16765 - Is the supermassive black hole binary candidate J0950+5128 actually a single perturbed accretion disk?

Cycle: 29, Proposal Category: GO

(UV Initiative)

(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) SDSSJ095036.75+512838.1	COS/FUV COS/NUV	5	29-Jul-2021 15:04:04.0	yes

5 Total Orbits Used

ABSTRACT

We propose UV spectroscopy of the supermassive black hole binary (SBHB) candidate J095036+512838 (J0950) to test the alternative scenario that it harbors a perturbed accretion disk around a single black hole. By analogy to spectroscopic binary stars, this object was originally selected as a

SBHB candidate by virtue of the ~1300 km/s blueshift of its broad Balmer lines relative to the rest frame set by the narrow lines. According to new spectroscopic monitoring of the radial velocity curve, J0950 recently passed conjunction and is consistent with a SBHB with a period of order decades. This is an extremely strong indication of binary motion that no other candidate has shown before, making J095036 the strongest candidate of its class. The radial velocity curve also conclusively rules out the hypothesis that this is a recoiling black hole. We will observe the Ly-alpha and C IV broad lines to discriminate between the SBHB hypothesis and the single, perturbed accretion disk hypothesis. In the former scenario the UV lines are expected to be offset in velocity just as the optical Balmer lines while in the latter they are expected to be centered at the redshift of the narrow optical emission lines.

OBSERVING DESCRIPTION

The target has a redshift of 0.2144, galactic E(B-V) value of 0.149, and GALEX FUV and NUV AB magnitudes of 20.25 and 19.67, respectively. We will observe it for 5 orbits with COS/G140L to detect the broad Ly-alpha and CIV emission lines and determine whether they have velocity offsets relative to the rest frame set by narrow lines in a ground-based optical spectrum. The A segment covers 1281-2148 Angstroms, which includes both Ly-alpha and C IV at the target redshift.

We obtained the target coordinates from the SDSS DR16 SkyServer. These coordinates are in the ICRS coordinate system. We computed astrometric errors by following the prescription described in the SDSS DR16 web pages. In summary, the uncertainties in the astrometric solution of each plate are combined in quadrature with the uncertainties in the centroid of the object. The final uncertainties are listed in the target forms and are better than 0.1 arcsec.

We will acquire the target with COS using ACQ/IMAGE in the NUV. This approach is recommended for targets with coordinate uncertainties <0.4 arcsec even if the science observations to follow are in the FUV. This is advantageous, because the acquisition exposure time to reach S/N 20 given the GALEX NUV magnitude is much shorter than using ACQ/PEAKXD+ACQ/PEAKD in the FUV. We will carry out the ACQ/IMAGE procedure with MIRRORA because the target is faint.

Science observations will be conducted with COS/G140L. As recommended to preserve the life of the detector and improve S/N in the FUV, we will use all FP-POS positions. In order to minimize overheads associated with these small movements, we will observe different positions in different orbits. We aim to keep exposure times in each position similar, but prioritized changing positions during occultation so that no time is lost. Buffer times for each exposure are set to the exposure time for that orbit, because the buffer fill time is extremely long for this target. This approach is

advantageous because no data will be lost if the target is brighter than expected from the GALEX magnitudes, which is possible because it is a quasar.

We have configured the exposures into a single visit. The science goal of this program is to compare the Ly-alpha and CIV broad line profiles to the H-beta profile in the optical. The orbit allocation is needed to reach high enough S/N ratio in the UV line profiles to measure properties of the broad lines (namely, their velocity offset and shape). The target is a quasar, so it is variable and changes in the broad-line profiles are common on week to month timescales. Importantly, if we were to split the program into 2 visits and the shape of the line profile changed between them, we would not be able to combine the resulting spectra to reach our target S/N.

Given our science goal of comparing the H-beta and UV line profiles, we need to observe them at the same time to rule out differences due to variability. Coordinated observations with ground-based observatories place very loose scheduling constraints on the HST observations. We determined that the optical and UV observations need to be taken within one month of each other. Given the coordinates of the target, we can obtain a ground-based spectrum during the period between the start of November and the end of May. Given the need for observations within 1 month, we require the HST observations be scheduled between October and June, inclusive. This constraint does not substantially impact schedulability, it only removes two small windows in September 2022.

Visit

Proposal 16765, Visit 01 Thu Jul 29 19:04:05 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: BETWEEN 01-OCT-2021:00:00:00 AND 30-JUN-2022:23:59:59; BETWEEN 01-OCT-2022:00:00:00 AND 30-JUN-2023:23:59:59

Fixed Targets

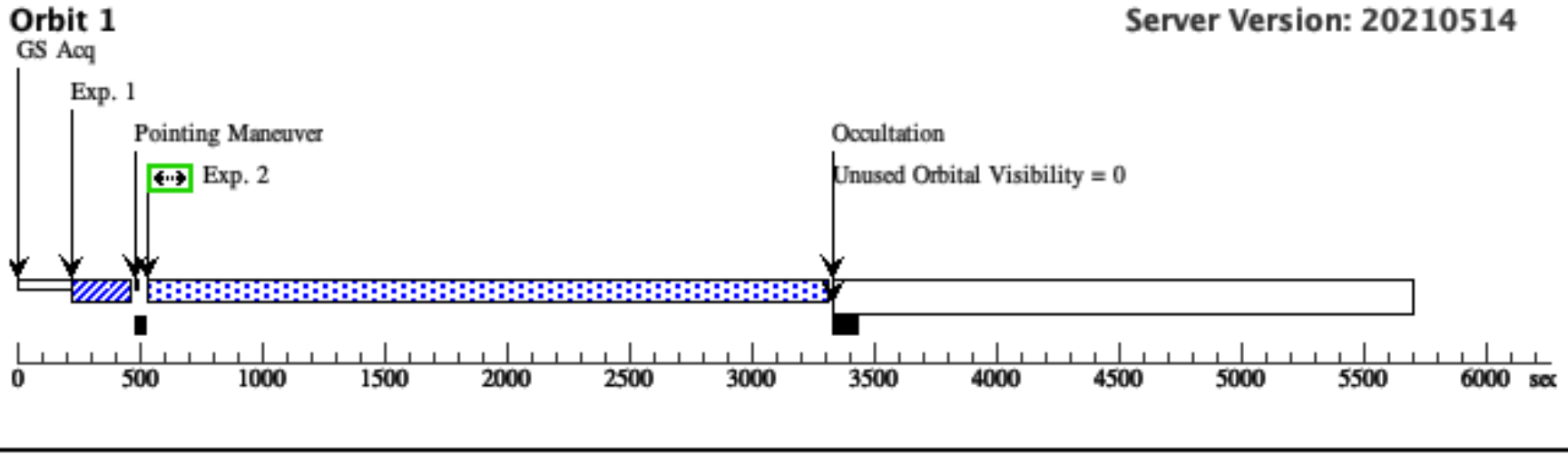
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	SDSSJ095036.75+512838.1	RA: 09 50 36.7500 (147.6531250d) Dec: +51 28 38.10 (51.47725d) Equinox: J2000	Redshift: 0.2144	V=18.35 GALEX_NUV_MAG=19.67, GALEX_FUV_MAG=20.25	Reference Frame: ICRS

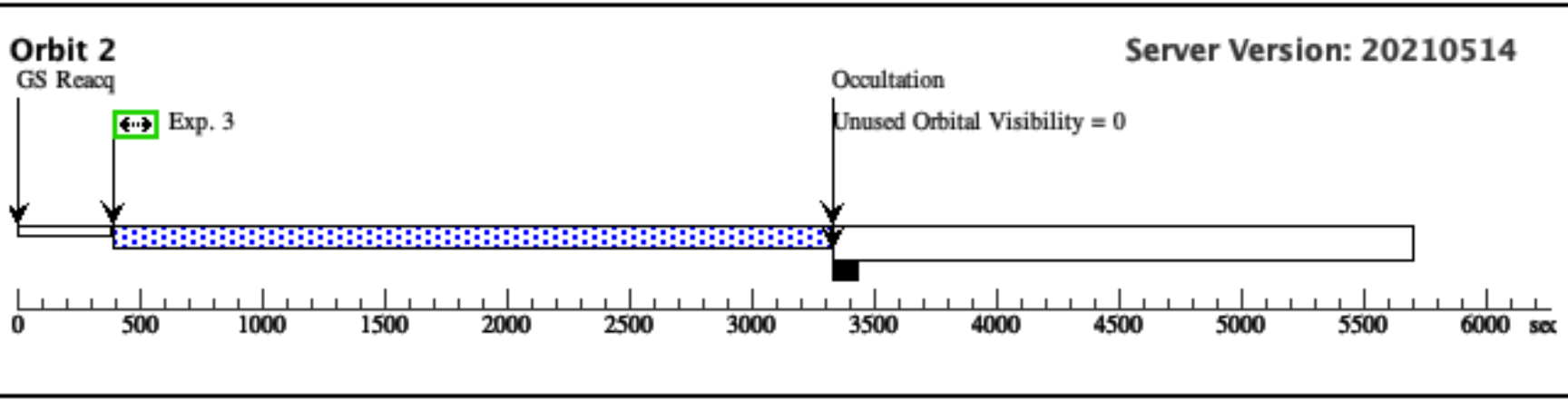
Comments: The coordinates were updated in phase 2 to SDSS DR16 (ICRS) with uncertainties. Target radius in SDSS u-band is <0.35". Spectral classification is QSO. No relevant proper motion.
Category=GALAXY
Description=[SEYFERT]
Extended=NO

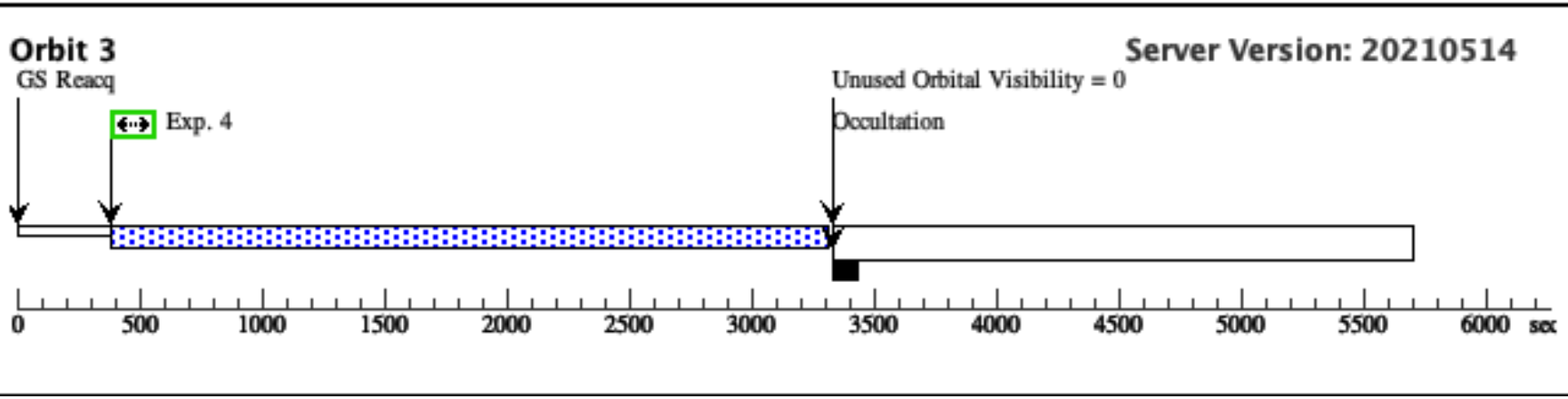
Exposures

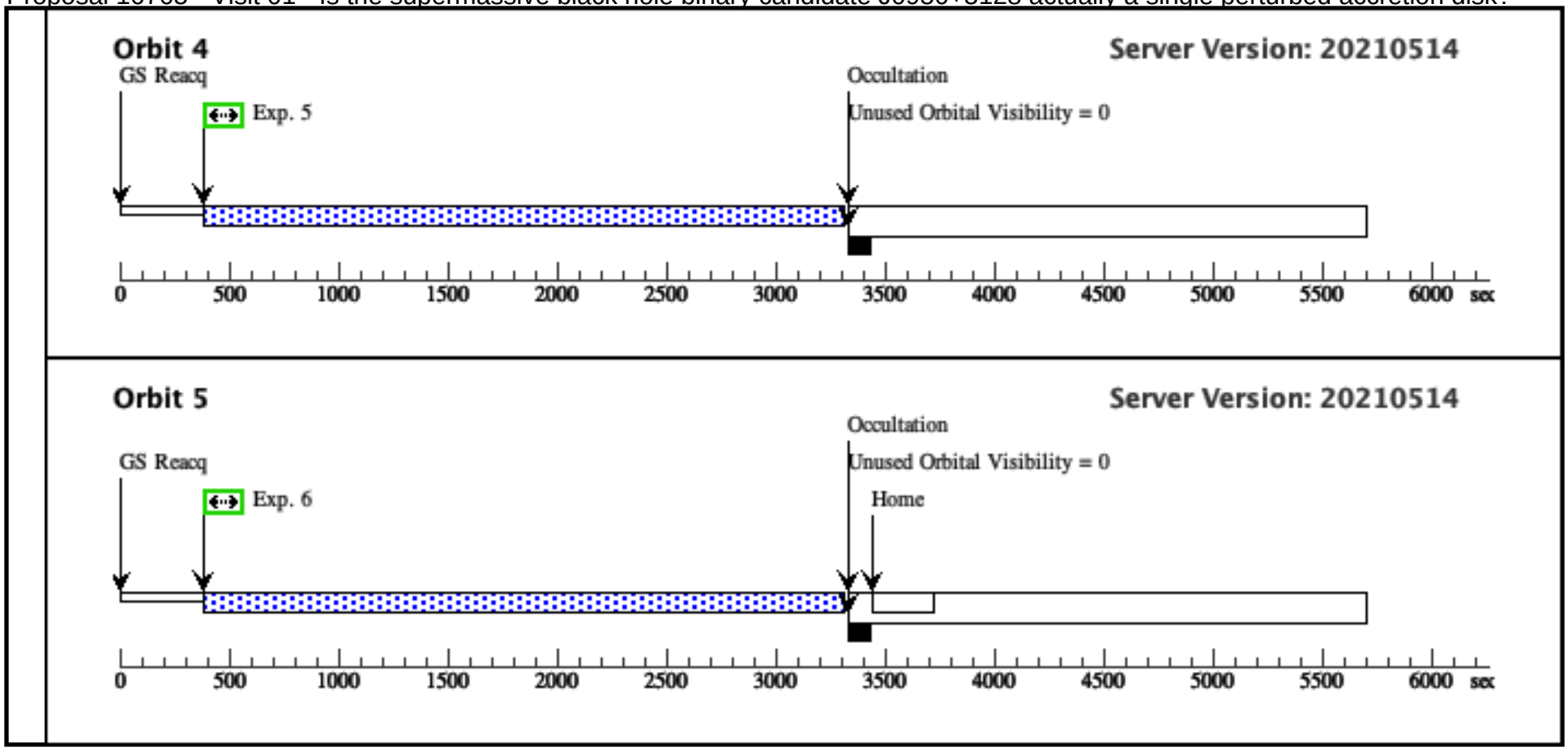
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ (COS.ta.1525357)	(1) SDSSJ095036.75+512838.1	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				7 Secs (7 Secs) *[==>]*	***[1]***
2	G140L-1280-FP1 (COS.sp.1529992)	(1) SDSSJ095036.75+512838.1	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=2607; FLASH=YES; FP-POS=1; SEGMENT=BOTH			2607 Secs (2607 Secs) *[==>]*	***[1]***
3	G140L-1280-FP1 (COS.sp.1529992)	(1) SDSSJ095036.75+512838.1	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=2877; FLASH=YES; FP-POS=1; SEGMENT=BOTH			2877 Secs (2877 Secs) *[==>]*	***[2]***
4	G140L-1280-FP2 (COS.sp.1529992)	(1) SDSSJ095036.75+512838.1	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=2877; FLASH=YES; FP-POS=2; SEGMENT=BOTH			2877 Secs (2877 Secs) *[==>]*	***[3]***
5	G140L-1280-FP3 (COS.sp.1529992)	(1) SDSSJ095036.75+512838.1	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=2877; FLASH=YES; FP-POS=3; SEGMENT=BOTH			2877 Secs (2877 Secs) *[==>]*	***[4]***
6	G140L-1280-FP4 (COS.sp.1529992)	(1) SDSSJ095036.75+512838.1	COS/FUV, TIME-TAG, PSA	G140L 1280 A	BUFFER-TIME=2877; FLASH=YES; FP-POS=4; SEGMENT=BOTH			2877 Secs (2877 Secs) *[==>]*	***[5]***

Orbit Structure





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