ROTATION AND THE EVOLUTION OF THE MASS-ACCRETING COMPONENT IN CLOSE BINARY SYSTEMS

Wim Packet
Astrofysisch Instituut, Vrije Universiteit Brussel,
Pleinlaan 2, B-1050 Brussels, Belgium

When mass is transferred between the two components in a close binary system, the matter falling towards the secondary star can gain a considerable amount of angular momentum. Eventually a ring or disk around this star is formed. The star can increase its angular momentum by accreting part (or the whole) of this matter. We have examined the ensuing changes in rotational velocity of the mass-accreting star. A simplified calculation (assuming accretion from a ring, rigid rotation of the star, and taking the stellar radius as well as its radius of gyration constant) shows that the star reaches its break-up velocity after increasing its original mass by only a few percent.

More detailed evolutionary calculations, using a spherically symmetric evolution code, have been performed for a number of theoretical systems. The variation of the radius and the radius of gyration can be taken into account in this way. These computations confirm the simplified calculations: the stars are spun-up to their break-up velocity soon after the beginning of mass transfer and <u>before</u> they grow into contact.

This result has a number of important consequences: spherically symmetric accretion models can no longer describe the accreting star satisfactorily; contact configurations may be avoided in a number of systems; mass loss from the system may occur everywhere in the orbital plane; tidal effects will probably be very important during the mass exchange process.

A more detailed account of this research will be published in Astronomy and Astrophysics.

This investigation is supported by the National Foundation of Collective Fundamental Research of Belgium (F.K.F.O.) under No.2.9002.76.

D. Sugimoto, D. Q. Lamb, and D. N. Schramm (eds.), Fundamental Problems in the Theory of Stellar Evolution, 179–180.

DISCUSSION

Sugimoto: Isn't break-up velocity the limiting value of rotational velocity which can be attained by accretion?

Packet: In our computations, the stars attained rotational velocities much higher than their break-up velocity. This effect, which is clearly unphysical, comes from two of our assumptions: 1) rigid rotation of the star and 2) accretion continuing undiminished when the star approaches its critical velocity. Both assumptions are not fulfilled almost certainly in nature. Relaxing them and assuming that the mass accretion rate goes to zero in some way as ω approaches ω_{cr} will give an asymptotic approach to the break-up velocity. However, the purpose of our work was not to spin stars up to super-break-up velocities, but to show that rotation is a most important feature in the evolution of mass-accreting stars and should be taken into account.

Ruciński: In Algol, a well known mass-transfar binary, the episodes of mass transfer can be rather well located in time and the primary (mass-gaining) component seems to be able to resume synchronous rotation (to within 1 km/s) on a time scale of weeks. Could you comment on this?

Packet: Algol is in the slow stage of mass transfer and the amount of matter exchanged during a mass-transfer event is very small. Thus the amount of angular momentum that the accreting component gains will also be small, and can be transfered back to the orbital motion in a short time. In binaries like U Cep, and probably β Lyr, the phenomenon is much larger, and will be still larger during the first stage of mass transfer as I have shown. In such cases, the resynchronization time-scale may be comparable to or longer than the mass-loss timescale of the primary.

https://doi.org/10.1017/S0074180900073861 Published online by Cambridge University Press