



Radio Emission from AM CVns in the Context of Compact White Dwarf Binaries

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1) Motivation

- AM CVns are ultra-compact white dwarf binaries (WDBs) with He-rich accretion.
- To-date, there are no definitive radio detections of AM CVns; Only one radio detection of an AM CVn system (HM Cnc, Ramsay+2007) has been claimed to-date and we revisit it in this work.
- There are other classes of WDBs which show radio emission and their radio emission mechanism is not understood yet: i) cataclysmic variables (CVs), ii) white dwarf pulsars (WDPs) and iii) some long period radio transients (LPTs).
- CVs have been shown to be significant radio emitters and recent interest in radio emission from WD binaries has been fuelled by the increase in radio detections of LPTs and WDPs. CVs have a WD accretor and unlike AM CVns, host a low-mass non-degenerate main sequence donor; WDPs host a rapidly spinning WD and a low-mass M-dwarf, emitting pulsed radio emission; LPTs produce periodic and highly polarized radio pulses. At least three LPTs host WDs.
- In CVs, jets and/or reconnection events in the accretion disk may explain synchrotron emission. Coherent non-thermal radiation in CVs could be due to electron-cyclotron emission, plasma emission, ECME or gyrosynchrotron emission. However, the exact mechanism(s) for the emission(s) is unconfirmed.
- Radio observations of AM CVns can constrain emission mechanisms in WDBs.

For the first time ever, we perform a population study in radio wavelengths of all known AM CVns, comparing this to survey and literature searches of radio-detected CVs. We compare AM CVn upper limits and radio-detected CVs to LPTs and WDPs.

2) Synopsis of Results

- AM CVn pop. specific radio luminosity (R_{lum}) constrained: $\leq 1.3 \times 10^{18}$ erg/s/Hz.
- Deepest targeted AM CVn R_{lum} upper limit obtained: $\leq 9.0 \times 10^{14}$ erg/s/Hz.
- LPT-like and WDP-like luminosities in AM CVns ruled out.
- No statistically significant difference in R_{lum} between CV subclasses.
- AM CVns likely radio-fainter and/or quieter than CVs.
- HM Cnc's 2005 literature detection re-reduced and reclassified as upper limit.

3) Targets & Methods

Observation	Target	Data Processing Methodology
Targeted	AM CVn	Observed with the VLA, centred at 6 GHz. Data reduction with VLA pipeline in CASA 6.5.4.
	HP Lib	Neither system detected.
Targeted	ASASSN-14mv	Observed with MeerKAT, centred at 1.3 GHz, as part of ThunderKAT. Data reduction with OXCAT.
	HP Lib	Neither system detected.
Targeted	HM Cnc	Observed with the VLA. Observations from 2005 (Ramsay+2007) re-reduced and re-imaged with AIPS and ParselTongue. We can neither confirm nor refute the 2005 Observations from 2010/11 reduced in CASA 5.3.0, non-detection.
Survey	AM CVns ¹ (98)	Survey data image cut-outs obtained from LOFAR LoTTS-DR2, RACS-low DR1 and VLASS.
	CVs ² (54)	Fluxes fitted with PyBDSF.

^{1,2} Selection cuts were placed to create a gold sample, which only includes systems with Gaia DR3 distance fractional error < 0.1 and photometric flux fractional error < 0.3.

4) Results

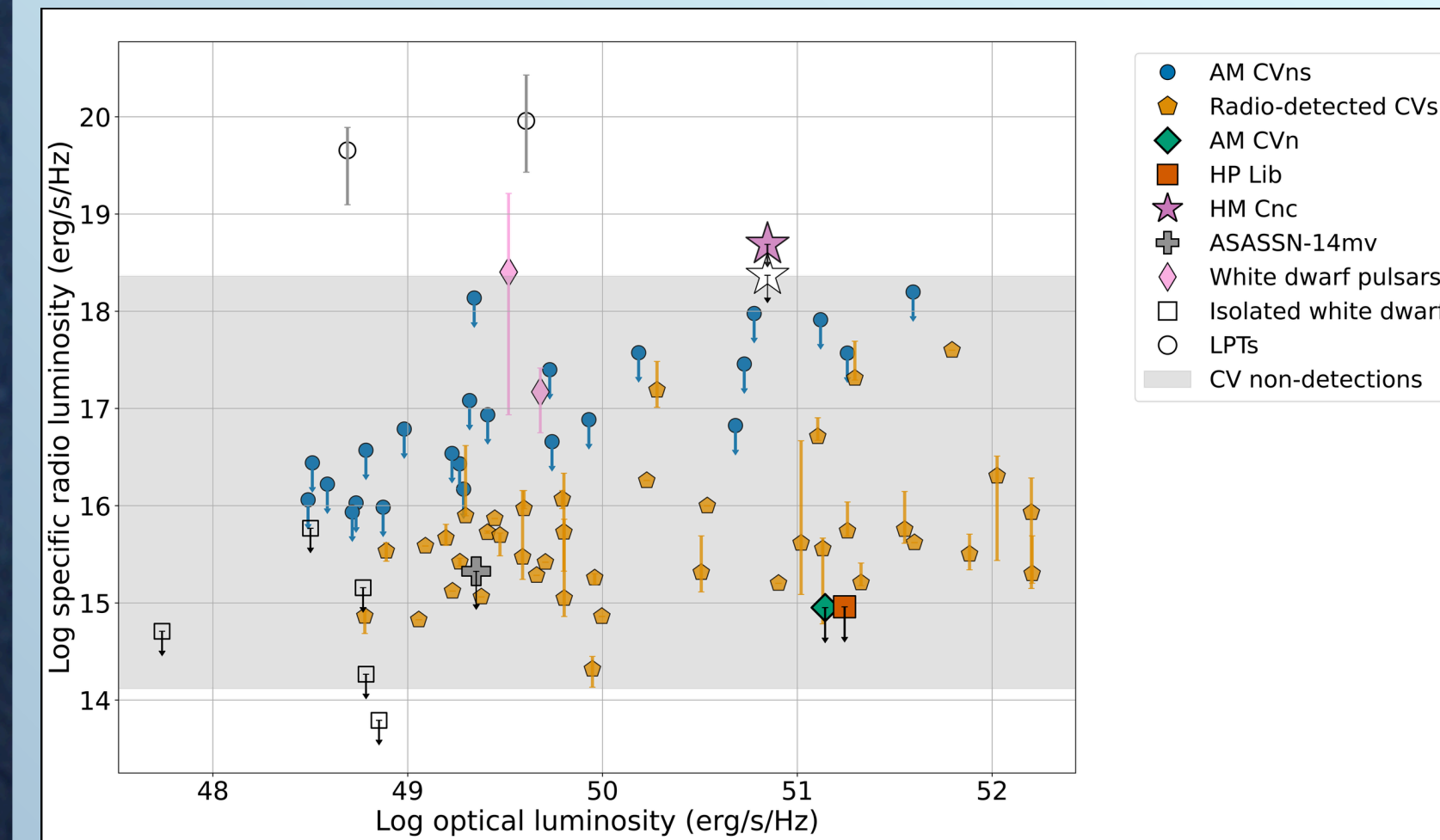


Figure 1: Specific radio luminosity plotted against Gaia DR3 BP optical luminosities. The pink star for HM Cnc is our luminosity from the re-reduction of the 2005 observation of HM Cnc reported as a detection by Ramsay+2007, and the white star is from the 2010/11 observations. The bars indicate the range in which the system has radio detections.

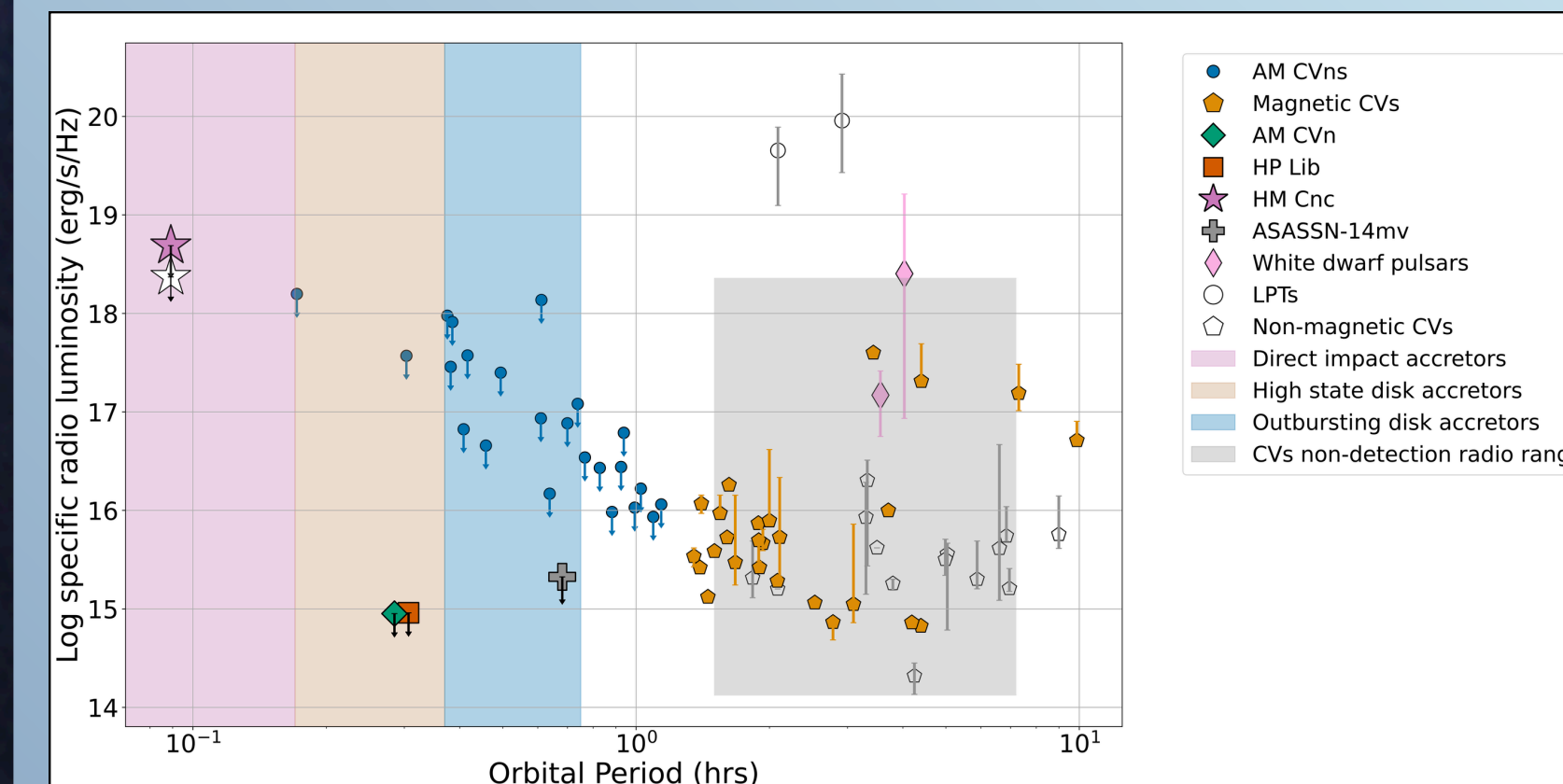


Figure 2: Specific radio luminosity plotted against orbital period. See Figure 1 caption for distinguishing HM Cnc points.

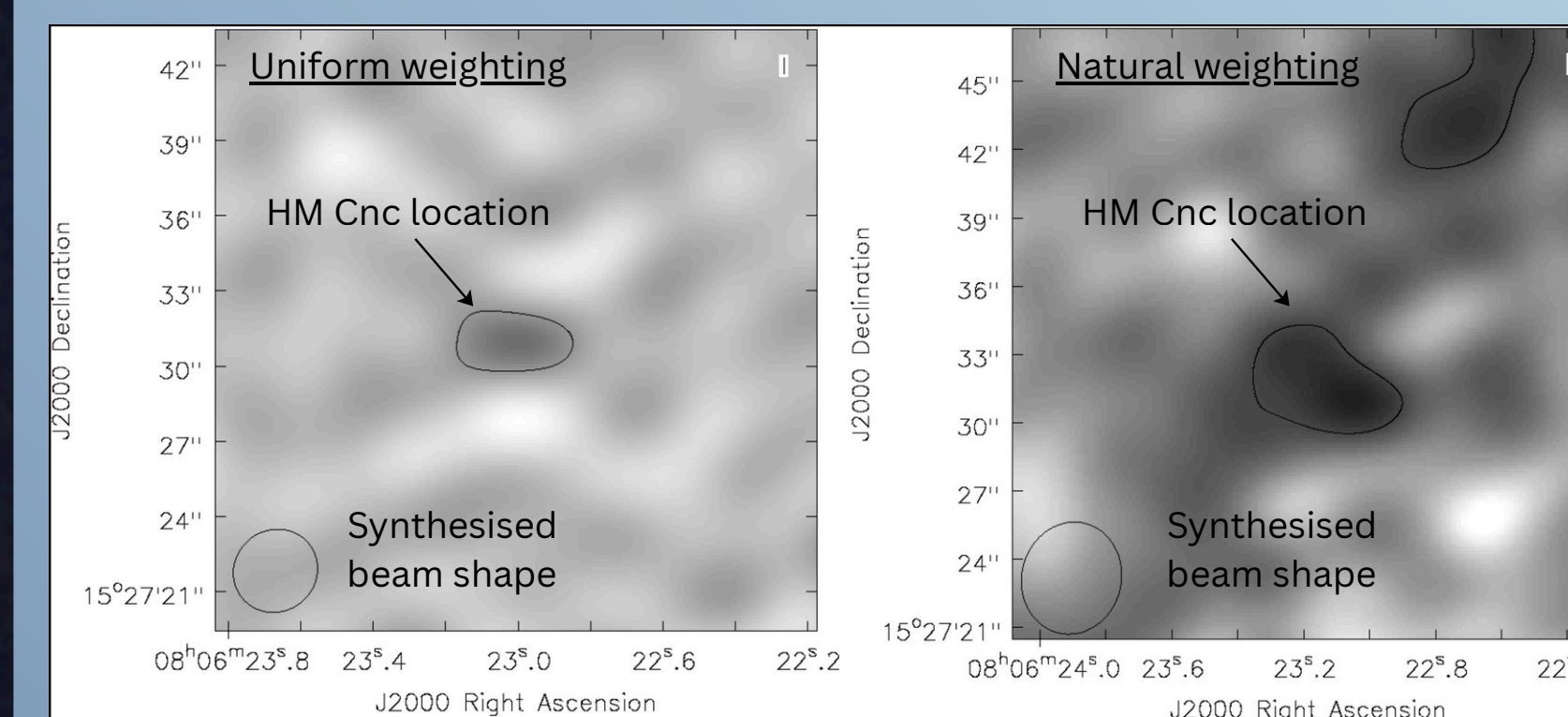


Figure 3: Contour plots for HM Cnc from our re-reduction of the 2005 detection reported by Ramsay et al. (2007). Contour lines are at the 3σ level. The contours for the target, HM Cnc, do not match the shape of the synthesised beam, as would have been expected for a WDB if the emission had been point-like.

This work is from Sahu et al. in prep.

5) Analysis, Discussion and Conclusions

5.1 Radio Luminosity of the AM CVn Population

- Conservative population upper limit: $\leq 1.3 \times 10^{18}$ erg/s/Hz.
- Targeted observations, deepest specific radio luminosity upper limit: $\leq 9.0 \times 10^{14}$ erg/s/Hz corresponding to AM CVn itself, VLA, 6 GHz.

Since we detect no radio emission from AM CVns, we cannot test whether there exist any differences in specific radio luminosity between different classes of AM CVns.

5.2 HM Cnc

Upon re-reducing the 2005 detection of HM Cnc reported by Ramsay+2007, we found a consistent flux density, however the source was spatially extended. As this is inconsistent with radio emission from a WDB at this distance, there is contamination with a noise peak. We cannot confirm nor refute their detection.

We instead place an upper-limit on the flux density of 1.3×10^{18} erg/s/Hz.

5.3 What does this mean for AM CVns' radio behaviour?

Since we cannot confirm nor refute the detection of HM Cnc, we are unable to determine if AM CVns show variable or flaring radio emission. If AM CVns do exhibit flaring behaviour in radio wavelengths, their duty cycle must be lower than CVs based on our non-detections. If so, we require much longer observations of a larger sample of AM CVns to constrain their flare duty cycle (fraction of time in the 'high' state).

5.4 AM CVns and CVs

Comparing R_{lum} of AM CVn upper limits and CV detections with MC trials, we find that we should have detected 16% of AM CVns if they have comparable luminosities (4 out of 29 gold sample AM CVns). We posit that if the emission mechanism in CVs and AM CVns is the same, then AM CVns are likely to have fainter luminosities. If not, they may have different mechanisms. Assuming AM CVns are variable, our observations may have missed radio flares. Moreover, all targeted AM CVn limits are fainter than nova-like CVs which are physical analogues to AM CVns i.e. non-magnetic, high state disk.

5.5 AM CVns, CVs, LPTs and WDPs

The deepest R_{lum} limit for AM CVns rules out WDP-like luminosities. If AM CVns show flaring behaviour, their flare luminosities are lower than WDPs or their flare duty cycles are significantly lower than WDPs. The two WD-hosting LPTs have R_{lum} over 5σ away from that of the median R_{lum} of CVs. This suggests that LPTs with WDs have radio mechanisms different to those in radio-active CVs or else less efficient. AM CVns are unlikely to have LPT-like R_{lum} values as the two WD-hosting LPTs have R_{lum} over 10^4 times larger than the deepest AM CVn upper limit.

5.6 CV Subclasses: KS Test and MC Simulations with Anderson-Darling (AD) Test

Set 1	Set 1 size	Set 2	Set 2 size	KS p-value	AD p-value
Magnetic	26	Non-mag	14	0.50	> 0.05
> P_{gap}	19	< P_{gap}	17	0.45	> 0.05
Non-Mag > P_{gap}	12	Non-mag < P_{gap}	2	0.33	-
Mag > P_{gap}	7	Mag < P_{gap}	15	0.06	0.018*

Done to investigate how magnetic fields and donor substructure affect R_{lum} .

No significant difference found. We argue mass accretion rate does not impact R_{lum} ; there is no statistically significant difference in R_{lum} above or below P_{gap} despite mass transfer rates in CVs above and below P_{gap} being different due to the donor structure.

* $p < 0.05$ can reject H_0 but more observations of Mag > P_{gap} needed to verify this.

[1] Green M. J., et al., 2025, A&A, 700, A107

[3] Coppejans D. L., et al., 2020, New Astron. Rev., 89, 101540

[2] Ramsay G., et al., 2007, MNRAS, 382, 461

[4] Kersten J., et al., 2025, MNRAS, 539, 1894

For a complete list of references, please scan the QR code on the right.

