Abstract. Correlation between the spins (rotational velocities) in binaries has previously been established. We now continue and show that the degree of spin correlation is independent of the components' separation. Such a result might be related for example to Zhang's non-linear model for the formation of binary stars from a nebula.

1. Introduction

Synchronization is common among members of close binary systems. Theoretical arguments for such synchronization have been advanced by Zahn (1970, 1975, and 1977). Empirical results by Levato (1976), Giuricin G. et al. (1984; 1984), and others, seem to agree with Zahn’s model.

As a binary system evolves, the original angular momentum of the accreting mass is shared between orbital and spin angular momentum, provided no external perturbations is present. Thus, we expect that spin angular momenta of the components are roughly parallel to the orbital one. In that case, the measured \( v \sin i \) values should be correlated.

Indeed, Steinitz & Pyper (1970) found that there is such a correlation between the projected spins of the members in binary systems. Subsequent work by Farbiash & Steinitz (2003) yielded similar results for an extended sample (1010 binary systems). Data selection and restrictions imposed on choice of the binary systems is given there. The basic conclusion arrived at was that

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v_1 \sin i_1 \cong v_2 \sin i_2, \tag{1}\]

which can be understood either as:

1. \( v_1 \ll v_2 \) while \( \sin i_1 \gg \sin i_2 \),
   or:
2. \( v_1 \simeq v_2 \) as well as \( \sin i_1 \simeq \sin i_2 \).

Since \( i_1 \) and \( i_2 \) are angles depending on the observer, the probability of the first relation is extremely small. We accept the second relation, interpreting it as twofold meaning: Spin axes of members in binary systems are roughly parallel, and also rotational speeds are correlated.

Tidal interaction in close binary systems is an important process, therefore we expect this result. Remembering, however, that this interaction is
strongly dependent on distance between the interacting stars (Zahn, 1977), we ask whether tidal interaction is the only process bringing about spin correlation. If it is indeed the only process causing spin correlation, then this correlation will diminish with increasing separation distance. This is the subject of the current investigation.

2. Data

Choice of the data to be examined has been described originally by Farbiash & Steinitz (2003). For brevity we mention the salient points:

1. Spectral type of both components is earlier than F0 (slow rotation of stars later than F0 would automatically simulate correlation).

2. Giants and Supergiants are excluded since they may have lost their original rotational velocities.

3. Multiple systems including more than two stars are also excluded.

To ensure that the looked after correlation is not accidental due to proximity in spectral type, we have previously defined two extra sets of artificial binaries AB(Artificial Binaries), and ABR(Artificial Binaries, Restricted). These were obtained by shuffling the original components (regarded as single stars), and further restricting to a very narrow range in spectral type.

In addition to these samples, we now define a new subset, VB(Visual Binaries) containing only visual binaries whose separation between the components is known (Hartkopf & Mason, 2003). This set contains 33 systems.

3. Results and Conclusions

In fig.1 we plot the projected rotational velocity of one component versus the other component for all samples: AB, ABR, RB, and VB. The relevant part of the figure is the plot for the VB sample. Also, we plot in fig.2 the projected rotational velocity differences against the components’ separation.

From fig.1 we learn that:

- Spin correlation in visual binaries is indeed present.

And from fig.2 we see that:

- Spin correlation does not depend on separation distance.

"Memory" of initial conditions in close binary system are obviously erased due to tidal interaction. As this interaction becomes negligible for visual binaries, spin correlation just demonstrated should therefore be due to other mechanisms, which possibly do reflect initial conditions. For example, Zhang (2000) gave a non-linear model for the evolution of binary stars from a nebula, in which spin correlation is retained. For the current investigation the sample available
Figure 1. Projected rotational velocity of one component vs. the other component for samples AB (a), ABR (b), RB (c), and VB (d). (Fig 1a,1b, and 1c appeared in Farbiash & Steinitz, 2003)
Figure 2. Projected rotational velocity differences vs. the separation of components for sample VB (Visual Binaries).
to us is small - 33 visual binaries. A firmer base, an enlarged sample of visual binaries, would enable us to obtain more significant results pertaining to spin correlation, and thus obtain a better idea of the "memory" of initial conditions. We encourage therefore observers to collect $v \sin i$ values of a large sample of visual binary systems.

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