15074 - Identifying the donor star of the most extreme ULX pulsar

Cycle: 25, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. Marianne Heida (PI) (Contact)	**California Institute of Technology**	**mheida@caltech.edu**
Dr. Fiona A. Harrison (CoI)	California Institute of Technology	fiona@srl.caltech.edu
Dr. Daniel K Stern (CoI)	Jet Propulsion Laboratory	daniel.k.stern@jpl.nasa.gov
Dr. Dominic Walton (CoI) (ESA Member)	University of Cambridge	dwalton@srl.caltech.edu
Dr. Felix Fuerst (CoI) (ESA Member)	ESA-European Space Astronomy Centre	felix.fuerst@sciops.esa.int
Dr. Murray Brightman (CoI)	California Institute of Technology	murray@srl.caltech.edu

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) NGC5907-ULX	WFC3/IR	2	12-Jul-2017 17:03:31.0	yes

2 Total Orbits Used

ABSTRACT

Ultraluminous X-ray sources (ULXs) were once among the most promising candidates for long sought after intermediate-mass black holes, owing to their high X-ray luminosities (>10^39 erg/s) and off-nuclear positions. NGC 5907 ULX-1 was a prime example, and since it regularly reaches 10^41 erg/s it was thought to harbour a black hole with a mass of at least 500 solar masses. But in an astonishing discovery, the source was found to exhibit pulsations in the X-rays on second-timescales, revealing it to be a pulsar powered by accretion onto a neutron star with only 1.4 solar masses. This discovery challenges every known theory of accretion onto a compact object, which in this object exceeds the Eddington limit by a factor of 500. It requires us to imagine extreme departures from known accretion theory and/or binary evolution scenarios. The fuel source should be a massive companion star in order to sustain the required mass accretion rate, however X-ray timing favors a low-mass star. With the ability to detect a massive

star, a short HST/WFC3 NIR observation would solve this mystery. A detection of a supergiant donor would open the path to future dynamical mass measurements with JWST, while a non-detection would prove that this extreme ULX pulsar contains a low-mass donor star, forcing us to consider new evolutionary formation channels.

OBSERVING DESCRIPTION

The goal of this project is to either detect the donor star of the ULX pulsar in NGC 5907 (if it is an O or B supergiant) or set a strong limit on its magnitude (if it is a low-mass star).

To do this we will observe the ULX with WFC3/NIR in one filter, F160W. With four exposures of 1403 seconds (using the SPARS100 readout with Nsamp = 15), using the WFC3-IR-DITHER-BOX-MIN dither pattern to optimally sample the PSF, we obtain a total exposure time of 5612 seconds. According to the ETC, this will give us a S/N ratio of 7-8, depending on the subtype, for a B supergiant with H = 25.5; thus we will significantly detect a supergiant even if the extinction is at the upper edge of the suggested range.

Taking into account the overheads for guide star acquisition, the instrument overhead per exposure and the time needed to offset the satellite, the total time needed for two exposures is 55 minutes. This fits easily in the orbital visibility window for NGC 5907 of 58 minutes, so the four exposures we need fit in two orbits.

Proposal 15074 - Visit 01 - Identifying the donor star of the most extreme ULX pulsar

Visit

Proposal 15074, Visit 01 Wed Jul 12 21:03:32 GMT 2017

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: (none)

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	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		(1)

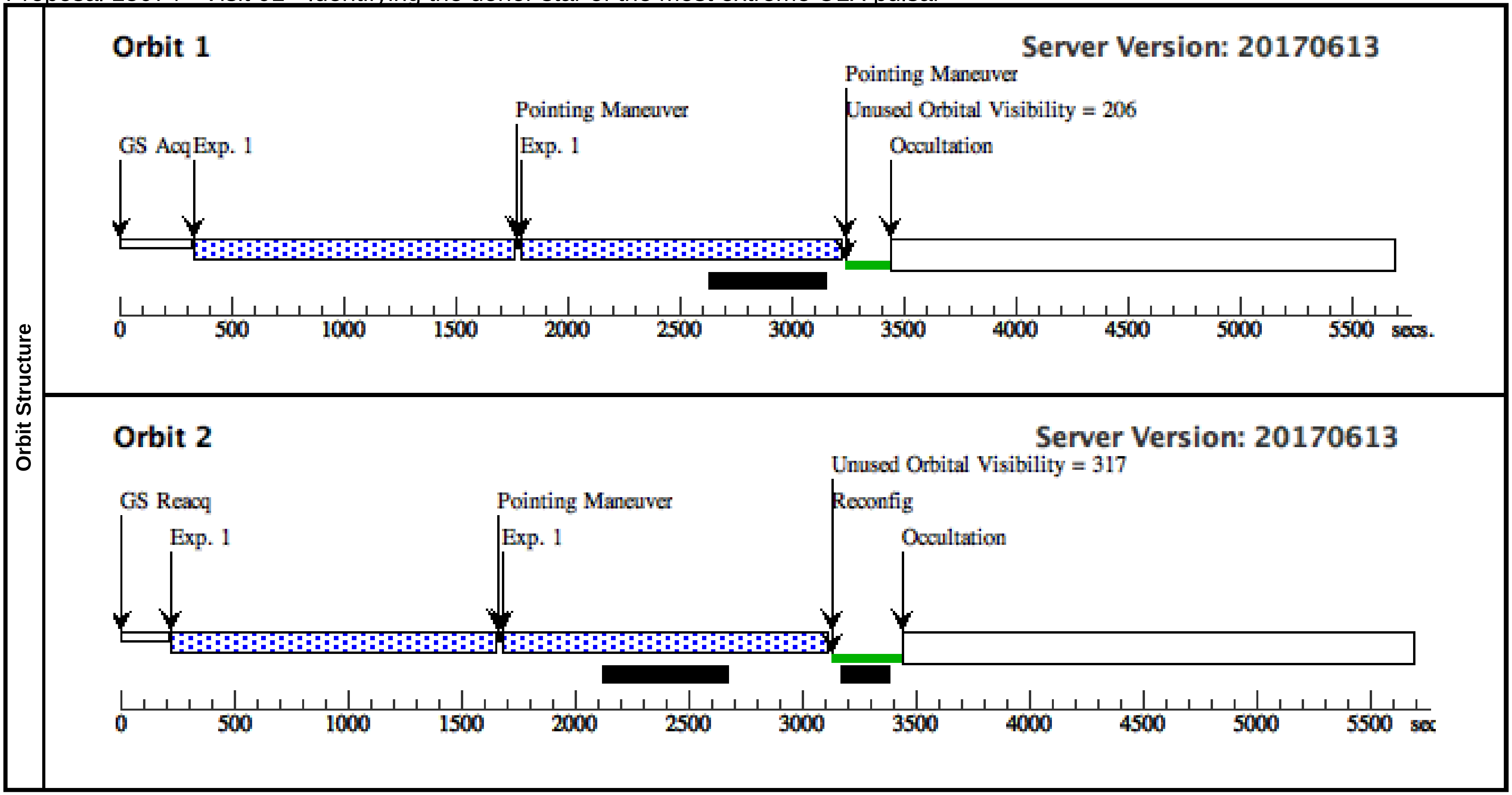
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	NGC5907-ULX	RA: 15 15 58.6000 (228.9941667d) Dec: +56 18 10.00 (56.30278d) Equinox: J2000		V=30	Reference Frame: SIMBAD

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) NGC5907-ULX	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=15; SAMP-SEQ=SPARS100		Pattern 1, Exps 1-1 in Visit 01 (1)	1402.936813 Secs (5611.747 Secs)	
								[==>(Pattern 1)] *[==>(Pattern 2)]*	***[1]***
								[==>(Pattern 3)] *[==>(Pattern 4)]*	***[2]***


Orbit Structure
Orbit 1
Server Version: 20170613
Pointing Maneuver
Unused Orbital Visibility = 206
Pointing Maneuver
GS Acq
Exp. 1
Exp. 1
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
secs.
Orbit 2
Server Version: 20170613
Unused Orbital Visibility = 317
GS Reacq
Pointing Maneuver
Reconfig
Exp. 1
Exp. 1
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec