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Age Dependent Angular Momentum, Orbital Period and Total Mass of Detached Binaries

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Abstract. The orbital angular momenta OAM (J) of detached binaries (including both cool and hot binaries) were estimated and nine subgroups were formed according to their OAM (J) distribution. The mean kinematical ages of all subgroups have been estimated by using their space velocity distributions and, thus, the age dependent variations of the mean OAM (J), orbital period (P), and total mass (M) of all subgroups were investigated. It was discovered that: i) The orbital period of detached binaries with radiative components decrease very slowly during the main sequence (MS) evolution. It is interesting that the large amount of mass loss is almost balanced by the OAM loss, and not much change in the orbital periods is observed. ii) The nuclear evolution of radiative components beyond the MS initiates the increase of the periods until the components have convective upper layers, i.e. until they become later than F5 IV, and the system becomes a cool binary with sub-giant or giant components. iii) The large co-rotating distance of the magnetically-driven wind in cool binaries (CAB) carries out a large amount of OAM and then the periods of such binaries decrease significantly, and the orbits shrink until another effect such as mass transfer dominates the period changes.

Keywords. detached binaries, kinematic age, angular momentum, orbital period, mass

1. Introduction

The absolute dimensions, proper motions, and radial velocities of known detached binaries were collected from the literature. The subgroups of detached binaries and the number of systems with collected data are as follows: 1. Detached binaries with radiative atmospheres (dbrs; 108 systems) 2. Detached binaries with convective atmospheres (dbcs; 179 systems) 2a. Chromospherically active binaries (CABs 149 systems) 2aa. Dwarf CABs (DCABs; with main sequence components; 69 systems) 2ab. Evolved CABs (ECABs; with at least one component subgiant or giant; 80 systems) 2b. Chromospherically inactive binaries (CIABs; 30 systems).

2. Data Analysis

Stellar population and moving group (MG) analysis were carried out for all systems; the MG members were extracted and only the systems with thin disk population were considered. The orbital angular momentum (OAM) of each system was estimated and each group dbrs, DCABs, ECABs and CIABs were listed in order of increasing OAMs. Each group was divided into five subgroups with increasing OAM, except CIABs which were considered to be a single subgroup. The mean values of OAM, the mean orbital period P, the mean total mass M of the component stars, and the mean kinematical age τ for each subgroup were estimated together with standard deviations.

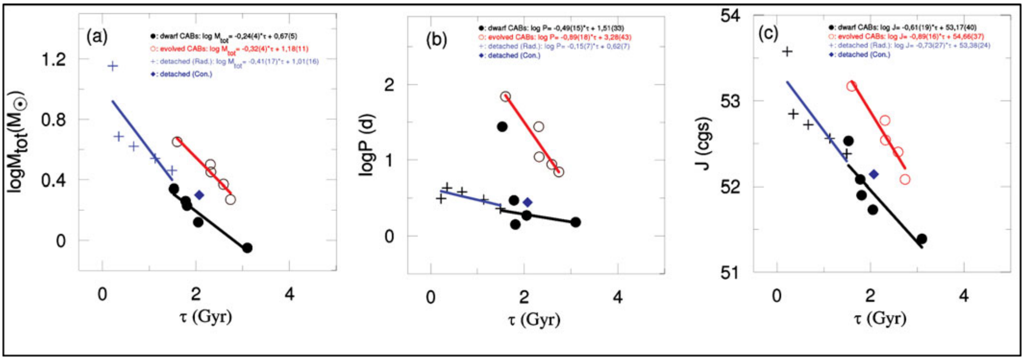

Figure 1. Age dependent J, P, and M of detached binaries.

3. Results

The results are presented in the following three diagrams of Fig 1. In Fig. 1, different decreasing rates of J, P, and M of all subgroups with increasing age are visible. Such strong dependences may be related with the origin of the systems, or may well be caused by some selection effects. For example (i) a certain kinematical age group contains also some younger systems. (ii) The short period systems have more chance to be observed. (iii) the chromospheric activity is an additional chance for observability. Different subgroups of detached binaries in Fig. 1 are definitely evolved towards increasing age but at different rates of J, P, and M changes, which is not clear in the diagram. However, having comparable masses of dbrs and ECABs in Fig. 1a implies evolution from dbrs to ECABs which requires an increase in P, as seen in Fig. 1b. Such an observational discovery is in line with the result of the theory of isotropic mass loss from detached binaries (see e.g. Pringle 1985, Demircan *et al.* 2006). The rate of P increase and related J, and M changes can be estimated by a detailed study. Since there are no evolved counterparts of DCABs in Fig. 1, the rates of the J, P, and M changes of this subgroup cannot be estimated. However, there is other evidence that the periods of DCABs decrease due to a large amount of J loss until another effect such as mass transfer dominates the period changes (see e.g. Van't Veer 1993, Demircan 1999, Guinan and Bradstreet 1988, Eker *et al.* 2006).

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