ROTATIONAL PROPERTIES AND SYNCHRONIZATION IN EARLY-TYPE CLOSE BINARIES

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We have rediscussed the synchronism between rotation and revolution in close binaries by an inspection of the published projected rotational velocities V sin i of about 250 early-type (from O to F5) eclipsing and double-lined spectroscopic binaries. Corrections of the V sin i - values (which are mainly taken from the catalog of Uesugi and Fukuda, 1982) for the aspect effect is straightforward for the eclipsing binaries with analyzed light-curves; in the other cases we have estimated the value of the orbital inclination angle i from the primary's minimum mass $M_1 \sin^3 i$ on the assumption that its mass follows Straižys and Kurilienė's (1981) mass-spectrum relations for different luminosity classes. For the components of non-eclipsing binaries, for which the absolute radii are not directly known, we have adopted values of the absolute radii in accordance with Straižys and Kurilienė's (1981) radius-spectrum relations for different luminosity classes. By using our estimates of the radii, for each component we have evaluated the synchronized velocity V_k (corresponding to the mean orbital angular velocity) and the pseudosynchronized velocity V_e, which corresponds to a synchronization with the instantaneous orbital angular velocity at periastron of an eccentric orbit; in close binaries with appreciably eccentric orbits synchronization is attained with $V/V_k>1$ and it is probably quickly reached at periastron (Hut 1981).

We have examined the degree of synchronism (expressed by the ratios Log V/V_k and Log V/V_e) as a function of the stellar fractional radius r. (Whenever it is not directly known from light-curve analyses, we have estimated r from the above-mentioned estimates of the absolute radii and from evaluation of the binary separation, which results - via Kepler's law - from the total mass of the system). In accordance with the view that tidal forces are stronger for large r, we have found that the fraction of stars showing pronounced deviation from synchronism ($V/V_k>2$) or pseudosynchronism ($V/V_e>2$) tends to increase as we go down to smaller r. Synchronism greatly prevails at $r>0.15$ (90% or 92% have $V/V_k<2$ or $V/V_e<2$, respectively), whereas supersynchronous and superpseudosynchronous rotators become

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essentially the rule for $r<0.05$ only (where their percentage is 98% and 78% respectively), i.e. for wider binaries than generally held (Levato 1976). In fact, the fraction of synchronous and especially pseudosynchronous rotators remains relatively high (49% and 73%, respectively) in the range $0.05<r<0.15$.

The degree of synchronism appears to be on average stronger in late A-and early F-type stars than in earlier-type stars. This can be due to the fact that the envelopes of late A-type and F-type stars are partially convective so that tidal forces are more efficient therein than in fully radiative envelopes. But, in contrast with earlier contentions (Levato 1976), the degree of synchronism does not appear to be stronger in "evolved" (subgiant, giant, supergiant) components than in "unevolved" (dwarf) ones.

Remarkably, the relatively high fraction of synchronized rotators with $r<0.10$ appears to be incompatible with current theoretical views on tidal interaction in early-type close binaries (Zahn 1977), even if stellar models including a plausible amount of overshooting are considered.

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DISCUSSION

SCARFE: For the eccentric binaries, did you use the angular velocity at periastron to compare with the rotational angular velocity?

GIURICIN: Yes.

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