NON CONSERVATIVE MASSIVE BINARY EVOLUTION
How much mass leaves the binary during the evolution from OB+OB to WR+OB

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The observations give us on one hand the mass ratio (q) distribution of OB+OB type binaries in a stage prior to Roche lobe overflow (RLOF), and on the other hand the q distribution of WR binaries which are considered to be in a stage after RLOF. By comparing both distributions one may hope to be able to say something about the mass loss during RLOF.

1. COMPUTATIONS

We will use the non-conservative massive close binary evolutionary calculations as has been described in three papers, i.e. Vanbeveren, De Grêve, van Dessel, de Loore, 1979, A&A 73, 19; Vanbeveren and De Grêve, 1979, A&A 77, 295; Vanbeveren and Packet, 1979, A&A 80, 242. Distinction is made between two mass loss phases, i.e. a stellar wind mass loss phase (further noted as SW) during core hydrogen burning prior to the Roche lobe overflow (RLOF), and the RLOF itself.

2. OBSERVATIONS

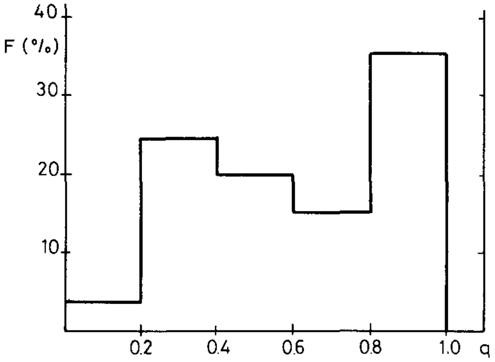
a. The mass ratio distribution for unevolved O-type binaries

The observed q-distribution for unevolved O-type binaries (~35 binaries listed by Garmany, Conti and Massey, 1981, Ap.J., in press) is shown in Figure 1. This distribution does not necessarily reflect the ZAMS q-distribution as SW increases q of a massive binary during core hydrogen burning. Assuming that Figure 1 gives a fairly good representation of the q-distribution for systems covering (in time) the whole core hydrogen burning, Figure 2 shows the ZAMS q-distribution by using the $\dot{M}$ formalism of de Loore, De Grêve, Vanbeveren, 1978, A&A 67, 373 and taking N=300.

b. The observed average mass ratio after RLOF

For 14 systems after RLOF the average mass ratio equals 2.1. Assuming that these 14 systems cover the whole core He burning phase, it follows

C. Chiosi and R. Stalio (eds.), Effects of Mass Loss on Stellar Evolution, 461–463.



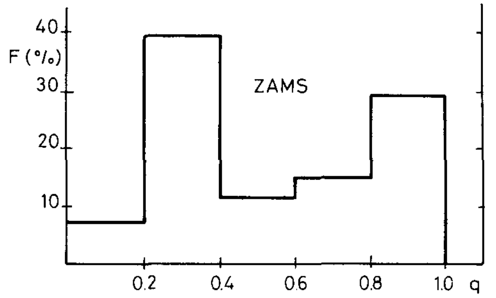


Figure 1 Figure 2

The mass ratio distribution for O type binaries as observed (Fig.1) and on the ZAMS (Fig.2) computed with the assumption that ±50% of the mass leaves the star during core hydrogen burning due to stellar wind.

that the average mass ratio for systems immediately after RLOF equals 1.7 (remind that in session V I showed that for the Galaxy the He burning remnant after RLOF should lose ± half of its mass in order to be consistent with the observed WN/WC ratio).

3. CONCLUSIONS

Using an IMF for O type primaries $\psi(M) \sim M^{-\alpha}$ (α=1,2) figure 1 (N=0) and figure 2 (N=300) were transformed by means of the computations mentioned in §1 into q-distributions for systems immediately after RLOF. The resulting average mass ratios depending on the assumptions concerning the SW and RLOF are summarized in table 1. By comparing the results of table 1 and the observed average q after RLOF (§2b) one concludes that independent from N~80% of the matter lost by the primary during its RLOF should also leave the system. Taking the SW and RLOF as one mass loss phase one concludes that during the evolution from OB+OB → WR+OB ± 50% (N=0) or ± 70% (N=300) of the original ZAMS primary mass has to leave the star and the system. During the WR phase the star is losing another 50% (on the average) of its mass as I have outlined in session V Wednesday.

REMARKS

a. As has been outlined by Kraitcheva, Popova, Tutukov, Yungelson (1979, Sov.Astron. 23, 290) the q=1 systems may be largely underestimated as a consequence of selection effects. Using their q distribution also for O type binaries (this distribution corresponds to theoretical expected distributions based on fragmentation; Lucy, 1980, IAU Symp.88), doing the same exercise as discussed in §3 and comparing the theoretical average q after RLOF with the observed one, one has to conclude that all material lost by the primary due to RLOF should also leave the system.

b. An average mass ratio for WR+OB systems equal to 5 (as proposed by A. Moffat Tuesday for the LMC) can be obtained with binary evolution only if the O type binary mass ratio distribution is strongly peaked at q=1, stellar wind mass loss is small and all material lost by the primary during its RLOF is almost entirely accreted by the secondary. I do not understand the difference compared to the Galaxy where all material should leave the system.

Table 1. The average mass ratio after RLOF without and with stellar wind mass loss by stellar wind (±50% of the mass leaves the star during core hydrogen burning) for a conservative RLOF and in the case that all material leaves the system during RLOF.

core hydrogen burning	RLOF	$\bar{q}$
no stellar wind	conservative	3.1
	all material leaves the system	1.6
with stellar wind	conservative	2.9
	all material leaves the system	1.6

DISCUSSION

NIEMELA: The mass ratios for the LMC WR + OB binaries may be so large because there are several stars contributing to the absorption lines.

VANBEVEREN: Decreasing the mass ratios for the LMC WR binaries will certainly make things better and comparable to the galaxy.

DE LOORE: I am somewhat concerned about your conclusions derived from these average. There is probably a spread. Is this now in conflict with our previous conclusions of the Toronto Symposium and the AAA paper (1980, 86,21 where we investigated system by system and found a general trend and a spread of values, or is this a confirmation?

VANBEVEREN: It is a confirmation because for most of the systems we obtained an upper limit for the mass loss from the system.