17753 - Binarity and Accretion Processes in AGB Stars: A UV Study of pi1 Gru

Cycle: 32, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*
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Dr. Alex De Koter (CoI) (ESA Member)	Universiteit van Amsterdam

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) PI.01-GRU	COS/FUV COS/NUV	2	10-Sep-2025 13:00:39.0	yes
02	(1) PI.01-GRU	COS/FUV COS/NUV	2	10-Sep-2025 13:00:40.0	yes

4 Total Orbits Used

ABSTRACT

The dramatic changes in the geometry and dynamics of the mass-ejection during the death throes of most stars that evolve in a Hubble time (i.e., with initial masses ~1-8 Msun), are widely believed to be due to binarity-induced formation of bound disks that power high-speed collimated jets. But observational evidence of this process are lacking. We propose to obtain multi-epoch UV spectra of the nearby (160 pc) late-spectral-type AGB star, pi1 Gru, that belongs to a newly-discovered class of AGB stars showing strong (and often variable) FUV fluxes -- suggestive of variable accretion of matter onto an accretion disk in a binary system. A STIS spectroscopic study of the prototype of this class, Y Gem, showing the presence of

flickering and high-velocity infall and outflows, supports this hypothesis. ALMA observations of pi1 Gru reveal strong departures from spherical symmetery in its dusty molecular wind (spiral structure, fast polar bubbles) and the presence of a close companion at ~6 AU, confirmed by optical imaging using SPHERE/ZIMPOL.

We will use the UV spectra of pi1 Gru to fit the UV continuum and derive the temperature and size of the accretion hot-spot. Using CLOUDY modelling, we will fit the emission lines to provide constraints on the physical parameters of the accreting flow. The line profiles, if resolved, will reveal the nature of the companion star. Our study will probe the early formation phase of bound disks in binary AGB stars, and provide valuable insights into the binary-induced accretion processes that make such disks, which have long been theorized to drive collimated outflows that produce aspherical morphologies in post-AGB objects.

OBSERVING DESCRIPTION

We will obtain multi-epoch UV spectra of pi1 Gru with COS using the G140L (center=1280 A) and G230L (center=2950 & 3360 A) gratings in TIME-TAG mode. The average GALEX
FUV (NUV) flux of pi1 Gru is 277(2680) uy. For this source, using COS ETC, we find:

FUV: Using the G140L grating, with Cen.Wave. setting lambda=1280 A(B[916-1195], A[1282-2148]) (spectral resolution R ~ 2000 - 5000), we will get a signal-to-noise ratio, S/N, of ~10 for the continuum with an exposure time of 12 min.

NUV: Using the G230L grating with two Cen.Wave settings: (i) setting lambda=3360 A (A[2060-2457], B[3162 -3560] and (ii) setting lambda=2950 A (A[1651-2049], A[2751 3150]) (R ~1550 -2900), we get an S/N of ~10 for the continuum with an exposure time of ~1.1 min. As seen from the study of Y Gem (Setal18), the S/N for the lines will be much higher than for the continuum.

The above selection of gratings and setting has been made in order to provide nearly fullwavelength coverage at lambda > 916 A in the FUV and NUV (for lambda < 3200 A) bands (since the G230L NUVB spectrum is expected to have negligible second-order contamination shortward of 3200 A.) There will be a ~300 A gap (between 2460 A and 2750 A) in the NUV spectra that we obtain, but it does not impact our ability to reach the science goals of our study. Stripe C of the COS/ MAMA detector may provide potentially useful data over wavelength bands 1900-2100 A for Cen.Wave.=2950 A and 2164 - 2361 A for Cen.Wave.=3360, with about 5% contamination from the first order spectra (ISR COS 2010-01), but these are not
critical for our proposed study.

Visit

Proposal 17753, Visit 01, implementation Wed Sep 10 17:00:40 GMT 2025

Diagnostic Status: No Diagnostics

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: (none)

Fixed Targets

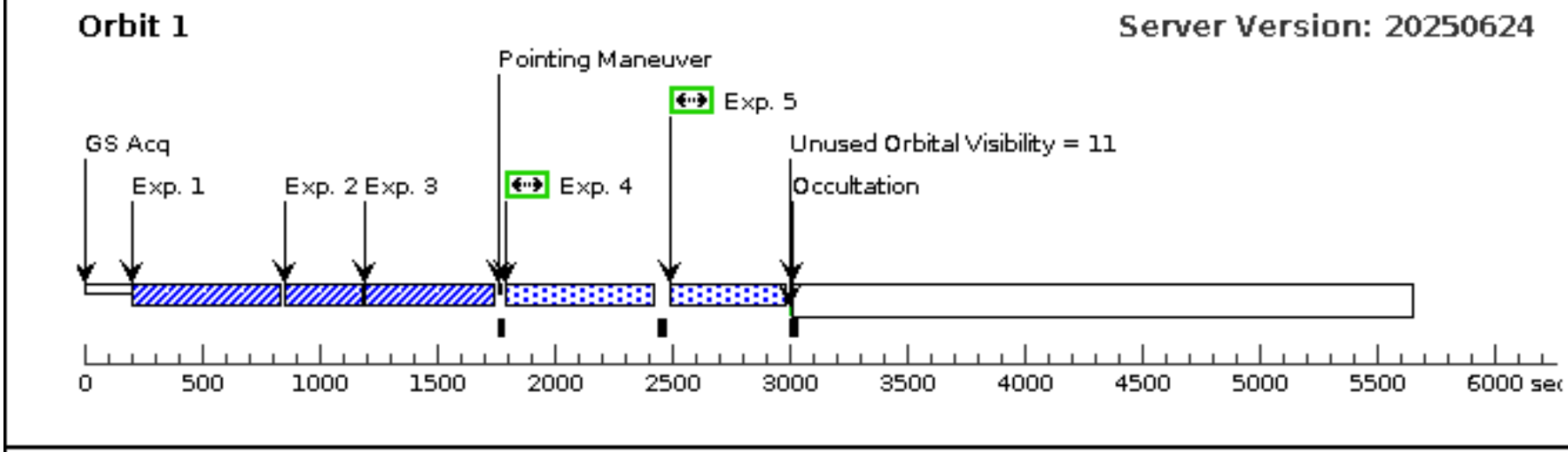
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	PI.01-GRU	RA: 22 22 44.2084 (335.6842017d) Dec: -45 56 52.79 (-45.94800d) Equinox: J2000	Proper Motion RA: 31.106 mas/yr Proper Motion Dec: -10.338 mas/yr Epoch of Position: 2000	V=6.55	Reference Frame: ICRS

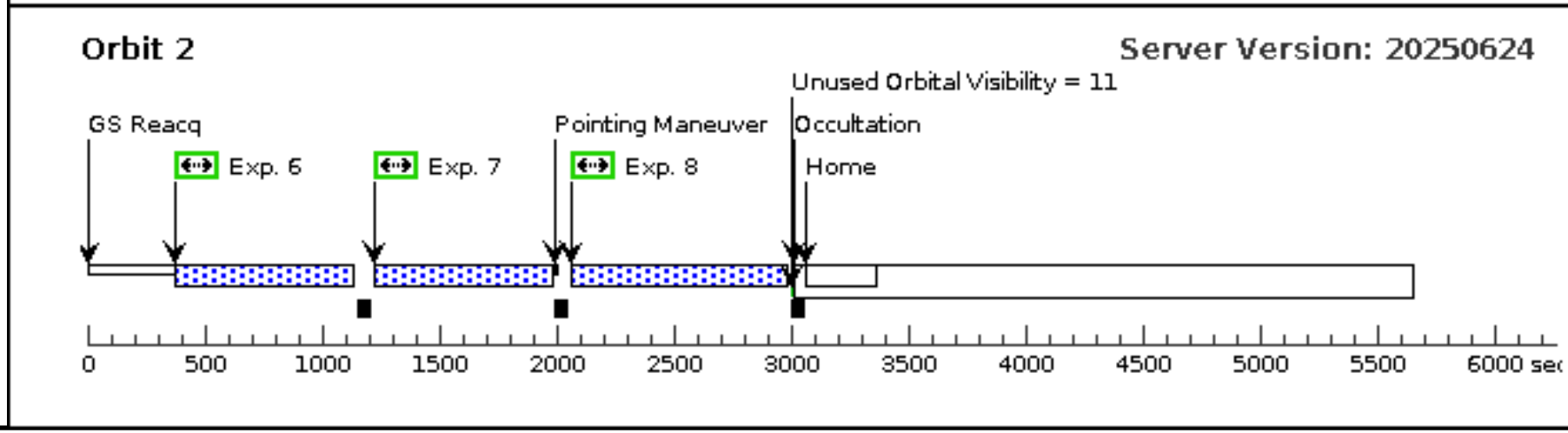
Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=STAR
Description=[ACCRETION DISK, AGB STAR, CIRCUMSTELLAR MATTER, S STAR]
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(1932177)	(1) PI.01-GRU	COS/FUV, ACQ/SEARCH, PSA	G140L 1105 A	STEP-SIZE=1.0; SCAN-SIZE=2; CENTER=DEF			80 Secs (80 Secs) *[==>]*	 ***[1]***
2	(1932177)	(1) PI.01-GRU	COS/FUV, ACQ/PEAKXD, PSA	G140L 1105 A				80 Secs (80 Secs) *[==>]*	 ***[1]***
3	(1932177)	(1) PI.01-GRU	COS/FUV, ACQ/PEAKD, PSA	G140L 1105 A	NUM-POS=5; STEP-SIZE=0.9; CENTER=FLUX-WT-FLR			80 Secs (80 Secs) *[==>]*	 ***[1]***
4	(1932180)	(1) PI.01-GRU	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=2000; FP-POS=1			440 Secs (440 Secs) *[==>]*	 ***[1]***
5	(1932180)	(1) PI.01-GRU	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=2000; FP-POS=2			440 Secs (440 Secs) *[==>]*	 ***[1]***
6	(1932180)	(1) PI.01-GRU	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=2000; FP-POS=3			710 Secs (710 Secs) *[==>]*	 ***[2]***
7	(1932180)	(1) PI.01-GRU	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=2000; FP-POS=4			710 Secs (710 Secs) *[==>]*	 ***[2]***
8	(1932186)	(1) PI.01-GRU	COS/NUV, TIME-TAG, PSA	G230L 2635 A	BUFFER-TIME=2000; FP-POS=1			680 Secs (680 Secs) *[==>]*	 ***[2]***

Orbit Structure





Visit

Proposal 17753, Visit 02, implementation Wed Sep 10 17:00:40 GMT 2025

Diagnostic Status: Warning

Scientific Instruments: COS/FUV, COS/NUV

Special Requirements: AFTER_01 BY 300 D TO 370 D

Diagnostics

(Visit 02) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

(Visit 02) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	PI.01-GRU	RA: 22 22 44.2084 (335.6842017d)	Proper Motion RA: 31.106 mas/yr	V=6.55	Reference Frame: ICRS
		Dec: -45 56 52.79 (-45.94800d)	Proper Motion Dec: -10.338 mas/yr		
		Equinox: J2000	Epoch of Position: 2000		

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Category=STAR
Description=[ACCRETION DISK, AGB STAR, CIRCUMSTELLAR MATTER, S 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	(1932177)	(1) PI.01-GRU	COS/FUV, ACQ/SEARCH, PSA	G140L 1105 A	STEP-SIZE=1.0; SCAN-SIZE=2; CENTER=DEF			80 Secs (80 Secs) *[==>]*	*[1]*
2	(1932177)	(1) PI.01-GRU	COS/FUV, ACQ/PEAKXD, PSA	G140L 1105 A				80 Secs (80 Secs) *[==>]*	*[1]*
3	(1932177)	(1) PI.01-GRU	COS/FUV, ACQ/PEAKD, PSA	G140L 1105 A	NUM-POS=5; STEP-SIZE=0.9; CENTER=FLUX-WT-FLR			80 Secs (80 Secs) *[==>]*	*[1]*
4	(1932180)	(1) PI.01-GRU	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=2000; FP-POS=1			494 Secs (494 Secs) *[==>]*	*[1]*
5	(1932180)	(1) PI.01-GRU	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=2000; FP-POS=2			507 Secs (507 Secs) *[==>]*	*[1]*
6	(1932180)	(1) PI.01-GRU	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=2000; FP-POS=3			750 Secs (750 Secs) *[==>]*	*[2]*
7	(1932180)	(1) PI.01-GRU	COS/FUV, TIME-TAG, PSA	G140L 1105 A	BUFFER-TIME=2000; FP-POS=4			750 Secs (750 Secs) *[==>]*	*[2]*
8	(1932186)	(1) PI.01-GRU	COS/NUV, TIME-TAG, PSA	G230L 2635 A	BUFFER-TIME=2000; FP-POS=1			662 Secs (662 Secs) *[==>]*	*[2]*

Orbit Structure