ON THE DISTRIBUTION OF YOUNG SPECTROSCOPIC BINARY STARS OVER THE MAJOR SEMIAXES OF THEIR ORBITS

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About 60% of stars of the disc population in our Galaxy are close binary systems (CBS). Half of the known CBS are spectroscopic binary stars (Kraitcheva et al., 1978).

To know the distribution of a correlation between the masses of CBS components and semiaxes of their orbits is necessary for the investigation of the origin and evolution of CBS. For such statistical investigations, a catalogue of CBS was compiled at the Astronomical Council. The catalogue is based on the 6th Batten catalogue (Batten, 1967), its extensions (Pedoussant and Ginestet, 1971; Pedoussant and Carquillat, 1973) and data published up to the end of 1980 (Popova et al., 1981). Now it is recorded on magnetic tape and contains data on 1041 spectroscopic binaries; 333 of them are stars with two visible spectra. The latter are mostly systems prior to mass exchange and the distribution of physical parameters in these systems reflects the distribution and presumably conditions at the time of formation. Using some assumptions, we can obtain for spectroscopic binaries masses of the components M_1 and M_2 (or the ratio $q = M_1/M_2$) and semiaxes of their orbits. Masses of components with the known sin i were obtained by the usual technique; when sin i was not known, masses were estimated from the spectra. We shall discuss here the distribution of CBS in the M-a plane.

In fig. 1 the distribution of 333 spectroscopic binaries with two visible spectra in lg M_1 - lg a is shown. Crosses mark pairs with $M_v > 7^m$, dots - brighter pairs. The bottom line a_{min} corresponds to the ZAMS contact systems with equal-mass components. The $a \lesssim 10\ R_o$, $M_1 \gtrsim 1.5\ M_o$ region is almost empty. The existence of this empty area was noted by Svechnikov (1969) and confirmed by Kraitcheva et al. (1978). Note that the upper boundary of the empty area has a slope d lg a / d lg $M_1 \sim 0.3$. Three stars that lie in this region (GK Cep, UZ Pup and V Sge) display mass exchange and are probably evolved (Batten, 1967). There are less massive stars with $a \lesssim 10\ R_o$. It is evident that among these stars there are practically no bright ones. Taking into account the observational selection due to the

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luminosities of the components, their radial velocities, inclinations of orbits, etc., we could derive the conclusion that the specific density (i.e., the number of pairs per unit interval lg a) is 30-60 times lower than the one for wider pairs with the same masses (Popova et al., 1981).

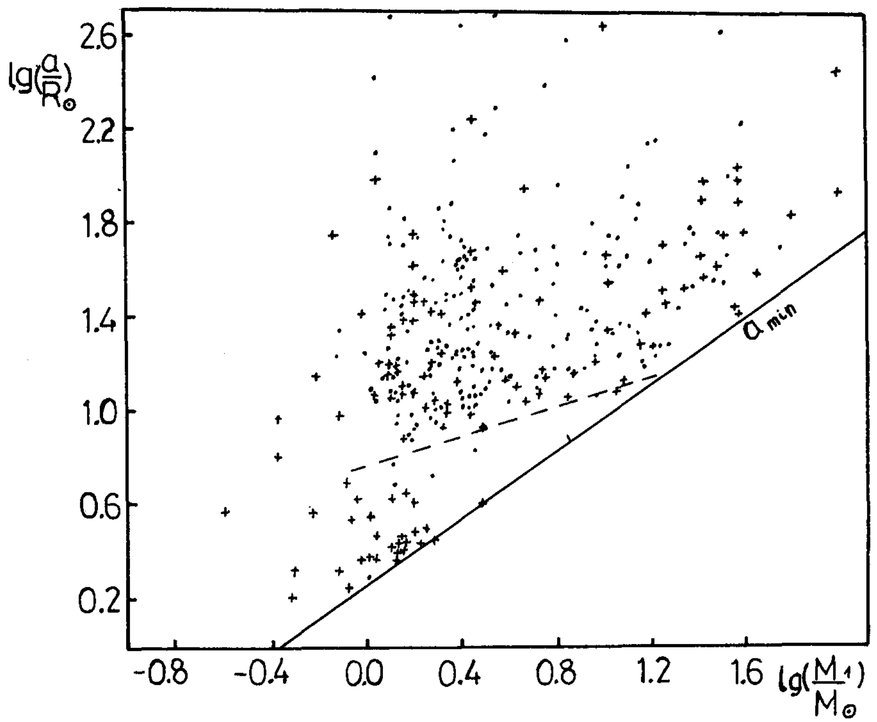

Figure 1. Distribution of CBS with two visible spectra in the lg M_1 - lg a plane.

The main question is: What are the reasons for the existence of this avoidance zone with $a \lesssim 10\ R_\odot$? The lack of CBS with $a \lesssim 10\ R_\odot$ is of genetic nature and the explanation of this feature is very important for the CBS formation theory.

Analysis of the formation of a single star in the accretion regime shows that the upper limit of an accreting star is about 30 $R_\odot$; the mass of a star at this moment reaches $\sim 2\ M_\odot$. This estimate is in good agreement with the results of calculations of stellar evolution near the Hayashi boundary (Larson, 1969). There is observational evidence for these estimates. Cohen and Kuhi (1979) on the basis of observations of young stellar aggregates showed that probably no object with a mass higher than 2-3 $M_\odot$ can be on the Hayashi tracks. Theoretical models of CBS formation in an accretion regime show that components in systems with a $\lesssim 10\ R_\odot$ coalesce when stars are fully convective (on the Hayashi tracks). Resulting rapidly rotating stars brake probably due to magnetic stellar wind. Binary stars with a $\gtrsim 10\ R_\odot$ remain double systems. Note that the theoretical relation a $\sim M^{1/3}$ for CBS forming in the accretion process from an initially uniform, rigidly rotating cloud is in agreement with the observational feature (see fig. 1). Details will be described in a subsequent paper.

Stars in the zone $M_1 \lesssim 1.5\ M_\odot$ and a $\lesssim 10\ R_\odot$ appear to be pairs closed due to intensive loss of angular momentum. Indeed in the zone $M_1 \lesssim 1.5\ M_\odot$, there are stars with high chromospheric activity (RS CVn type stars) for which X-ray observations reveal strong stellar wind spots and probably magnetic fields (Hall, 1976). It is known that a magnetic stellar wind can be an effective mechanism of angular momentum loss.

Thus, we conclude that CBS with a $\lesssim 10\ R_\odot$ cannot form, and that components of CBS with $M_1 \lesssim 1.5\ M_\odot$ can come into contact (W UMa stars) only in the process of angular momentum loss due to the magnetic stellar wind. The proposed scenario of CBS formation is preliminary and the solution of such complicated problems as a collapse with fragmentation, evolution with rotation, and magnetic stellar wind is needed to develop this scenario.

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