



18063 - UV Spectroscopy of the Stingray Nebula Central Star: Stellar Evolution in Real Time

Cycle: 33, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

<i>Name</i>	<i>Institution</i>
Dr. Kailash C. Sahu (PI) (Contact)	Eureka Scientific Inc.
Dr. Mudumba Parthasarathy (CoI)	Indian Institute of Astrophysics
Dr. W. Van Dyke Dixon (CoI)	Space Telescope Science Institute
Dr. Howard E. Bond (CoI)	The Pennsylvania State University

VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(1) V839-ARA	COS/FUV COS/NUV	1	16-Oct-2025 14:00:14.0	yes
02	(1) V839-ARA WAVE	STIS/CCD STIS/NUV-MAMA	1	16-Oct-2025 14:00:14.0	yes

2 Total Orbits Used

ABSTRACT

V839 Ara, the central star of the Stingray planetary nebula (PN), evolved from a B1-type post-AGB star in the 1970s to become hot enough to ionize the surrounding ejecta and reveal itself as a new PN by the 1990s. It provided the first-ever opportunity to study the transition of a star from the post-AGB to the PN phase, prompting studies with ground- and space-based telescopes. However, several aspects of this rapid evolution have remained

enigmatic. After the initial fast rise in temperature, high-resolution HST UV spectra obtained in 2015 showed a decrease in T_{eff} , suggesting that V839 Ara is already returning toward the AGB (a "born-again AGB star" event). HST images in 2016 showed that the nebular emission had faded precipitously, in keeping with an observed decrease in the central star's T_{eff} . This has led to the speculation that the star is undergoing a late thermal pulse (LTP). However, known LTP stars are hydrogen-poor and rich in He, C and s-process elements, while V839 Ara shows solar abundances. And the current LTP models do not reproduce its observed rapid evolution.

V839 Ara provides a unique opportunity to study the transition of a post-AGB star to a PN, and then apparently back toward the AGB. Since 2015, there have been no further UV spectra of the central star. We will obtain new HST UV spectra and, in conjunction with spectral-synthesis models, make a direct and accurate measurement of its present T_{eff} , $\log g$, and chemical composition. Our measurements will provide important and much-needed constraints on models of post-AGB evolutionary tracks, leading to a better understanding of this brief and fast-evolving phase of stellar evolution.

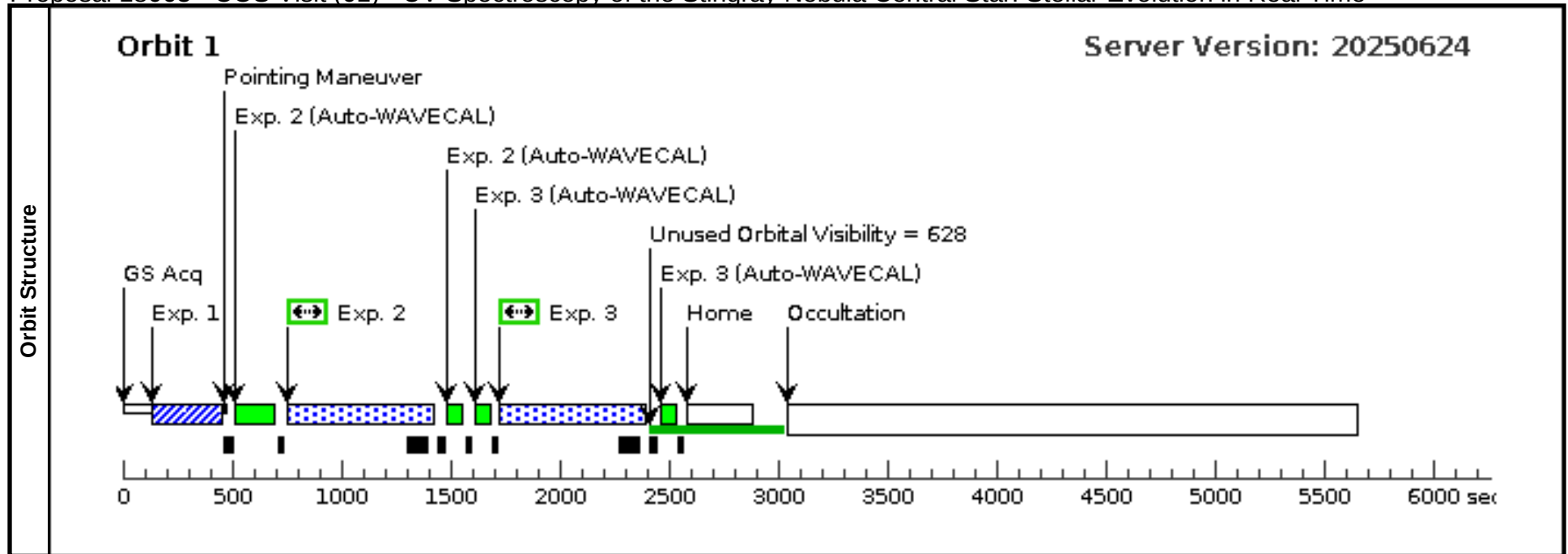
OBSERVING DESCRIPTION

Visit 1: The exposure time is exactly that required to reach $S/N = 27$ at 1310 Å.

Visit 2: The nebula is smaller than the COS aperture, and at longer wavelengths, the nebular emission lines dominate the stellar continuum. So we use STIS and observe through the 52x0.1 aperture, which will minimize the nebular contamination. The exposure time is sufficient to achieve the required $S/N \sim 100$.

Proposal 18063 - COS Visit (01) - UV Spectroscopy of the Stingray Nebula Central Star: Stellar Evolution in Real Time

Visit	Proposal 18063, COS Visit (01), implementation								Thu Oct 16 18:00:15 GMT 2025	
	Diagnostic Status: No Diagnostics									
	Scientific Instruments: COS/FUV, COS/NUV									
	Special Requirements: (none)									
Fixed Targets	#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous				
	(1)	V839-ARA	RA: 17 16 21.0646 (259.0877692d)	Proper Motion RA: 2.610 mas/yr	V=15.4	Reference Frame: ICRS				
		Alt Name1: CD-59-6479	Dec: -59 29 23.52 (-59.48987d)	Proper Motion Dec: -8.338 mas/yr	G=15.35					
		Alt Name2: STINGRAY-NEBULA	Equinox: J2000	Epoch of Position: 2016.0						
				Radial Velocity: 12.6 km/sec						
	Comments: SIMBAD reports V = 10.75, but this includes the nebula. Bobrowsky et al. (1998) estimate that stellar mag is V = 15.4.									
	Category=STAR									
	Description=[BE, PLANETARY NEBULA CENTRAL STAR, POST-AGB STAR]									
	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/IMAG E (COS.ta.214 5953)	(1) V839-ARA	COS/NUV, ACQ/IMAGE, PSA	MIRRORB				5 Secs (5 Secs)	
									[==>]	[1]
	Comments: S/N calculation is based on the STIS G230L spectrum from program 7653, which was obtained in 1999.									
	The ETC recommends an exposure time of 1.1 seconds to achieve S/N = 20 through the PSA, but the nebular emission raises the background, so we increase the exposure time to 5 seconds. (Note that requesting S/N = 40 yields an exposure time of 4.5 seconds, so this exposure time is not unreasonable.)									
	The ETC returns a warning about "Partial overlap between instrument throughput band and target spectrum." Using a model scaled to match the COS spectrum at 2000 A yields the same exposure time.									
	2	G130M/129 0 (COS.sp.202 3471)	(1) V839-ARA	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=51 1; FP-POS=3			621 Secs (621 Secs)	
									[==>]	[1]
	Comments: Exposure time of 1242 seconds chosen to achieve S/N = 27 (per resolution element) at 1310 A. S/N calculation is based on the COS G130M/1222 spectrum from program 13708, which was obtained in 2015.									
	3	G130M/129 0 (COS.sp.202 3471)	(1) V839-ARA	COS/FUV, TIME-TAG, PSA	G130M 1291 A	BUFFER-TIME=51 1; FP-POS=4			621 Secs (621 Secs)	
								[==>]	[1]	
Comments: Exposure time of 1242 seconds chosen to achieve S/N = 27 (per resolution element) at 1310 A. S/N calculation is based on the COS G130M/1222 spectrum from program 13708, which was obtained in 2015.										



Proposal 18063 - STIS Visit (02) - UV Spectroscopy of the Stingray Nebula Central Star: Stellar Evolution in Real Time

Visit	Proposal 18063, STIS Visit (02), implementation										Thu Oct 16 18:00:15 GMT 2025	
	Diagnostic Status: No Diagnostics											
	Scientific Instruments: STIS/NUV-MAMA, STIS/CCD											
	Special Requirements: (none)											
Fixed Targets	#	Name	Target Coordinates		Targ. Coord. Corrections		Fluxes		Miscellaneous			
	(1)	V839-ARA	RA: 17 16 21.0646 (259.0877692d)		Proper Motion RA: 2.610 mas/yr		V=15.4		Reference Frame: ICRS			
		Alt Name1: CD-59-6479	Dec: -59 29 23.52 (-59.48987d)		Proper Motion Dec: -8.338 mas/yr		G=15.35					
		Alt Name2: STINGRAY-NEBULA	Equinox: J2000		Epoch of Position: 2016.0							
	Radial Velocity: 12.6 km/sec											
	Comments: SIMBAD reports V = 10.75, but this includes the nebula. Bobrowsky et al. (1998) estimate that stellar mag is V = 15.4.											
	Category=STAR											
	Description=[BE, PLANETARY NEBULA CENTRAL STAR, POST-AGB STAR]											
	Extended=NO											
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit	
	1	IMAGE/AC Q (STIS.ta.214 3379)	(1) V839-ARA	STIS/CCD, ACQ, 50CCD	MIRROR				1 Secs (1 Secs)			
									[==>]		[1]	
	Comments: S/N calculation based on Castelli & Kurucz model with Teff = 45,000 K, E(B-V) = 0.18, V = 15.6. Time required for S/N=40 is 0.22 sec, and time for saturation is 24.5 sec. Given that the target has some surrounding nebulosity, we use exp time of 1 sec to be safe.											
	2	G230L (STIS.sp.20 25019)	(1) V839-ARA	STIS/NUV-MAMA, TIME-TAG, 52X0.1	G230L 2376 A	BUFFER-TIME=48 8;				2224 Secs (2224 Secs)		
						WAVECAL=NO				[==>]		[1]
	Comments: S/N calculation based on the STIS 52X0.05 G230L spectrum from program 7653, which was obtained in 1999.											
	3	WAVECAL WAVE		STIS/NUV-MAMA, ACCUM, 52X0.1	G230L 2376 A				[==>]		[1]	
	Comments: Moved WAVECAL to the end to maximize on-target exposure time.											
Orbit Structure	Orbit 1 Server Version: 20250624											