16058 - Far-Ultraviolet Spectroscoy of the Transient Accreting Black Hole MAXI J0630

Cycle: 27, Proposal Category: GO/DD

(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) MAXI-J0630	COS/FUV COS/NUV	1	24-Dec-2019 11:01:25.0	yes

1 Total Orbits Used

ABSTRACT

MAXI J0637-430 was discovered as a luminous X-ray transient on November 2. Its optical counterpart is a bright blue emission line source, confirming the system as an X-ray binary (XRB) in outburst. Follow-up observations show that the accretor is a black hole (BH) and that the system is already in a soft spectral state. MAXI~J0637-430 happens to be located along an unusually transparent line of sight. This makes it one of the rare black-hole X-ray binaries for which far-ultraviolet (FUV) spectroscopy can be obtained. Such observations are critical and timely. Over the last few

years, high resolution X-ray spectroscopy has revealed mass loss in the form of powerful disk winds is ubiquitous in soft-state BH XRBs. The implied mass-loss rates are at least comparable to the accretion rate, so these outflows represent a major mass, energy and angular momentum sink. However, X-ray wind signatures can only probe hot, highly ionized material in the flow. Any warm, moderately ionized component will be invisible to such observations, even if it dominates the mass, energy and angular momentum flux. Detecting such a component requires FUV spectroscopy, yet no high-quality FUV spectra exist for any BH XRB in a canonical soft state. We therefore propose to obtain such data for MAXI~J0637-430. The system is currently visible by HST, but only through Nov 19. Since the outburst evolution is unusually fast (the hard-state brightening and hard-to-soft state transition were completely missed by MAXI), the system is likely to have faded again by the next (January) visibility window. A single-orbit disruptive ToO will allow us to obtain this ground-breaking data set.

OBSERVING DESCRIPTION

We will use the COS/G140L detector/grating combination to obtain time-resolved FUV spectroscopy of MAXI J0637-430. This provides the optimal combination of sensitivity, resolution and wavelength coverage for our purposes. Extrapolating from the latest NUV/optical photometry gathered on 2019 Dec 17 with Swift/UVOT to the FUV suggests that Flambda(1500A) = 1.4e-14 erg/s/cm2/A at this time. With our set-up, this would yield S/N = 10 in under 400 s (COS.sp.1398892). Between Nov 7 and Dec 17 (40 days), the source faded by a factor of 3 in the bluest Swift band. Our observing window for this program lies between 2019 Dec 31 and 2020 Jan 7, so a maximum of about 20 days after the Dec 17 observations. We therefore consider that the source may fade by another factor of 2 by the time our program executes, i.e. we assume Flambda(1500) = 7e-15 erg/s/cm2/A for our ETC calculations. With this flux level, our set-up will yield S/N = 10 in 780 s (COS.sp.1398903). Thus a good quality FUV spectrum can be obtained in a single orbit.

Since we might achieve S/N > 15 or so, depending on the source flux, we will use FP-POS=ALL to reduce the fixed pattern noise that would otherwise limit the maximum achievable S/N. The extra overhead incurred for doing this -- in the form of buffer dumps following each exposure -- is only about 3 minutes. Given the relatively uncertain FUV flux level, we conservatively adopt a BUFFER-TIME = 1500 s for our observations, although the actual dumps follow each FP-POS exposure, which is only about 700 s in total duration.

There are no safety concerns for COS. The existing Swift/UVOT observations show that the system is nowhere near bright enough to threaten detector damage. Even the most extreme extrapolation from the Dec 17 near-UV flux to the far-UV -- assuming that both near-UV and far-UV emission lie on the Rayleigh-Jeans tail of the disk spectrum and assuming E(B-V) = 0 -- yields local and global count rates below the bright object limits. We will, however, continue to monitor the system with Swift/UVOT in the NUV.

Based on our Swift/UVOT data, MAXI J0637-430 is by far the brightest NUV source within at least 4'. For our target acquisition, we will use the standard ACQ/IMAGE method with the PSA and MIRRORB. For the Dec 17 NUV brightness (Flambda(2085) = 6e-15 erg/s/cm2/s), this would yield S/N = 20 in 6.5 s (COS.ta.1398907). Again allowing for a fading by x2 between this date and the time the program is executed, we find that S/N = 20 is reached in 13 s (COS.ta.1398908). Since a successful target acquisition is critical, but the exposure time required for it is negligible, we will conservatively use an exposure time of 60 s. For the expected default NUV flux, this will yield S/N = 43 (COS.ta.1398918), but it will also yield S/N > 20 all the way down to NUV fluxes as low as Flambda(2085) = 5e-16 erg/s/cm2/A. Our target acquisition strategy will remain safely below the bright limits for NUV fluxes as high as 3e-14 erg/s/cm2/A -- which is brighter than the target was even in November 2019.

We are not using an ACQ/SEARCH first, because we have four independent position measurements that agree to within better than 0.4": a ground-based optical one (ATel #13278), a radio one (ATel #13275), a Gaia UVOT one (measured from our Dec UVW1 and V-band images), and a Gaia Alerts one (Gaia19ezl). We use the Gaia Alerts coordinates as our reference position, which is expected to be good to about 0.1 arcsec (Breedt, Gaia Team UK, private communication).

Visit

Proposal 16058, SINGLE-VISIT (01) Tue Dec 24 16:01:26 GMT 2019

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: BEFORE 01-FEB-2020:00:00:00

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	MAXI-J0630	RA: 06 36 23.6900 (99.0987083d) Dec: -42 52 3.72 (-42.86770d) Equinox: J2000		V=16+/-0.1	Reference Frame: ICRS

Comments:
Category=STAR
Description=[X-RAY TRANSIENT]
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.1398918)	(1) MAXI-J0630	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				60 Secs (60 Secs) *[==>]*	*[1]*
Comments: We are using a pure ACQ/IMAGE target acquisition, because we have three independent position measurements that agree to within better than 0.4": a ground-based optical one (ATel #13278), a radio one (ATel #13275) and a Gaia Alerts one (Gaia19ezl).									
2	FUV (COS.sp.1398903)	(1) MAXI-J0630	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=1500; FP-POS=ALL			300 Secs (2000 Secs) *[==>500.0 Secs (Split 1)]* *[==>500.0 Secs (Split 2)]* *[==>500.0 Secs (Split 3)]* *[==>500.0 Secs (Split 4)]*	*[1]*

Orbit Structure