THE POST-SUPERNOVA STAGE OF MASSIVE CLOSE BINARIES: THE POSSIBILITY OF A TIDAL INSTABILITY

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Abstract. It has been proposed that tidal interaction is the mechanism which restored the circular orbits of X-ray binaries after the supernova explosions which produced the compact components in those systems. (Lea and Margon, 1973; Sutantyo, 1974). This implies that the primaries must possess large viscosity in order to provide large energy dissipation rates required in this process. At the end of this process the system reaches a stable synchronous and circular orbit. If this hypothesis is true, there will be further consequence of the strong tidal interaction during the later stages of evolution of the system. The gradually changing structure of the primary during the post main-sequence stages will continuously disturb the stability of the orbit. There will be transfer of angular momentum from the orbital motion into the rotation or vice versa through the tidal interaction. At a certain stage, the radius of the primary exceeds a critical radius, the orbit becomes unstable and synchronism becomes impossible. The compact component will be spiralling down onto and into the primary as proposed by Sparks and Stecher (1974).

The evolution of the orbital period of massive X-ray binaries is followed from the actual observed state to the moment that one of the following situations occurs:

Case I: the star overflows its critical Roche lobe before the onset of the instability. A second stage of mass transfer starts.

Case II: the star exceeds a critical radius before filling the Roche lobe. The orbit becomes unstable and the compact object spirals inward to the companion.

The computations are performed under the assumption that tidal forces are strong enough to circularize and synchronize the orbit within the main-sequence lifetime of the massive companion. Changes in the moment of inertia of the latter are taken into account. It turns out that the final result depends critically on the mass ratio and the initial period. It is found that the orbits of Cen X-3 and 3 U 1700–37 are probably already unstable at present. Before the onset of the instability the tidal forces maintain a nearly synchronous orbit.

The detailed results were published in *Astrophys. Space Sci.* **38** (1975), 301.

References

Lea, S. M. and Margon, B.: 1973, *Astrophys. Letters* **13**, 33.
Sparks, W. M. and Stecher, T. P.: 1974, *Astrophys. J.* **188**, 149.
Sutantyo, W.: 1974, *Astron. Astrophys.* **35**, 251.

P. Eggleton et al. (eds.), Structure and Evolution of Close Binary Systems, 63.