12761 - Dynamical Evolution of the Recent Jet in CH Cyg

Cycle: 19, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. Margarita Karovska (PI)	**Smithsonian Institution Astrophysical Observatory**	**mkarovska@cfa.harvard.edu**
Mr. Warren J. Hack (CoI)	Space Telescope Science Institute	hack@stsci.edu
Dr. Terrance Gaetz (CoI)	Smithsonian Institution Astrophysical Observatory	gaetz@cfa.harvard.edu
Dr. John C. Raymond (CoI)	Smithsonian Institution Astrophysical Observatory	jraymond@cfa.harvard.edu
Dr. Nicholas Lee (CoI)	Smithsonian Institution Astrophysical Observatory	nlee@head.cfa.harvard.edu
Dr. Chris Carilli (CoI)	Associated Universities, Inc.	ccarilli@nrao.edu

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) V-CH-CYG (2) CH-CYG-QUAD-OFFSET	WFC3/UVIS	3	15-Sep-2011 21:17:09.0	yes

3 Total Orbits Used

ABSTRACT

We propose to carry out Chandra ACIS-S observations combined with HST/WFC3 multi-wavelength imaging of the powerful, multi-component jet which was detected in 2008 in the nearby symbiotic CH Cyg. CH Cyg is a fascinating system containing an evolved giant and a wind-accreting white dwarf, and it is one of the few symbiotics showing jet activity, especially in X-rays. Our goal is to measure the physical characteristics of the individual jet components, from the central source to the region of interaction with the circumbinary environment, reaching to within a few AU from the source of the jet. We will determine the characteristics of the central source, and of the inner and the outer jet, and the dynamical evolution, including precession, and

kinematics of the ejecta.

OBSERVING DESCRIPTION

The CH Cyg jet, because of its proximity, at a distance of 250 pc, and resolvable scale, provides an exceptional target for detailed high-angular resolution studies of jet formation, collimation, structure and early propagation, including the origin and effects of precession.

We were awarded 3 orbits of HST observations of CH Cyg as part of a joint Chandra and HST proposal (No. 13300810). The main goals of this project are to determine:

(1) the spatial and spectral characteristics of the jet,

(2) its dynamical evolution as it propagates and interacts with the surrounding close circumbinary environment,

(3) if the inner jet is continuous with occasional outburst, and

(4) whether the jet precesses.

We plan to carry out WFC3 high-angular resolution imaging of CH Cyg, using the dither mode in several filters (including spectral lines and the continuum). This would allow us to unambiguously study the changes that have occurred since the 2008 HST observation, including the inner and extended jet structures and clumps, and the central region. We request a total of 3 orbits, in 1 visit.

We have selected a set of filters to separate line and continuum emission, to distinguish shocked from photoionized gas, and to determine the shock speed and the nature of the photoionizing continuum. For example, several filters (including F673N, F656N, F502N, and FQ436N) will be used with sufficient exposure time in order to measure the fainter extended features surrounding the central region. Short exposure times in some of these filters (F502N, F656N, F673N, and FQ437N) will allow us to map the central region without saturation.

Difference and ratio maps will reveal changes in local physical conditions. The H_alpha, [OII] at 3729Angstroms, and [OIII] at 5007Angstroms lines are bright, and they provide information on the ionization state of the gas. The [Mg II] line at 2800Angstroms is also expected to provide

information on the ionization state of the
gas, with the F275W images allowing us to remove the continuum from the [Mg II] exposures. The [SII] (at 6731Angstroms)/H_alpha ratio will allow us to identify shocked vs. ionized gas emission, e.g., the ratio will be >=0.4 for shocked gas, and smaller for photoionized gas. The O[III] 4363Angstroms/5007Angstroms ratio gives the temperature which further constrains either the shock speed or the ionizing spectrum.

We plan to carry out the observations in a dither mode to improve the sampling of the PSF, and to deal with cosmic rays. Although the pixel size for the WFC3/UVIS detector is 0.0395 arcseconds/pixel, by using an appropriate dither pattern, we will aim to reach ~0.025 arcseconds/pixel (~6AU at 250 pc), which will nearly double the number of pixels covering the regions of interest and better sample the PSF, allowing further enhancement in the resolution using deconvolution techniques. We plan to analyze the data using standard HST analysis procedures, and the latest HST calibration.

The observation require very minimal exposure times. These exposure times were based on ETC calculations using the online WFC3 ETC. We are also only interested in a relatively small field-of-view around CH Cyg itself. We propose to optimize the efficiency of the observing time by using subarray readouts (2048x2048 readout) to minimize the overheads for this proposal while still providing a >=80"x80" field of view. A sample Phase II proposal was generated using the latest APT based on the desired exposure times to avoid saturation, and on the use of dither patterns, and makes the most efficient use of the observing time.

The reduced overheads for subarray readouts added to the combined exposure times for a 4-point dither pattern for each filter fit into the time available in 3 orbits (~172 min, with 57.5 minutes per orbit). The sets of dither exposures can be split across the orbits to maximize efficiency. All exposures not using the QUAD filters will be taken using a 1024x1024 subarray readout nearest the C amp in order to minimize the effects of CTE while also minimizing readout overheads. The QUAD filter observations were designed to use a POS TARG offset to move the source closer to the amp for that quadrant in order ot minimize the effects of CTE.

We plan to combine the results from the multi-wavelength HST observations with the Chandra results, and derive a crucial information on the spatial, spectral and temporal characteristics of the jet. The results will provide key inputs and quantitative constraints to models of non relativistic jets, and to our understanding of jet formation and early stages of propagation and precession in a wide range of interacting binaries in which early jet activity cannot be spatially resolved.

We note that the V magnitude of CH Cyg is V~8.5 now (about the same as in June 2008). Because CH Cyg jet
features have expanded and therefore are expected to be fainter we have adjusted the exposures up from those in the 2008 observations.

We plan to continue to follow the CH Cyg brightness, and although we do not expect that it would change in a way that it will have any significant effect on the instrument (there may be a change of ~1 magnitude at most in the next year or so), we would like to confirm the exposures within a month of the final scheduling. The target is visible over several extended periods from Aug 2011 to Nov 2012, which will allow scheduling flexibility. If possible, our preference is to get the HST observations within a month of the Chandra observations.

ADDITIONAL COMMENTS

Observing the nebulosity around CH Cyg serves as the primary purpose for this proposal, nebulosity exhibiting a new feature (the jet) in 2008 that has been decreasing in intensity based on Chandra data ever since. These observations should be scheduled no later that July 2012 if at all possible in order to have the best possible chance of mapping the jet.

Visit

Proposal 12761, Visit 01

Fri Sep 16 01:17:21 GMT 2011

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

Diagnostics

(Exposure 13 (Pattern 1, Exps 13-14 in Visit 01)) Warning (Form): POS TARG & PATTERN should be used carefully with ACS ramp or WFC3 quad filters as central wavelengths & transmission efficiencies vary within the apertures.

(Exposure 14 (Pattern 1, Exps 13-14 in Visit 01)) Warning (Form): POS TARG & PATTERN should be used carefully with ACS ramp or WFC3 quad filters as central wavelengths & transmission efficiencies vary within the apertures.

Patterns

#	Primary Pattern	Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112 Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1-12), (13-14)

Fixed Targets

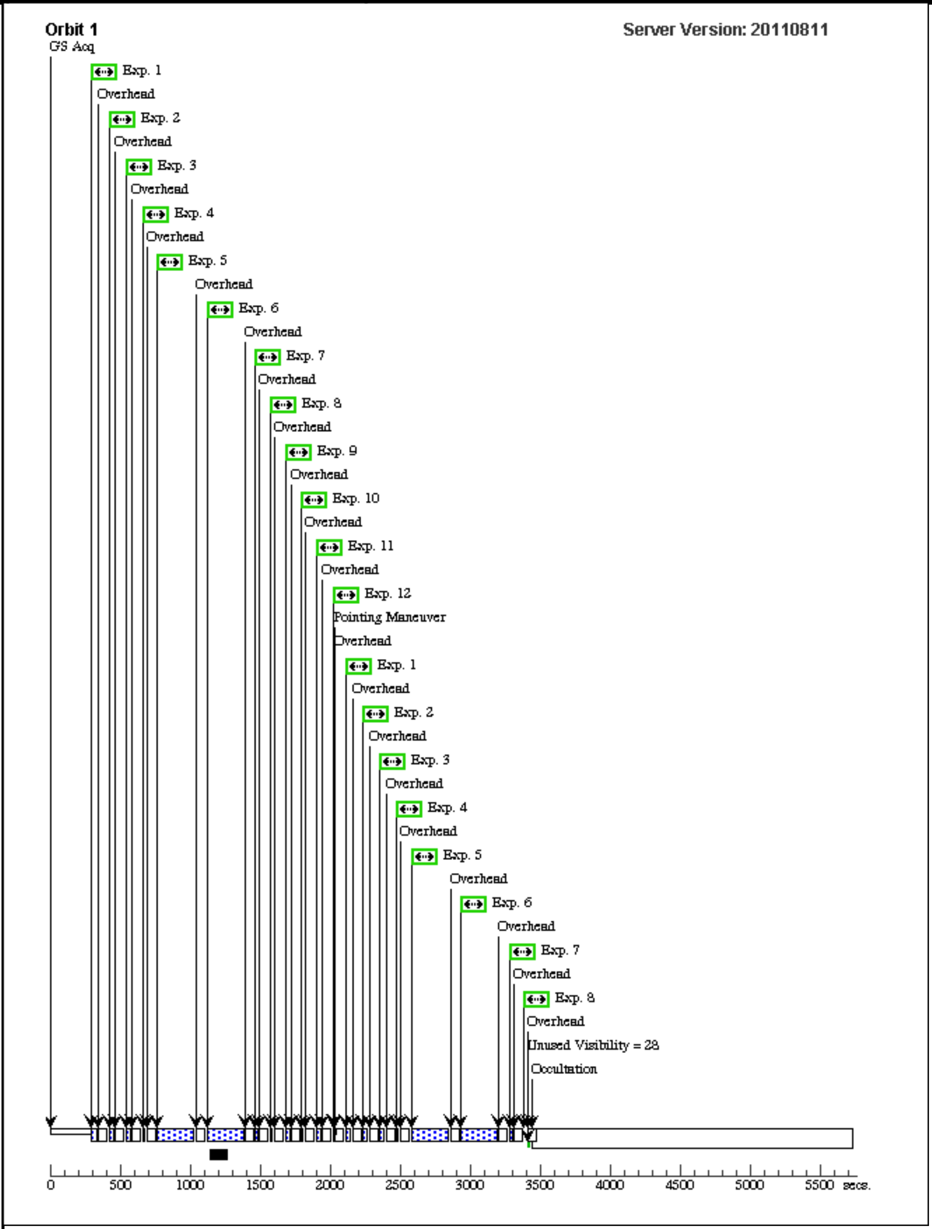
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	V-CH-CYG	RA: 19 24 33.0681 (291.1377838d) Dec: +50 14 29.13 (50.24142d) Equinox: J2000		V=8.84	Reference Frame: ICRS
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.					
(2)	CH-CYG-QUAD-OFFSET Alt Name1: QUAD-OFFSET	Offset from V-CH-CYG by RA Offset: 1.584 Secs Dec Offset: 0.0 Arcsec		V=8.84	Offset Position (CH-CYG-QUAD-OFFSET) Reference Frame: ICRS

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(1) V-CH-CYG	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F336W	CR-SPLIT=NO		Pattern 1, Exps 1-12 in Visit 01 (1)	8 Secs	
								[==>(Pattern 1)] *[==>(Pattern 2)]*	*[1]*
								[==>(Pattern 3)] *[==>(Pattern 4)]*	*[2]*
2		(1) V-CH-CYG	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F373N	CR-SPLIT=NO		Pattern 1, Exps 1-12 in Visit 01 (1)	15 Secs	
								[==>(Pattern 1)] *[==>(Pattern 2)]*	*[1]*
								[==>(Pattern 3)] *[==>(Pattern 4)]*	*[2]*
3		(1) V-CH-CYG	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F502N	CR-SPLIT=NO		Pattern 1, Exps 1-12 in Visit 01 (1)	1 Secs	
								[==>(Pattern 1)] *[==>(Pattern 2)]*	*[1]*
								[==>(Pattern 3)] *[==>(Pattern 4)]*	*[2]*
4		(1) V-CH-CYG	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F502N	CR-SPLIT=NO		Pattern 1, Exps 1-12 in Visit 01 (1)	15 Secs	
								[==>(Pattern 1)] *[==>(Pattern 2)]*	*[1]*
								[==>(Pattern 3)] *[==>(Pattern 4)]*	*[2]*
5		(1) V-CH-CYG	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F275W	CR-SPLIT=NO		Pattern 1, Exps 1-12 in Visit 01 (1)	240 Secs	
								[==>(Pattern 1)] *[==>(Pattern 2)]*	*[1]*
								[==>200.0 Secs (Pattern 3)]	*[2]*
								[==>180.0 Secs (Pattern 4)]	*[3]*
6		(1) V-CH-CYG	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F280N	CR-SPLIT=NO		Pattern 1, Exps 1-12 in Visit 01 (1)	240 Secs	
								[==>(Pattern 1)] *[==>(Pattern 2)]*	*[1]*
								[==>200.0 Secs (Pattern 3)]	*[2]*
								[==>180.0 Secs (Pattern 4)]	*[3]*
7		(1) V-CH-CYG	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F656N	CR-SPLIT=NO		Pattern 1, Exps 1-12 in Visit 01 (1)	1 Secs	
								[==>(Pattern 1)] *[==>(Pattern 2)]*	*[1]*
								[==>(Pattern 3)]	*[2]*
								[==>(Pattern 4)]	*[3]*
8		(1) V-CH-CYG	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F656N	CR-SPLIT=NO		Pattern 1, Exps 1-12 in Visit 01 (1)	15 Secs	
								[==>(Pattern 1)] *[==>(Pattern 2)]*	*[1]*
								[==>(Pattern 3)]	*[2]*
								[==>(Pattern 4)]	*[3]*

	9	(1) V-CH-CYG	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F673N	CR-SPLIT=NO	Pattern 1, Exps 1-12 in Visit 01 (1)	0.5 Secs	
							[==>(Pattern 1)]	***[1]***
							[==>(Pattern 2)] *[==>(Pattern 3)]*	***[2]***
							[==>(Pattern 4)]	***[3]***
	10	(1) V-CH-CYG	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F673N	CR-SPLIT=NO	Pattern 1, Exps 1-12 in Visit 01 (1)	15 Secs	
							[==>(Pattern 1)]	***[1]***
							[==>(Pattern 2)] *[==>(Pattern 3)]*	***[2]***
							[==>(Pattern 4)]	***[3]***
	11	(1) V-CH-CYG	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F547M	CR-SPLIT=NO	Pattern 1, Exps 1-12 in Visit 01 (1)	5 Secs	
							[==>(Pattern 1)]	***[1]***
							[==>(Pattern 2)] *[==>(Pattern 3)]*	***[2]***
							[==>(Pattern 4)]	***[3]***
	12	(1) V-CH-CYG	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F547M	CR-SPLIT=NO	Pattern 1, Exps 1-12 in Visit 01 (1)	0.5 Secs	
							[==>(Pattern 1)]	***[1]***
							[==>(Pattern 2)] *[==>(Pattern 3)]*	***[2]***
							[==>(Pattern 4)]	***[3]***
	13	(2) CH-CYG-QUAD -OFFSET	WFC3/UVIS, ACCUM, UVIS-QUAD-SUB	FQ437N	CR-SPLIT=NO	Pattern 1, Exps 13-14 in Visit 01 (1)	30 Secs	
							[==>(Pattern 1)] *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[3]***
	14	(2) CH-CYG-QUAD -OFFSET	WFC3/UVIS, ACCUM, UVIS-QUAD-SUB	FQ437N	CR-SPLIT=NO	Pattern 1, Exps 13-14 in Visit 01 (1)	5 Secs	
							[==>(Pattern 1)] *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	***[3]***

Orbit Structure



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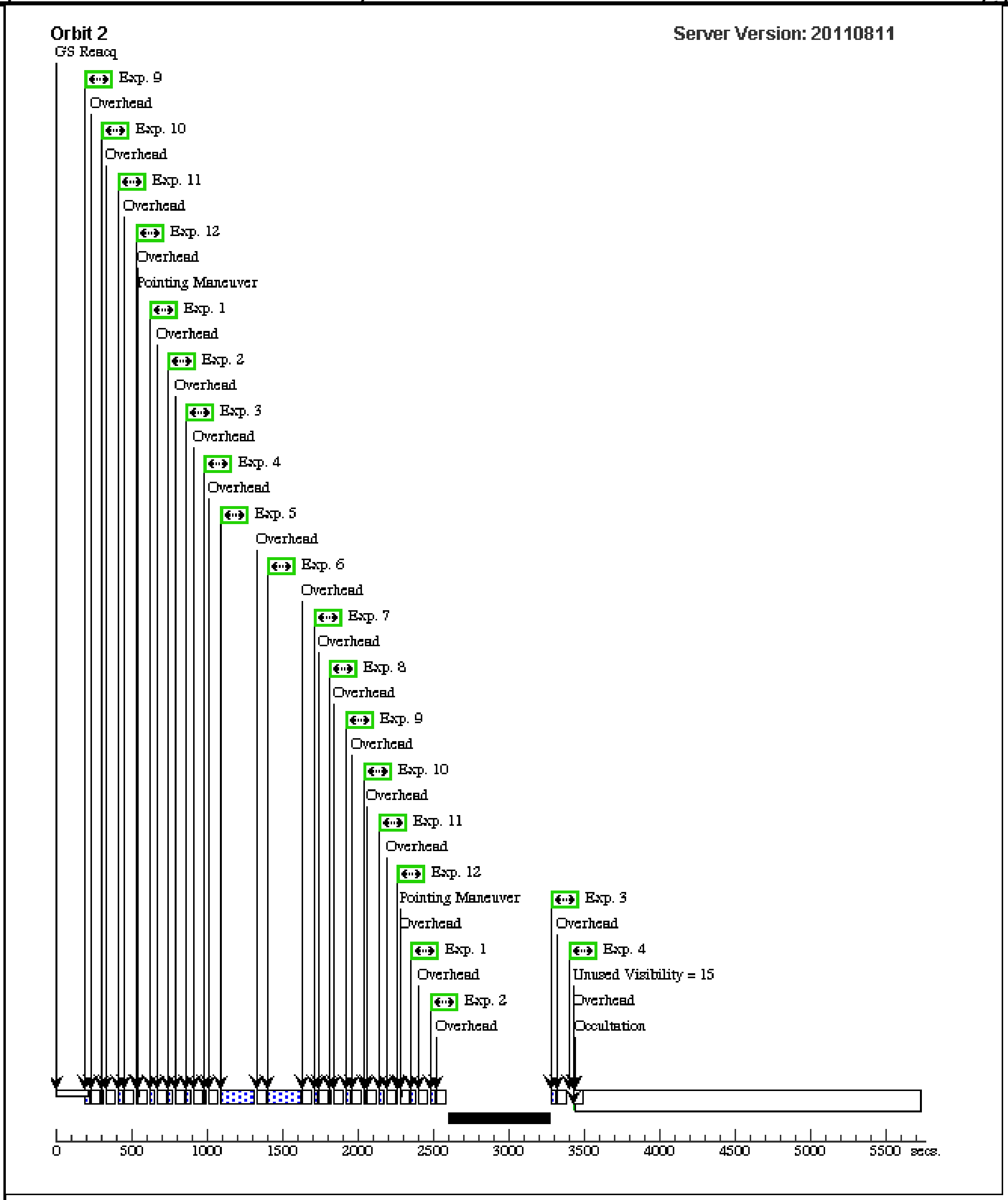

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