DYNAMICS OF INITIAL BINARIES IN OPEN CLUSTERS

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N-body calculations have shown that hard binaries play a dominant role in the evolution of small stellar systems. However, only one or two such binaries form by dynamical interactions and since the final components tend to be massive, their effect and observability in open clusters are limited to relatively short time-scales. In the present investigation we consider an initial population of binaries with physical evolution times exceeding the cluster age. These calculations may be applicable to a later phase when the heavier stars have suffered mass loss.

Each system consists of N = 250 equal-mass particles and includes $N_b = 8$ initial binaries of the same binding energy. Three models have been studied with dimensionless binary energies, $E_b = 5$, 10, and 20, measured with respect to the average kinetic energy of field particles. Because of the large number of periods per crossing time we assume unperturbed two-body motion if the external perturbation is $< 10^{-6}$ of the two-body contribution. Since the binaries are twice as heavy as the single particles the early phase is characterized by segregation towards the centre, where strong interactions may occur. In this way a modest initial binary population may acquire a significant central space density relative to the single particles, with interesting dynamical consequences. The binaries studied here are too hard to be destroyed in encounters with single particles; however, a companion may be exchanged with a field particle. The general trend of evolution is in the direction of increased binding energy with an occasional disruption due to binary-binary interactions but only a few binaries remain strongly bound to the centre. The models are terminated (for technical reasons) after 34, 34, and 19 standard crossing times, respectively, with a corresponding number of hard binaries $N_b = 6$, 8, and 7, and exchanged companions $N_e = 7$, 4, and 2. The energy stored in these binaries is increased by 90%, 79%, and 5%; note however that the absolute energy transfer rate in model III is quite significant in view of the shorter time when these binaries were centrally concentrated. The escape rates are very similar to

James E. Hesser (ed.), Star Clusters, 325–326.

https://doi.org/10.1017/S0074180900092068 Published online by Cambridge University Press

previous isolated models without initial binaries, giving relative escape rates per crossing time of 8×10^{-4}, 7×10^{-4}, and 1.0×10^{-3}.

We compare the probability of exchange with a theoretical estimate of Hills (1977) based on numerically calculated cross sections, adopting a virial theorem scale factor R = 2.2 pc and a mean mass $m = m_{\odot}$. Thus for model II the probability that a binary has suffered an exchange collision is $P_e = 0.5$ for an assumed age $t_f = 3 \times 10^8$ y. From the work of Hills, $P_e \simeq 0.06$ for an equivalent semi-major axis a = 350 AU; the smaller value may be ascribed to the mass segregation effect. Finally, it is still an open question whether core collapse is merely delayed until the binaries have been destroyed or ejected, or whether new binaries can form at an appropriate rate.

REFERENCE

Hills, J.G.: 1977, *Astron. J.* 82, 626.

DISCUSSION

TRIMBLE: On that very last point, is that the kind of system, a giant plus neutron star, that you expect to get out of that? That's exactly what Gunn and Griffen don't see all the way down the core of their globular clusters.

AARSETH: No, both components would be either neutron stars or a neutron star plus black hole.

https://doi.org/10.1017/S0074180900092068 Published online by Cambridge University Press