TIDAL STRIPPING AND DISRUPTION OF GLOBULAR CLUSTERS

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Tidal stripping and disruption of globular clusters may be responsible for the absence of low density clusters in the inner region of the Galaxy. We have studied these processes by integrating orbits of stars while the cluster is moving through a spherically symmetric galactic potential with constant circular velocity (V_{cir}=220 km/s). The response of the cluster to the tidal field of the galaxy is calculated in a selfconsistent manner with a collisionless N-body code with N=5000 (van Albada 1982, van Albada and Bontekoe in preparation).

The following cluster parameters were used:
Mass: 2×10^5 M_{sun}.
Outer radius: 50 pc.
Density distribution: polytrope n=4 ($\log r_t/r_c \simeq 0.75$).
Crossing time: 2.3×10^6 yr.
This choice represents a cluster of average mass and outer radius with low central concentration.

The cluster was put on an eccentric orbit with apocenter at 5 kpc. At this distance the instantaneous tidal radius of the cluster is much greater than the initial outer radius. As the cluster approaches the galactic center the tidal surface shrinks and for pericenter distances $\lesssim$ 2 kpc it lies well inside the cluster.

During the passage of the center two phenomena occur. First, stars outside the tidal surface are removed from the cluster. (More precisely, stars with sufficient nergy to reach the tidal surface will ultimately escape.) Second, depending on the speed with which the cluster passes the galactic center, energy is added to the motion of the stars in the cluster leading to a general decrease in binding energy. The resulting expansion of the envelope of the cluster is largest for fast passages. In first approximation the shape of the distribution of binding energies, N(E), does not change, but shifts by an amount ΔE towards more positive values. The core radius of the cluster is not immediately affected since ΔE is generally small with respect to the central potential of the cluster. In first instance the net effect of a tidal shock is therefore an

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increase in central concentration of the cluster. Thus, tidal effects do in general not lead to a truncation of the system.

Two examples are shown in Figure 1 (orbits) and Figure 2 (time evolution of fractional mass shells). These results show that clusters with small central concentration can easily be disrupted totally within a Hubble time if their pericenter distances are small.

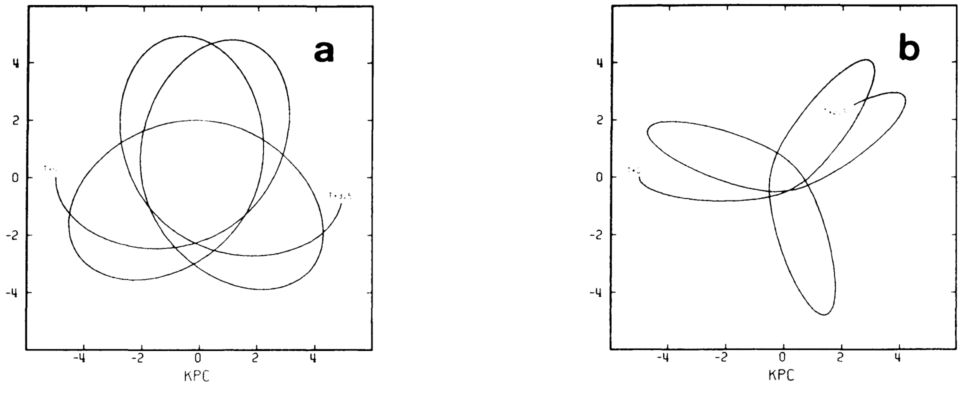
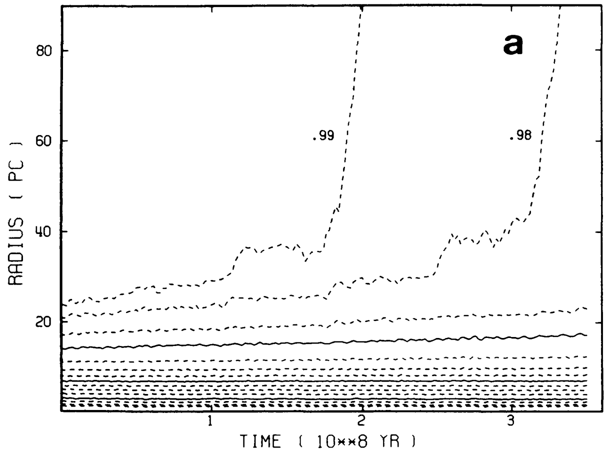


Figure 1. Orbits of two clusters in a galactic potential with constant circular velocity of 220 km/s. Apocenter in both cases is at 5 kpc. Pericenter lies respectively at 2 kpc (a) and 0.5 kpc (b).



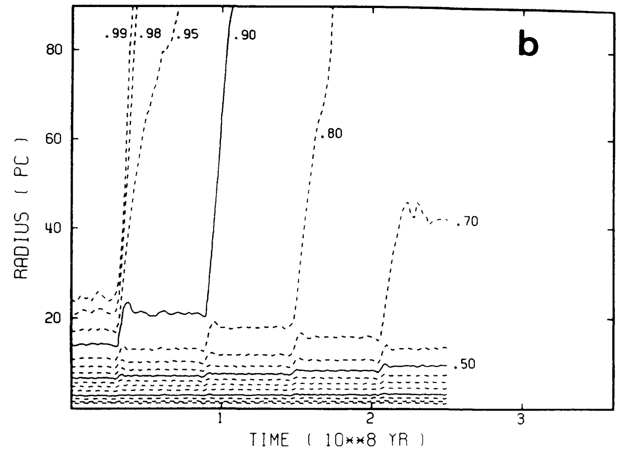


Figure 2. Time evolution of radii of shells containing given fraction of total mass for clusters whose orbits are shown in Figure 1. Note sudden expansion at pericenter passage in Figure 2b. In both cases the structure of the inner region is hardly affected.

Detailed calculations of stripping and disruption of clusters, which include tidal effects by the disk component and internal evolution, are necessary to determine the evolution of properties of globular cluster systems. The X-ray sources in the bulge of our Galaxy may be associated with remnants of disrupted clusters (Watson et al. 1981, Grindlay 1984). It is also conceivable that the spheroidal components of galaxies consist entirely of disrupted clusters (Fall and Rees 1977).

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