DYNAMICAL EVOLUTION OF ROTATING GLOBULAR CLUSTERS

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1. Objectives and method

We have computed simplified globular cluster evolutionary tracks which take into account the effects of internal relaxation, of the cluster rotation, of the galactic tidal field, and, in a cruder way, of stellar evolution and of gravitational shocking. The objectives are first to quantify the influence of rotation in the dynamical evolution of globular clusters; and second, to investigate the evolution of globular cluster angular momentum and flattening (Lagoute and Longaretti 1995a, Longaretti and Lagoute 1995b,c).

In the evaporation phase (when rotation is expected to affect most the dynamics), globular clusters' evolution is well represented by a sequence of equilibrium distribution functions (King, 1966, Wiyanto *et al.* 1985). We have therefore solved the evolutionary problem in two steps. First, following Michie (1963), we have shown that "rotating" King models are an approximate solution of the Fokker-Planck equation for rotating clusters in the evaporation phase (prior to core collapse). Second, we have computed the evolution through the time dependence of the four parameters on which the distribution function depends from the use of the Fokker-Planck losses of mass, energy and angular momentum and of the tidal constraint [see also King (1966), Chernoff *et al.* 1986 and Chernoff and Shapiro (1987)]. About 150 000 evolutionary tracks have been computed.

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2. Conclusions:

Rotation *decreases* the critical concentration at which the gravothermal instability sets in, but this decrease is rather modest (15% for the most rapidly rotating clusters).

Rotation *increases* the mass loss rate by up to a factor of 4, but the total mass loss (integrated over the whole evolution) decreases at most by a factor of 2, due to angular momentum losses during the evolution.

The evolution of the concentration is less affected, because it uncouples from the evolution of the mass as soon as the rotational energy of the cluster exceeds $\sim$ 5% of its kinetic energy, i.e., *even for slowly rotating clusters.*

Rotation, like gravitational shocking, reduces the domain of survival of globular clusters to higher concentrations.

Globular clusters loose on average about half their initial angular momentum during their evolution, although their flattening often decreases much more dramatically.

Internal relaxation results in a *decrease* of the cluster flattening during the evolution, whereas gravitational shocking induces an increase of the flattening. Combined with the dependence of the relaxation time-scale on the cluster mass, these effects provide a simple explanation for the correlations between flattening and relaxation time (Davoust and Prugniel 1990) and flattening and luminosity (Van den Bergh and Morbey 1984) observed in the Galactic globular clusters, and the flattening/age relation found by Frenk and Fall (1982) in the Magellanic Clouds.

3. References

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