14126 - Startlingly fast evolution of the Stingray Nebula

Cycle: 23, Proposal Category: GO

(Availability Mode: AVAILABLE)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Mr. Zachary Edwards (PI) (Contact)	**Louisiana State University and A & M College**	**zedwar4@tigers.lsu.edu**
Prof. Bradley E. Schaefer (CoI) (AdminUSPI)	Louisiana State University and A & M College	schaefer@lsu.edu
Dr. Howard E. Bond (CoI)	The Pennsylvania State University	heb11@psu.edu
Dr. Kailash C. Sahu (CoI)	Space Telescope Science Institute	ksahu@stsci.edu
Mr. Zhichao Xue (CoI)	Louisiana State University and A & M College	zxue3@lsu.edu

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) NAME-STINGRAY-NEBULA	WFC3/UVIS	2	24-Jul-2015 21:42:27.0	yes

2 Total Orbits Used

ABSTRACT

The Stingray Nebula provides the unique opportunity to watch the ionization of a planetary nebula, a helium shell flash, and the evolution of the central star. Importantly, before 1980 the Stingray's spectrum was characteristic of a B1 I star, then in 1990 the Stingray's spectrum was dominated by bright emission lines characteristic of a young planetary nebula, indicating the fast evolution of this system. Despite its fast evolution, the Stingray has not been imaged for 15 years. We propose to use 2 orbits of HST, using WFC3, to define the evolution of this planetary nebula and its central star. These observation will address three science goals: First, measure the differential expansion of the shell from 1992 to present. Second, detect brightening from the fast wind of the 1980s ionization event impacting the inside of the planetary nebula shell. Third, define the motion of the central star through the HR diagram to provide quantitative measures for comparison to theory. This program cannot be done from ground-based observatories since it requires HST's angular resolution to detect expansion, and resolve the central star from the surrounding nebula.

OBSERVING DESCRIPTION

We propose to take WFC3 images of the Stingray to answer three main science questions: First, we will measure the differential expansion of the shell from 1992 to present. Second, we will detect the collision of the fast stellar wind from the 1980s with the PN shell. Third, we will define the current position of the central star on the HR diagram so as to follow its fast and startling evolution. All three goals can be accomplished with just two HST orbits of imaging with WFC3-UVIS. We will take exposures through narrow band filters F502N ([O III]), F487N (H_beta), and F658N ([N II]) as to nearly match the exposures from the first epoch images. Indeed, these first epoch images provide the proof that our exposure times will produce good S/N and not be saturated in the nebula. We will also take short and long exposures through the F438W (B), F555W (V), and F625W (SDSS r') filters.

To accomplish the first two science goals, we will use our narrow band images in 2015 as second epoch images, for direct comparison with first epoch HST images variously from 1992, 1996, and 2000. Our analysis is to make a direct comparison to measure the expansion and to difference the images to seek the collisional brightening. Within two HST orbits, we have time for three narrow-band filters, and these must be F502N ([O III]), F487N (H_beta), and F658N ([N II]). These three filters have the highest S/N in the nebula, and they have the most first epoch images. (The 1992 data set has both [O III] and H_beta, the 1996 set has all three, while the 2000 images include [O III] and [N II].) The three sets of old first epoch images will provide multiple time baselines of 23 years, 19 years, and 15 years.

Our original observing plan was to take short exposures in F487N and F658N to protect against overstaturation due to unexpected brigthening. After calculating the expected counts, the long exposures are far from overstaturation and thus we do not require the short observations. Therefore, we are reallocating the time orignially used for the F487N and F658N filters to take an exposure in the F656N filter. This provides yet another filter with high S/N to accomplish our first two stated science goals.

In addition, we are left with ~5 minutes of unused orbital visability. Thus, in addition our proposed program, we will get a long exposure in [SII] (F673N). This additional filter (providing a 19 year baseline) will allow us to a 5th measure of the shell expansion as well as provide another spectral element to detect any collisional brightening.

Visit

Proposal 14126, Visit 01, implementation Sat Jul 25 01:42:30 GMT 2015

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

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)

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	NAME-STINGRAY-NEBULA Alt Name1: V839ARA Alt Name2: SAO244567	RA: 17 16 21.0800 (259.0878333d) Dec: -59 29 23.30 (-59.48981d) Equinox: J2000		V=12.26+/-0.01	Reference Frame: SIMBAD

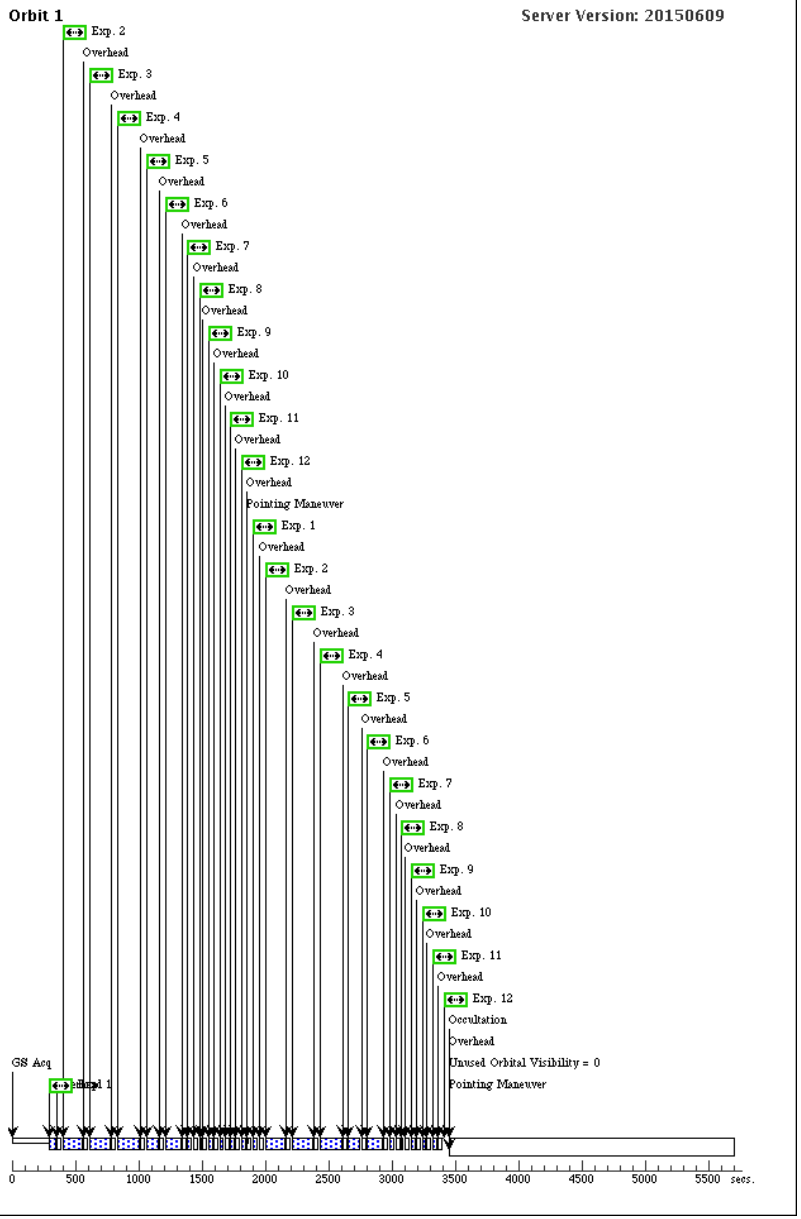
Comments: This object was generated by the target selector and retrieved from the SIMBAD database.
Extended=YES

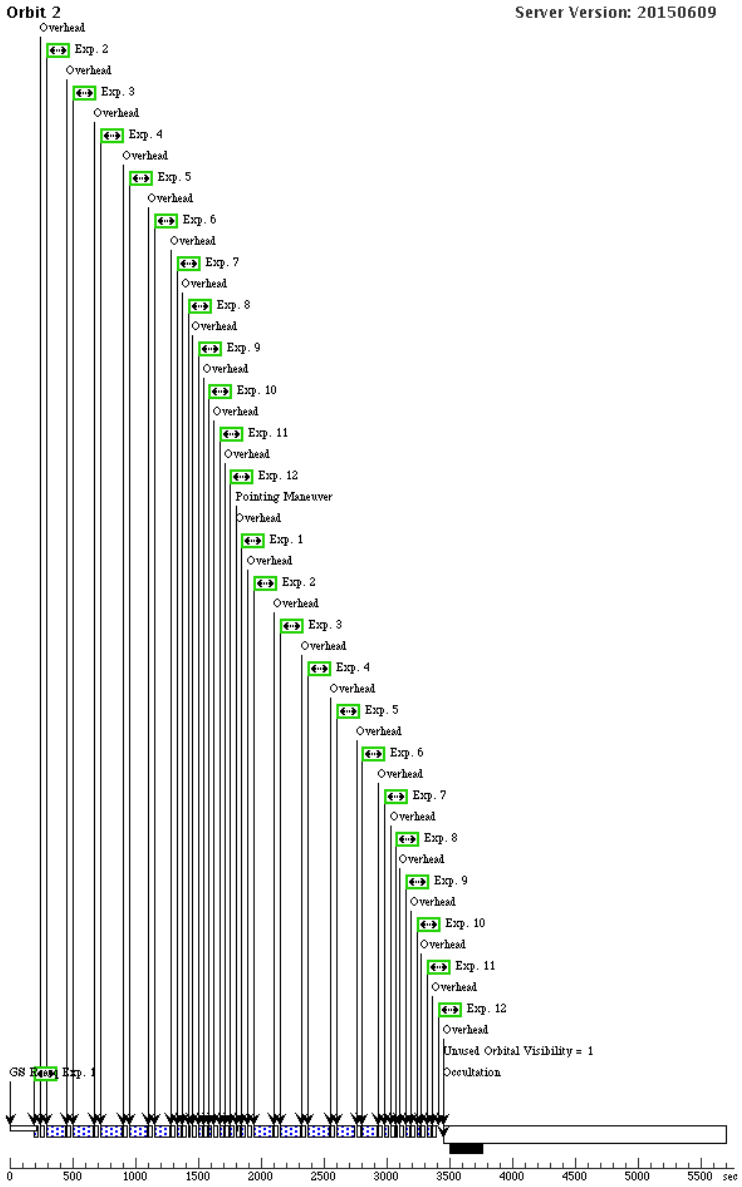
Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	F502N Short	(1) NAME-STINGRAY-NEBULA	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F502N	CR-SPLIT=NO; FLASH=12		Pattern 1, Exps 1-12 in Visit 01 (1)	15 Secs (60 Secs)	
								[==>(Pattern 1)]	***[1]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	***[2]***
								[==>(Pattern 4)]	
2	F502N Long	(1) NAME-STINGRAY-NEBULA	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F502N	FLASH=11; CR-SPLIT=NO		Pattern 1, Exps 1-12 in Visit 01 (1)	150 Secs (600 Secs)	
								[==>(Pattern 1)]	***[1]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	***[2]***
								[==>(Pattern 4)]	
3	F487N Long	(1) NAME-STINGRAY-NEBULA	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F487N	CR-SPLIT=NO; FLASH=11		Pattern 1, Exps 1-12 in Visit 01 (1)	150 Secs (600 Secs)	
								[==>(Pattern 1)]	***[1]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	***[2]***
								[==>(Pattern 4)]	
4	F658N Long	(1) NAME-STINGRAY-NEBULA	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F658N	CR-SPLIT=NO; FLASH=11		Pattern 1, Exps 1-12 in Visit 01 (1)	150 Secs (600 Secs)	
								[==>(Pattern 1)]	***[1]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	***[2]***
								[==>(Pattern 4)]	
5	F656N	(1) NAME-STINGRAY-NEBULA	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F656N	CR-SPLIT=NO; FLASH=12		Pattern 1, Exps 1-12 in Visit 01 (1)	60 Secs (382 Secs)	
								[==>68.0 Secs (Pattern 1)]	***[1]***
								[==>68.0 Secs (Pattern 2)]	
								[==>123.0 Secs (Pattern 3)]	***[2]***
								[==>123.0 Secs (Pattern 4)]	
6	F673N	(1) NAME-STINGRAY-NEBULA	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F673N	FLASH=11; CR-SPLIT=NO		Pattern 1, Exps 1-12 in Visit 01 (1)	90 Secs (360 Secs)	
								[==>(Pattern 1)]	***[1]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	***[2]***
								[==>(Pattern 4)]	
7	F555W Short	(1) NAME-STINGRAY-NEBULA	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F555W	CR-SPLIT=NO; FLASH=12; BLADE=A		Pattern 1, Exps 1-12 in Visit 01 (1)	1 Secs (4 Secs)	
								[==>(Pattern 1)]	***[1]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	***[2]***
								[==>(Pattern 4)]	
8	F555W Long	(1) NAME-STINGRAY-NEBULA	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F555W	CR-SPLIT=NO; FLASH=11		Pattern 1, Exps 1-12 in Visit 01 (1)	15 Secs (60 Secs)	
								[==>(Pattern 1)]	***[1]***
								[==>(Pattern 2)]	
								[==>(Pattern 3)]	***[2]***
								[==>(Pattern 4)]	

	9	F625W Short	(1) NAME-STINGRAY-NEBULA	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F625W	FLASH=12; CR-SPLIT=NO; BLADE=A	Pattern 1, Exps 1-12 in Visit 01 (1)	1 Secs (4 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	 ***[1]*** ***[2]***
	10	F625W Long	(1) NAME-STINGRAY-NEBULA	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F625W	FLASH=12; CR-SPLIT=NO	Pattern 1, Exps 1-12 in Visit 01 (1)	22.5 Secs (90 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	 ***[1]*** ***[2]***
	11	F438W Short	(1) NAME-STINGRAY-NEBULA	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F438W	FLASH=12; CR-SPLIT=NO; BLADE=A	Pattern 1, Exps 1-12 in Visit 01 (1)	1 Secs (4 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	 ***[1]*** ***[2]***
	12	F438W Long	(1) NAME-STINGRAY-NEBULA	WFC3/UVIS, ACCUM, UVIS2-C512C-SUB	F438W	CR-SPLIT=NO; FLASH=12	Pattern 1, Exps 1-12 in Visit 01 (1)	30 Secs (120 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]*	 ***[1]*** ***[2]***

Orbit Structure




Orbit 2
Server Version: 20150609
Overhead
Exp. 2
Overhead
Exp. 3
Overhead
Exp. 4
Overhead
Exp. 5
Overhead
Exp. 6
Overhead
Exp. 7
Overhead
Exp. 8
Overhead
Exp. 9
Overhead
Exp. 10
Overhead
Exp. 11
Overhead
Exp. 12
Pointing Maneuver
Overhead
Exp. 1
Overhead
Exp. 2
Overhead
Exp. 3
Overhead
Exp. 4
Overhead
Exp. 5
Overhead
Exp. 6
Overhead
Exp. 7
Overhead
Exp. 8
Overhead
Exp. 9
Overhead
Exp. 10
Overhead
Exp. 11
Overhead
Exp. 12
Overhead
Unused Orbital Visibility = 1
Occultation
GS
Exp. 1
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec