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Magnetic Fields in Interacting Binaries

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Abstract. Wickramasinghe et al. (2014) and Briggs et al. (2015) have proposed that the strong magnetic fields observed in some single white dwarfs (MWDs) are formed by an α–Ω dynamo driven by differential rotation when two stars, the more massive one with a degenerate core, merge during common envelope (CE) evolution (Ferrario et al., 2015b). We synthesise a population of binaries to investigate if fields in the magnetic cataclysmic variables (MCVs) may also originate during stellar interaction in the CE phase.

Key words: magnetic field – white dwarfs – binaries: general – novae, cataclysmic variables

1. Methods and Discussion

In the MCVs, a red dwarf transfers matter to a MWD via magnetically confined accretion flows. Cyclotron and Zeeman spectroscopy have revealed fields of a few 10^7–10^8 G (Ferrario et al., 1992, 1993a, 1996) in the high field MCVs (the polars; Ferrario & Wehrse, 1999). Fields of a few 10^6–10^7 G are inferred in the intermediate polars (Ferrario & Wickramasinghe, 1993; Ferrario et al., 1993b).

We have synthesised a population of binaries with the BSE code of Hurley et al. (2002) for a CE efficiency parameter α in the range 0.1–0.9. We have assumed that the field B, achieved by the WD during CE evolution, is proportional to the orbital angular velocity Ω of the binary when the envelope gets ejected. If 10^{13} G is the highest field that can be stably generated in a WD then

$$B = \gamma 10^{13} \left(\frac{\Omega}{\Omega_{\rm crit}}\right) \mathrm{G}. \tag{1}$$

where $\Omega_{\rm crit}$ is the break-up angular velocity of the WD and γ is a parameter that determines the efficiency with which the poloidal field is regenerated by the decaying toroidal field. The best fit to observations requires $\gamma \sim 10^{-3}$.

We find that if $\alpha < 0.4$ we can produce binaries emerging from the CE that are close to contact, in agreement with Schwope et al. (2009) who proposed that those detached magnetic binaries where the MWD accretes matter from the wind of its companion are the progenitors of the MCVs. The theoretical and observed field and mass distributions are overlapped and shown in Fig. 1.

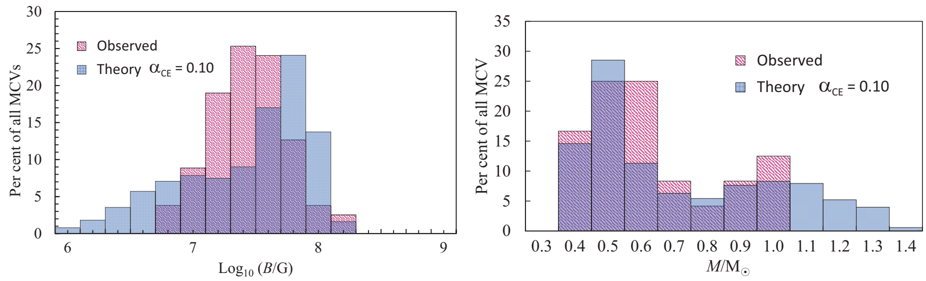

Figure 1. *Left*: Comparison of the theoretical field strength for $\alpha = 0.1$ and observations from Ferrario et al. (2015a). *Right*: Comparison of the theoretical mass distributions to observations from Zorotovic et al. (2011).

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