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Population Synthesis of Post-Common Envelope White-Dwarf-Main-Sequence Binaries in the Sloan Digital Sky Survey

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Abstract. We present preliminary results of detailed Monte Carlo simulations of the population of white dwarf-main sequence binary systems in the Sloan Digital Sky Survey Data Release 7 (SDSS DR7). We have used the most up-to-date stellar evolutionary models, a complete treatment of the Roche lobe overflow episode, as well as a full implementation of the orbital evolution of the binary system. Moreover, we included the different selection criteria and observational biases within SDSS and examined the role played by the binding energy parameter and by the common envelope efficiency. Our Monte Carlo simulator correctly reproduces the properties of the observed distribution of white dwarf plus main sequence binary systems.

1. The model and results

We have expanded an existing Monte Carlo code (García-Berro et al. 1999, 2004) specifically designed to study the Galactic populations of single white dwarfs to deal with the population of binaries in which one of the components is a white dwarf. The masses of each of the components of the binary system were obtained using a standard initial mass function (Kroupa et al. 1993). Also, a constant star formation rate and a disc age of 10 Gyr were adopted. In addition, orbital separations were randomly drawn according to a logarithmic probability distribution (Nelemans et al. 2001). The eccentricities were also randomly drawn according to a thermal distribution (Heggie 1975). For each of the components of the binary system analytical fits to detailed stellar evolutionary tracks were used (Hurley et al. 2000). We also used a detailed prescription for evolution during the common envelope (de Kool 1990), and up-to-date white dwarf cooling tracks (Renedo et al. 2010). Tidal effects and wind mass-loss were also considered. Angular momentum losses due to to magnetic braking and gravitational radiation were taken into account as well (Schreiber & Gänsicke 2003; Zorotovic et al. 2010).

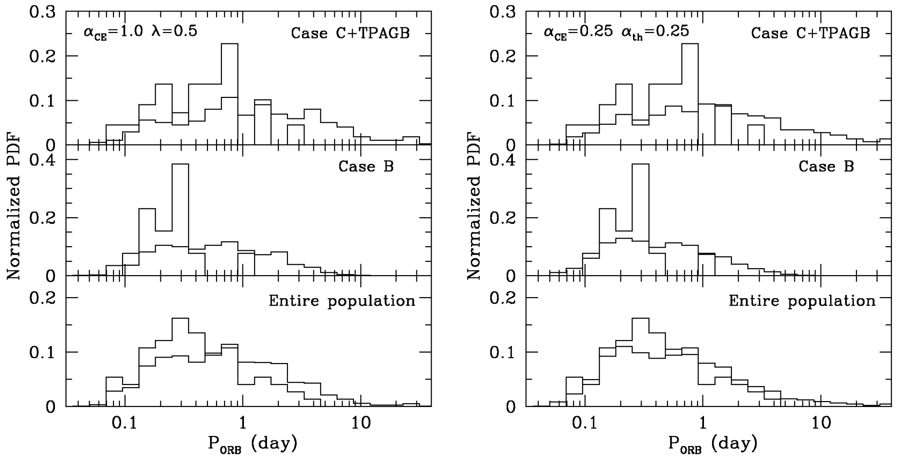

Figure 1. Distribution of present-day WD+MS systems for different simulated models (dark line) compared with the observational distribution (light line). See text for details.

Our synthetic binary systems were distributed in the direction of the SDSS fields according to a double-exponential density law. Also, the number density of our simulations was normalised to that of the local disc (Holmberg & Flynn 2000). Finally, a period filter and colour selection criteria were also applied.

We have studied different prescriptions for $\alpha_{\rm CE}$ and λ. Specifically, for our fiducial simulation we adopted $\alpha_{\rm CE} = 1.0$ and $\lambda = 0.5$ and compared it with $\alpha_{\rm CE} = 0.25$ and a variable λ that depends on the evolutionary stage of the donor at the onset of mass transfer. Figure 1 shows the period histogram of present-day WD+MS systems once cataclysmic variables have been discarded. The top, middle and bottom panels show the distributions for case C and TPAGB, case B, and the entire population, respectively, of the simulated (dark line) and the observational distribution (light line). Our results nicely agree with observations once the corresponding filters are used. Although models with a variable λ are those which best match observations, a more detailed statistical analysis remains to be done.

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