18078 - Constraining variability of white dwarf planetary debris accretion

Cycle: 33, Proposal Category: GO

(UV Initiative)

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) V-ZZ-PSC	COS/FUV	2	15-Aug-2025 14:01:13.0	yes

2 Total Orbits Used

ABSTRACT

White dwarfs accreting the remnants of evolved planetary systems have recently been confirmed as a new class of X-ray source using Chandra. This is the first direct evidence that these degenerate stars are actively accreting the remains of the planetary systems that orbit them. Metals from accreted planetary remnants have been identified in thousands of white dwarfs but inferring accretion rates and parent body compositions depends on accurate

white dwarf atmospheric models. The inferred accretion rate is always averaged over the diffusion timescale which can range from days to millions of years. This hampers any search for variability in the accretion rate. The discovery of X-rays produced from the accretion of planetary debris provides the first independent measurement of the accretion rate of these systems, enabling a measurement of the instantaneous accretion rate. We propose to exploit HST to search for long-term variations in the inferred accretion rate of the only system with a measured X-ray accretion rate detected to date, G29-38. This object is one of the closest metal-polluted white dwarfs, has a diffusion timescale of approximately one year and ongoing X-ray monitoring, which makes it the stand-out target for this study.

OBSERVING DESCRIPTION

We propose multi-cycle observations (2 orbits in each of the next 3 cycles) with COS to search for variability in the metal absorption (and emission) lines as a proxy for accretion rate. The COS observations will be obtained using the G130M grating centered at 1300\,\AA, providing a wavelength coverage 1140--1440\,\AA, an identical setup to the existing sets of COS observations, in order to allow the best chance to detect photospheric abundance variations of Si, C, Fe, and O.

From the publicly available 2010 and 2021 COS observations, we measured a Si abundance of $\mathrm{[Si/H]}$=-5.32 ± 0.1 and -5.50 ± 0.1, respectively, and a C abundance of $\mathrm{[C/H]}$=-6.71 ± 0.1 and -6.52 ± 0.1, respectively.
In order to interpret the Chandra observations, contemporaneous COS observations are essential to establish the photospheric abundance baseline.

Combined with the two archival epochs, our observations will provide three additional epochs which will be sufficient to probe variations on yearly timescales.
The proposed multi-epoch observations will ensure a S/N\,$>$\,30.

This will yield a 10\% precision on Si and C abundances,
allowing to compare against the independent measurement of accretion rate provided by X-ray (\textit{Chandra}) observations. As the pulsation periods of G29-38 span $\simeq$110--1240\,s, every HST orbit will cover at least two cycles of all the excited pulsation modes. We therefore request two orbits per cycle in order to average over four of the longest pulsation periods.

The high S/N of the proposed observations of G29-38 will provide accurate, multi-epoch abundances of C, O, Si, and Fe, and be sensitive to S, P, Al, Cr, Mn, and Ni. An inferred accretion rate at each epoch will be computed by coupling these measured abundances to state-of-the-art WD atmosphere models of metal diffusion \cite{cunningham19,koester2020}. The detailed time-dependent knowledge of the atomic composition of the

debris disk at G29-38 will be a critical input for the mineralogical modeling of the JWST NIRSpec+MIRI spectroscopy of the dust that will be obtained in the Cycle 4 program.

Visit

Proposal 18078, Visit 01 Fri Aug 15 18:01:14 GMT 2025

Diagnostic Status: Warning

Scientific Instruments: COS/FUV

Special Requirements: (none)

Diagnostics

(Visit 01) Warning (Orbit Planner): COS EXPOSURE TIME ROUNDED DOWN TO NEAREST 0.1 SECONDS

(Visit 01) Warning (Orbit Planner): COS EXPOSURE TIME ROUNDED DOWN TO NEAREST 0.1 SECONDS

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	V-ZZ-PSC	RA: 23 28 47.2099 (352.1967079d) Dec: +05 14 49.97 (5.24721d) Equinox: J2000	Proper Motion RA: -398.246 mas/yr Proper Motion Dec: -266.744 mas/yr Epoch of Position: 2016.0	V=13.062395	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.

All values re-entered from SIMBAD for the 2016 epoch, and double-checked in the ESA Gaia Archive.
Category=STAR
Description=[DA, ZZ CETI 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	(COS.sa.2025411)	(1) V-ZZ-PSC	COS/FUV, ACQ/PEAKXD, PSA	G130M 1291 A				5.3 Secs (5.3 Secs) *[==>]*	*[1]*
2	(COS.sa.2025411)	(1) V-ZZ-PSC	COS/FUV, ACQ/PEAKD, PSA	G130M 1291 A	NUM-POS=5.0; STEP-SIZE=0.9; CENTER=FLUX-WT-FLR			5.3 Secs (5.3 Secs) *[==>]*	*[1]*
3	(COS.sa.2025418)	(1) V-ZZ-PSC	COS/FUV, TIME-TAG, PSA	G130M 1291 A	FP-POS=3; BUFFER-TIME=800			2059.0 Secs (2059 Secs) *[==>]*	*[1]*
4	(COS.sa.2025418)	(1) V-ZZ-PSC	COS/FUV, TIME-TAG, PSA	G130M 1291 A	FP-POS=4; BUFFER-TIME=800			2537.0 Secs (2537 Secs) *[==>]*	*[2]*

Orbit Structure