

Monte Carlo simulations of the post-common envelope white dwarf-main sequence binary population

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Abstract. We present a detailed Monte Carlo simulator of the population of binary systems within the solar neighborhood. 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. Preliminary results are presented for the population of white dwarf-main sequence binaries, resulting from a common envelope episode. We also study the role played by the binding energy parameter, λ , and by the common envelope efficiency, α_{CE} . Finally, results are compared with the population of identified white dwarf-main sequence binaries.

Keywords: stars: white dwarfs — stars: binaries — Galaxy: stellar content

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THE MODEL

We have expanded an existing Monte Carlo code [1, 2] 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 [3]. We only considered stars with masses $0.1 M_{\odot} < M < 30 M_{\odot}$. Also, a constant star formation rate and a disk age of 10 Gyr were adopted. In addition, orbital separations were randomly drawn according to a logarithmic probability distribution [4]. The eccentricities were also randomly drawn according to a thermal distribution [5], $f(e) = 2e$ for $0 \leq e \leq 0.9$. For each of the components of the binary system analytical fits to detailed stellar evolutionary tracks were used [6]. We also used a detailed prescription for evolution during the common envelope [7], and up-to-date white dwarf cooling tracks [8]. Tidal effects and wind mass-loss were also considered. Angular momentum losses due to magnetic braking and gravitational radiation were taken into account as well [9, 10]. Our synthetic binary systems were distributed in the direction of the SEGUE fields according to a double-exponential density law with a scale height $H = 250$ pc and scale length $R = 3.5$ kpc. Also, the number density of our simulations was normalized to that of the local disk [11]. Finally, a period filter and color selection criteria were also applied.

RESULTS

We have studied three different prescriptions for α_{CE} and λ . Specifically, we have adopted $\alpha_{\text{CE}} = 1.0$ and $\lambda = 0.5$, $\alpha_{\text{CE}} = 0.25$ and $\lambda = 0.5$, while in a third set of simulations we employed $\alpha_{\text{CE}} = 0.25$ and a variable λ , which depends on the evolutionary stage of the donor at the onset of mass transfer. Figure 1 shows the distribution of present-day WD+MS systems once cataclysmic variables have been discarded. The top panels show the distributions when no filter is applied, whereas the bottom panels show the result of applying the period filter and color selection criteria. In each panel case B binaries are represented using black dots, case C are shown as dark-blue dots and binaries resulting from a TPAGB case are displayed as light-blue dots. The observational data [10] are shown as red triangles. Our results nicely agree with observations once the corresponding filters are used. Although models 2 and 3 are those which best match observations a more detailed statistical analysis remains to be done.

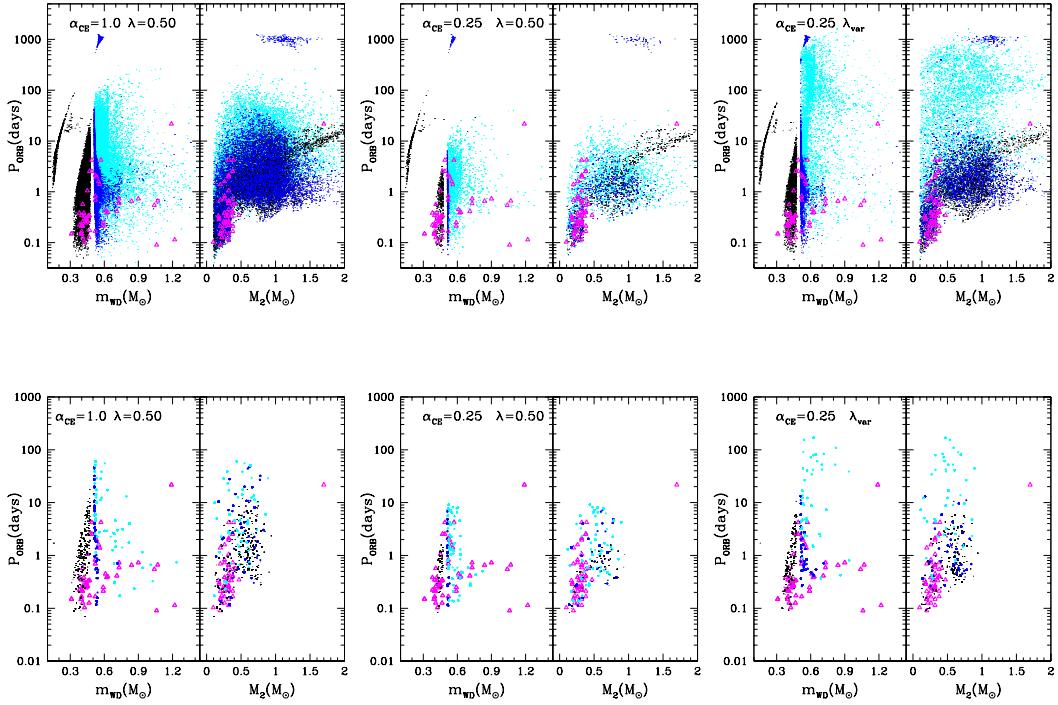


FIGURE 1. Distribution of present-day WD+MS systems for the different models when no filter is applied (top panels) and when the period filter and the color selection criteria are taken into account (bottom panels). See text for details.

CONCLUSIONS

We have presented a Monte Carlo simulator of the population of the post-common envelope white dwarf-main sequence binary population. We have analyzed the effects of the different observational selection criteria in the synthetic population of binary systems and we have also studied the impact of adopting different values of α_{CE} and λ . Our simulations correctly reproduce the observed distributions of periods, white dwarfs and secondary masses. Models with a variable λ best fit the observational distributions for large periods.

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