of the galaxy stellar content that is also commonly used (V-H). Finally, the F547M filter will also ensure that we have an image of the host galaxy in a flat part of the stellar spectrum, consistent with HST images previously obtained for the reverberation sample, and facilitating the correction of the AGN continuum luminosity at rest-frame 5100Å for contamination from starlight. This filter will additionally provide information on potential globular clusters in a passband similar to V , where the Milky Way population has been well calibrated.

We require 2 orbits to acquire deep observations in all three filters. For optical observations of AGN host galaxies with HST, we have found that a set of short+long exposures provides the required dynamic range to separate the bright, unresolved AGN point source from the faint, extended host galaxy in the final drizzled images. The saturated pixels in the nucleus in the long exposures can be corrected by scaling up the same pixels in the shorter exposures by the appropriate exposure time ratio before drizzling the sets together. For the F547M and F814W images, we will take two sets

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of short+long exposures separated by a standard 2-point dithering pattern to facilitate the rejection of cosmic rays and detector artifacts (e.g., transient warm pixels). For the F160W observations, we will use the standard STEP50 sequence in MULTIACCUM mode, allowing for multiple samplings of the AGN PSF before it saturates and deep exposures for the fainter host galaxy. We will utilize a 4-point dithering strategy for the F160W observations. The galaxy is compact and will cleanly fit on one chip of the UVIS detector, but it is also inclined to our line of sight, so we will set some loose ORIENT constraints to ensure that the major axis is oriented more-or-less along the widest part of the chip.

Based on our surface brightness decompositions of ground-based images, we estimate the AGN PSF to be  $g = 16.3\text{mag}$  and  $r = 16.0\text{mag}$ , although this is likely an overestimate of the brightness given our inability to cleanly separate the AGN from the bulge. But taking these estimates at face value, we estimate a time to saturation in F547M of 156 s and in F814W of 125 s in the central pixels of the AGN PSF. AGNs are highly variable, so we will keep our short exposures significantly shorter than these estimates to ensure that we do not saturate.

The high declination of UGC06728 provides a visibility per orbit of approximately 60min. Accounting for the typical overheads of the observatory and instrument, the total estimated exposure times in each filter are 1750s for F547M, 1750s for F814W, and 1700s for F160W. Using the WFC3 exposure time calculator, we estimate that we will reach limiting surface brightnesses in each drizzled image (defined here as  $S/N \sim 5$  per pixel) of  $\mu_V = 21.5\text{mag/arcsec}^2$ ,  $\mu_I = 21.0\text{mag/arcsec}^2$ , and  $\mu_H = 22.0\text{mag/arcsec}^2$ .

Additionally, we will be able to identify potential globular clusters at  $S/N \sim 5$  (for point sources in a 0.2" circular aperture) down to  $m_V = 26.25\text{mag}$ . The globular cluster luminosity function method relies on identifying clusters down to 1mag below the luminosity function turn over. These observations would allow us to constrain a turn over at a faint-end limit of  $m_V = 25.25\text{mag}$ , corresponding to a distance of  $D=38\text{Mpc}$  (assuming  $M(V,TO) = -7.68\text{mag}$  for the Milky Way; Rejkuba 2012). This is well beyond the estimated distance of the galaxy based on its observed redshift ( $z = 0.0065$ ,  $D=27\text{Mpc}$ ) and provides a large buffer for potentially strong peculiar velocities.

Proposal 15263 - Visit 01 - The Host Galaxy of the Low Mass Black Hole in UGC 06728

Wed Jul 12 21:09:38 GMT 2017

Visit	<b>Proposal 15263, Visit 01</b> <b>Diagnostic Status: No Diagnostics</b> Scientific Instruments: WFC3/IR, WFC3/UVIS Special Requirements: ORIENT 300D TO 10 D; ORIENT 120D TO 190 D									
	#	Primary Pattern	Secondary Pattern	Exposures						
Patterns	(1)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing= Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(1-2), (4-5)						
	(2)	Pattern Type=WFC3-IR-DITHER-BOX-MIN Purpose=DITHER Number Of Points=4 Point Spacing=0.572 Line Spacing=0.365 Coordinate Frame=POS-TARG Pattern Orientation=18.528 Angle Between Sides=74.653 Center Pattern=false		(3)						
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	UGC-6728	RA: 11 45 16.0070 (176.3166958d) Dec: +79 40 53.41 (79.68150d) Equinox: J2000		V=15.2	Reference Frame: SIMBAD				
<i>Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.</i>										
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1		(1) UGC-6728	WFC3/UVIS, ACCUM, UVIS1	F547M	FLASH=11.0		Pattern 1, Exps 1-2 in Visit 01 (1)	75 Secs (150 Secs) [=>(Pattern 1)] [=>(Pattern 2)]	[1]
	2		(1) UGC-6728	WFC3/UVIS, ACCUM, UVIS1	F547M	FLASH=3.0		Pattern 1, Exps 1-2 in Visit 01 (1)	810 Secs (1620 Secs) [=>(Pattern 1)] [=>(Pattern 2)]	[1]
	3		(1) UGC-6728	WFC3/IR, MULTIACCUM, IR	F160W	SAMP-SEQ=STEP50; NSAMP=13		Pattern 2, Exps 3-3 in Visit 01 (2)	399.233383 Secs (1596.934 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)] [=>(Pattern 4)]	[1] [2]
	4		(1) UGC-6728	WFC3/UVIS, ACCUM, UVIS1	F814W			Pattern 1, Exps 4-5 in Visit 01 (1)	900 Secs (1800 Secs) [=>(Pattern 1)] [=>(Pattern 2)]	[2]
	5		(1) UGC-6728	WFC3/UVIS, ACCUM, UVIS1	F814W	FLASH=10.0		Pattern 1, Exps 4-5 in Visit 01 (1)	75 Secs (150 Secs) [=>(Pattern 1)] [=>(Pattern 2)]	[2]

