COMMENTS ON 'THE WHITE DWARF COLLAPSE IN LOW MASS BINARY SYSTEMS'*

(Letter to the Editor)

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White dwarfs have been shown to possess high-angular momenta, in low-mass binary systems, in the context of formation of 'spinars'. Whether the collapse to a neutron star occurs spontaneously or is triggered by mass transfer from the companion, is an unresolved question. Many models of type I SN (Whelan and Iben, 1973) refer to the latter case, where the accreting degenerate dwarf is driven over the Chandrasekhar limit. However, in his recent paper Lipunov (1983) did not consider the formation of a neutron star from a SN explosion in greater detail.

The occurrence of pulsars in binary systems also poses serious evolutionary problems, although the number of known ones is very small (only four, but with a range of orbital periods from a fraction of a day to ~ 1000 days). The deciding factors for the occurrence of a SN event in a binary can be summarised as:

(1) Massive white dwarfs, close to Chandrasekhar limit,
(2) Chemical composition,
(3) Mass transfer rate.

It has been established that massive white dwarfs occur in cataclysmic binaries (CB) in the mass range 0.8 to $1.37 M_\odot$ (Law and Ritter, 1983). Their chemical composition is considered C–O or O–Ne–Mg, rather than He. In case of C–O WD, carbon deflagration disrupts the core with no remnant. Electron capture SN formation is more plausible with a O–Ne–Mg WD and a neutron star being left behind (Nomoto, 1980). Another group of binaries similar to the CBs are the symbiotic binaries, with orbital periods of the order of $\sim 10^2$ days (while it is a few hours for CBs). The typical mass transfer rates in case of both CBs and SBs are 10^{-8} to $10^{-9} M_\odot$ yr^{-1}. The accretion rate for the outer envelope of WD to grow into a red giant size is $1.5 \times 10^{-7} M_\odot$ yr^{-1}.

Based on the computations of Wheeler *et al.* (1975), the effect of explosion on the dynamics of a CB, can be shown to result into a binary of longer orbital period (with a neutron star component). A typical calculation for a system like GK Per (~ 0.6 day) leads to two cases: (1) smaller mass loss, almost circular orbit and period ~ 0.8 day; (2) larger mass loss, eccentric orbit ($e \simeq 0.9$) and period ~ 100 days. A SB-like TX CVn (70.6 days) results in an orbit of ~ 100 days with a small eccentricity.

* Paper by V. M. Lipunov, 1983, *Astrophys. Space Sci.* **97**, 121.

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The magnetic fields that are associated with these WDs in CB and probably SB, are generally low (10^5–10^6 G) with the exception of AM Her systems. Since such a WD will have the Alfvén radius $R_A < R_{WD}$, the equilibrium period will be the minimum possible period. But the excessive angular momentum will be lost in the SN explosion.

The initial asymmetry ($\Delta R/R$) also will be lower, of the order of 10^{-8} for such WD with smaller magnetic fields. This results in a kick velocity of the order of 10^2 km s^{-1} (rather than 10^3 km s^{-1} derived by Lipunov), which is in agreement with the observed space velocities of pulsars.

Thus, it is possible that low mass binary systems like CB and SB, with massive and weak magnetic field WDs as primaries, form neutron stars associated with high-space velocities.

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