16881 - The Origin of The Fastest Spinning White Dwarf in a CV Binary

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) LAMOST-J0240	COS/FUV COS/NUV	5	23-Dec-2021 18:00:13.0	yes

5 Total Orbits Used

ABSTRACT

Recently, LAMOST-J0240 was identified as a likely second propeller in a cataclysmic variable (CV) system with optical properties that are very similar to the original propeller: AE Aqr. Only after the Cycle 29 proposal deadline was the white dwarf (WD) rotation in LAMOST-J0240 detected with a period of just 25s, making it the fastest spinning WD in a CV binary. We propose ultraviolet spectroscopy of this newly confirmed propeller to tests two theories of magnetic CV evolution. First, we will use the CIV and NV emission line ratio, observable only in the FUV, to test the thermal time-scale mass transfer model as the way to spin-up WDs. Peculiar CNO abundance ratios are a signature of unstable mass transfer that can reach down to the companion star's core. Inverted NV/CIV ratios are seen in CV systems with WD spin periods between 30s and 40s. Second, we will test

the crystallization theory for generating magnetic fields in WDs by precisely measuring the WD surface temperature. In an analogy with convective planetary magnetic field generation, only fast-spinning WDs that have cooled to the point of core crystallization form significant fields. Being a propeller, LAMOST-J0240 clearly has a fast rotating, magnetic WD, and the model predicts that its surface temperature should be half of the ground-based limit of 25000K. Further, the data will establish a baseline for estimating the spin-down age of the WD to constrain the time since the unstable mass transfer event.

OBSERVING DESCRIPTION

LAMOST-J0240 is an intermediate polar (IP) that has a rapidly spinning, magnetic white dwarf (WD). Gas donated from the secondary gets accelerated by the rotating magnetosphere and is ejected from the system. The scenario is thought to be similar to AE Aquarii, except in J0240 we view the system nearly edge-on, so that eclipses and the ejected gas is visible in optical spectra. Here, we plan to observed J0240 in the FUV with COS using the G140L grating and Time-tag mode. We plan to cover an entire binary orbit of 7.3 hours. This period is nearly identical to 5 Hubble orbits, so observing over 5 consecutive orbits is ideal. If this is not schedulable, we can divide the observations up into two visits (3+2) with a constraint to allow the second visit to complete the binary orbital phase coverage. COS ETC calculations are based on the brightest FOS spectrum of AE Aqr scaled to the distance of J0240 (36 times fainter).

Visit

Proposal 16881, visit01 (01), implementation Thu Dec 23 23:00:13 GMT 2021

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Fixed Targets

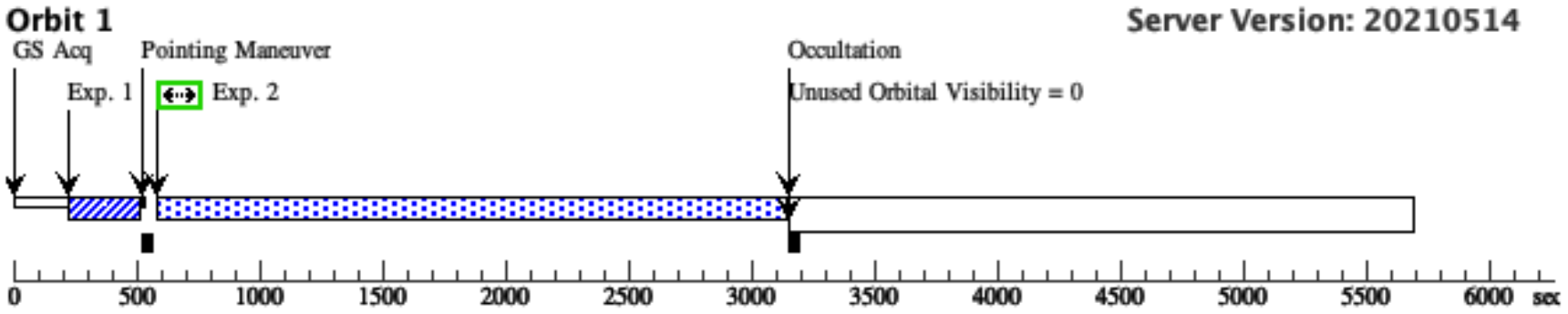
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	LAMOST-J0240	RA: 02 40 48.5357 (40.2022321d) Dec: +19 52 27.05 (19.87418d) Equinox: J2000	Proper Motion RA: -4.060 mas/yr Proper Motion Dec: -5.969 mas/yr Parallax: 0.0016" Epoch of Position: 2000	V=17.0+/-0.5 Between 1e-16 and 12e-16 erg/cm2/s/Ang at 2200 Ang from Swift	Reference Frame: ICRS

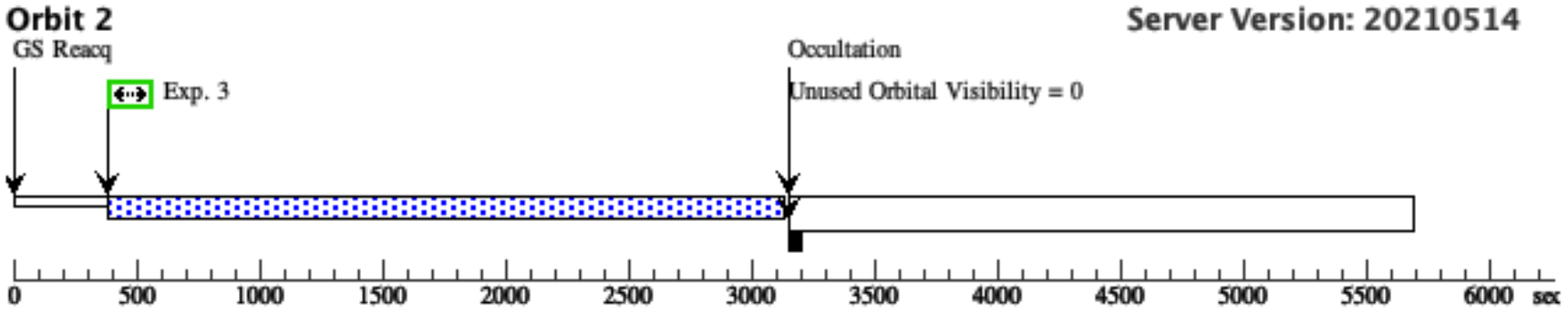
Comments: Variable in the optical with an amplitude of 1 magnitude
Category=STAR
Description=[EJECTA, EMISSION LINE STAR, INTERMEDIATE POLAR]
Extended=NO

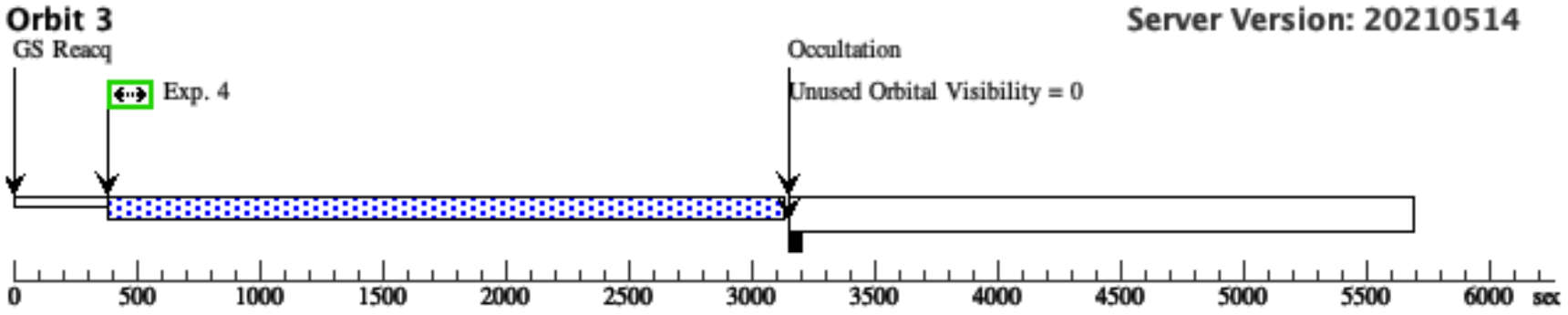
Exposures

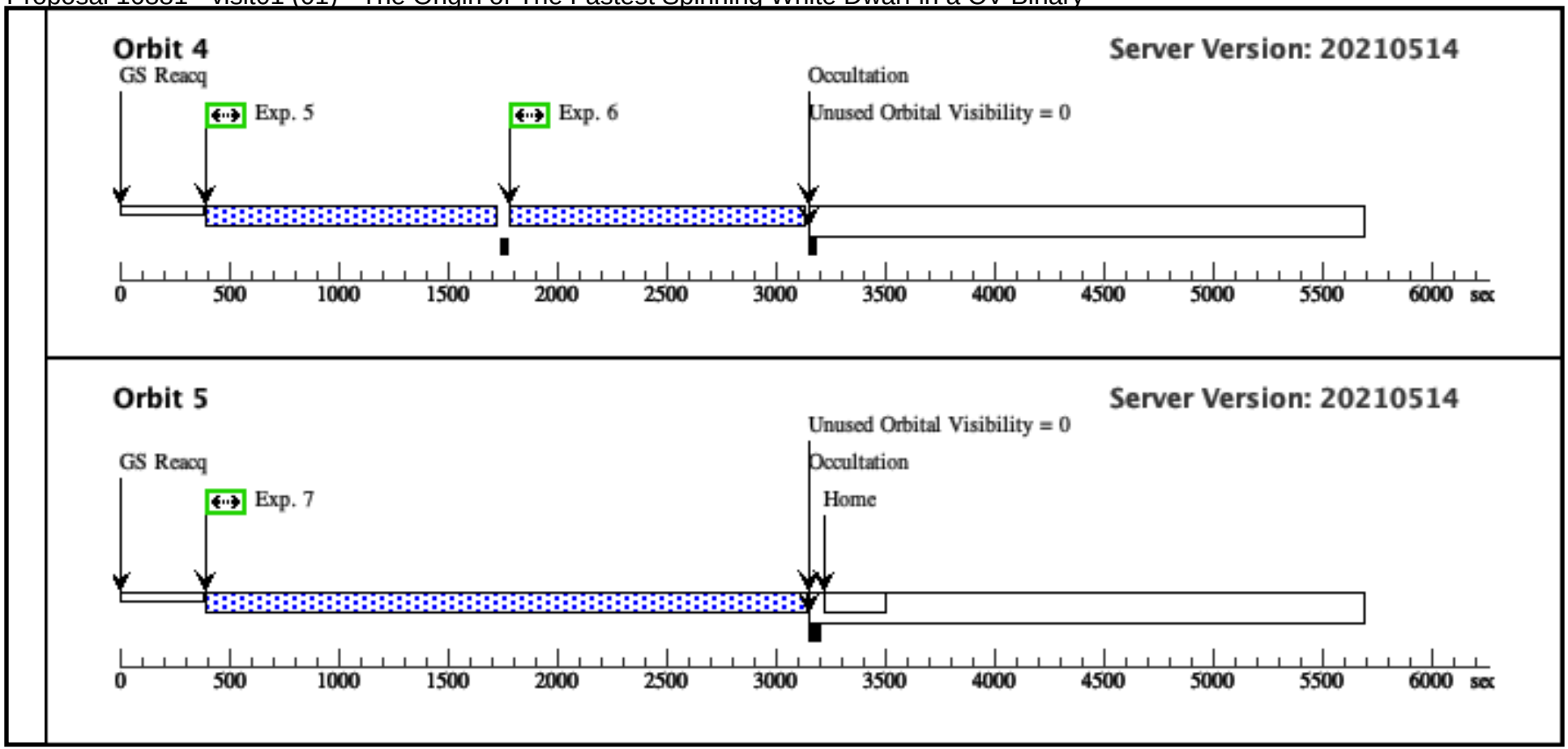
#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	acq1 (COS.ta.1678798)	(1) LAMOST-J0240	COS/NUV, ACQ/IMAGE, PSA	MIRRORA				30 Secs (30 Secs) *[==>]*	***[1]***
Comments: Swift UVOT provide a flux of 1e-16 erg/cm2/s/A at 2200 Ang. The imaging acquire ETC shows a S/N=20 in a 20s exposure of NUV, Mirror A, and the PSA. To be safe, we have increased the exposure to 30 s.									
2	sci1 (COS.sp.1680507)	(1) LAMOST-J0240	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=8000; FP-POS=1			2376 Secs (2376 Secs) *[==>]*	***[1]***
3	sci2 (COS.sp.1680509)	(1) LAMOST-J0240	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=8000; FP-POS=2			2700 Secs (2700 Secs) *[==>]*	***[2]***
4	sci3 (COS.sp.1680509)	(1) LAMOST-J0240	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=8000; FP-POS=3			2700 Secs (2700 Secs) *[==>]*	***[3]***
5	sci4 (COS.sp.1680511)	(1) LAMOST-J0240	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=8000; FP-POS=3			1285 Secs (1285 Secs) *[==>]*	***[4]***
6	sci5 (COS.sp.1680512)	(1) LAMOST-J0240	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=8000; FP-POS=4			1300 Secs (1300 Secs) *[==>]*	***[4]***
7	sci6 (COS.sp.1680509)	(1) LAMOST-J0240	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=8000; FP-POS=4			2700 Secs (2700 Secs) *[==>]*	***[5]***

Orbit Structure





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