PRE-MAIN-SEQUENCE EVOLUTION OF CLOSE BINARIES WITH MASS TRANSFER

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The scenario begins with two spherical masses of Roche radii, as given by Paczynski (1971)[1], at a separation of centers, A. The mass flows from the initially more massive star a in rapid rotation to its companion b. The separation changes in accordance with the conservation of orbital angular momentum. The corresponding Roche radius of b is considered to be its radius. The luminosities of the stars are given in the approximate expressions following Schatzman (1963)[2] for convective or radiative equilibrium. The luminosity of b determines the time for a given mass transfer with the use of the virial theorem. This time step and the virial theorem, then, determine the change of the radius of a. The angular speed of a is maintained such that the centrifugal and gravitational accelerations are equal at the equator. If the total angular momentum of the system is conserved, the angular momentum of b can be computed. Initially, b is considered to rotate in synchronism with the orbital revolution. The mass transfer stops when the centrifugal and gravitational accelerations become equal at the equator of b, or when the change in potential energy becomes zero. In the table, S_f is the ratio of final rotational and orbital angular speeds; t is the time interval in 10^3y; initial M_a is 3 solar masses; M_{bi} = 0.7 for part 1, and A_i = 32.2 solar radii for part 2.

1)	A_i	A_f	S_{af}	S_{bf}	t	ΔM	log L_a		log L_b		log T_a		log T_b	
	86.0	83.8	2.82	3.40	0.34	.012	2.66	2.59	1.37	1.37	3.61	3.61	3.44	3.44
	53.7	52.4	2.82	3.40	1.09	.012	2.36	2.29	1.07	1.07	3.63	3.64	3.46	3.47
	17.2	16.8	2.82	3.40	18.6	.012	1.62	1.55	0.33	0.33	3.70	3.70	3.53	3.53
	15.0	14.7	2.83	3.40	24.4	.011	1.54	1.55	0.24	0.25	3.71	3.73	3.53	3.54
	10.7	10.7	2.92	3.42	19.9	.004	1.32	1.86	0.03	0.03	3.72	3.88	3.55	3.55
2)	M_{bi}													
	2.0	34.0	17.3	2.31	45.8	1.15	1.90	0.94	1.55	1.98	3.67	3.72	3.63	3.68
	1.85	32.9	19.2	2.48	56.5	1.21	1.91	0.95	1.49	1.94	3.67	3.74	3.61	3.67
	1.5	29.0	4.21	3.15	21.4	.180	1.94	1.65	1.33	1.36	3.67	3.68	3.59	3.61
	0.7	31.4	2.82	3.40	3.89	.012	2.03	1.96	0.74	0.74	3.66	3.67	3.49	3.49

[1] Paczynski, B. 1971. Ann. Rev. Astron. Astrophy. 9, p. 183.
[2] Schatzman, E. 1963. In "Star Evolution", ed. L. Gratton, p. 177.

D. Sugimoto, D. Q. Lamb, and D. N. Schramm (eds.), Fundamental Problems in the Theory of Stellar Evolution, 111.