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Aspects of Mass Transfer in X-ray Binaries

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Summary

The final stage of mass transfer in a compact binary system is very important for calculating the orbital parameters of the resulting system. We demonstrate how simple "bifurcation mechanisms" may lead to the existence of three classes of binary millisecond pulsars and a possible gap in the orbital period distribution. Recent discoveries indicate that such a gap could exist (see Fig. 2).

Furthermore, we demonstrate that the expected theoretical correlation (e.g. Joss et al. 1987, Rappaport et al. 1995) between orbital periods and white dwarf companion masses does not seem to fit observations of wide-orbit low-mass binary pulsars (LMBPs). It is interesting to notice that the five LMBPs with $P_{\rm orb} > 100^{\rm d}$ all have companion masses which are lighter (at the $\sim$80 % confidence level on average) than expected from the theoretical core-mass period relation.
This poster summarizes the results of Tauris (1996).

Table 1. Classes of Binary Pulsars

Class	$P^{\rm f}_{\rm orb}$	$M_{\rm WD}$	$P^{\rm i}_{\rm orb}$	$M_{\rm comp}$	*rel.%*
A1	$< 15.0^{\rm d}$	$< 0.45 M_\odot$	$\lesssim 2.0^{\rm d}$	$< M_{\rm ce}$	53
A2	$< 20.0^{\rm d}$	$> 0.45 M_\odot$	$\gtrsim 1.0^{\rm d}$	$> M_{\rm ce}$	13
B	40-1000$^{\rm d}$	$< 0.45 M_\odot$	$\gtrsim 2.0^{\rm d}$	$< M_{\rm ce}$	34

Columns 2 and 3 contain observable parameters of binary pulsars, whereas the parameters in column 4 and 5 are those of the progenitor systems prior to the X-ray phase. $M_{\rm ce}$ is the critical "bifurcation mass" above which the neutron star will spiral in through the envelope of its companion star. Column 6 gives the relative distribution of the 32 observed binaries.

References

Joss P. C., Rappaport S. A., Lewis W., 1987, ApJ 319, 180
Rappaport et al., 1995, MNRAS 273, 731
Tauris T. M., 1996, A&A submitted

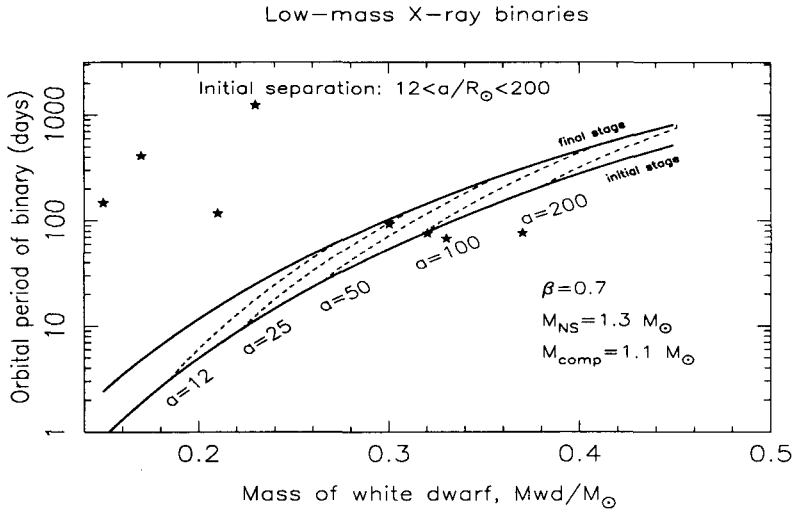

Figure 1. The $(M_{\rm WD},P_{\rm orb})$-relation for low-mass binary pulsars (LMBPs) is plotted as a full line at the end of the evolutionary tracks. The mass of the neutron star is assumed to be $1.3M_\odot$ prior to accretion. For $a < 10R_\odot$ the evolution is determined by loss of orbital angular momentum via a magnetic stellar wind (MSW) and/or gravitational wave radiation (GWR). Also plotted is the eight observed wide-orbit LMBPs assuming an orbital inclination angle of $i = 60°$.

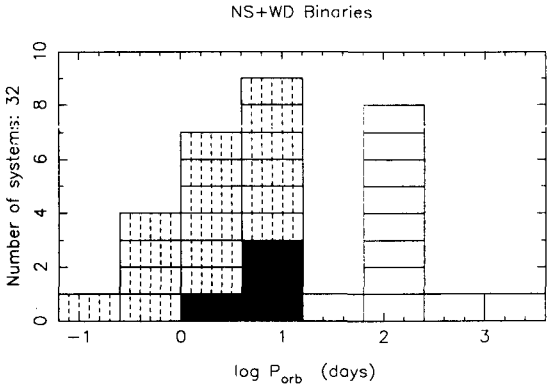

Figure 2. The orbital period distribution of NS+WD binaries. The three different progenitor classes (cf. Table 1) are indicated. Orbital periods and companion masses fit well into our model for all observed systems – cf. Tauris (1996).

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