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STAR CLUSTER ENCOUNTERS: A POSSIBLE EXPLANATION FOR ELLIPTICAL CLUSTERS

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RESUMEN

Presentamos simulaciones numéricas de encuentros de cúmulos estelares con el programa TREECODE de Hernquist en un computador CRAY YMP-2E. Variamos posiciones y velocidades relativas, tamaño de los cúmulos, masas y niveles de concentración, con un número total de partículas que va de 4608 hasta 20480. Comparamos interacciones de gran duración ($> 10^9$ años), donde el par se fusiona con cúmulos aislados de la LMC. Observando las simulaciones en un plano adecuado, los cúmulos resultantes muestran formas elípticas debido a la ruptura de uno de los miembros. Estas son esencialmente independientes del tiempo, aunque dependen de los parámetros estructurales iniciales de los miembros del par. Los choques pueden ser un posible mecanismo que explique la elipticidad observada en varios cúmulos estelares en las Nubes de Magallanes. Como ejemplo, el cúmulo NGC 1831 de la LMC (con una edad $\simeq 5 \times 10^8$ años) aumenta su elipticidad hacia las regiones externas, teniendo esto una contraparte en nuestro modelo con un tiempo de evolución de 5.85×10^8 años. NGC 1831 podría ser el resultado de la fusión de un par. Este escenario puede ser comprobado cinemáticamente con grandes telescopios, ya que produce anisotropias en la velocidad.

ABSTRACT

We present numerical simulations of star cluster encounters with Hernquist's TREECODE in a CRAY YMP-2E computer. We vary relative positions and velocities, cluster sizes, masses and concentration, using from 4608 to 20480 particles. Long duration fusions (> 1 Gyr) are compared with isolated LMC clusters. When seen from a favorable plane the resulting clusters show elliptical shapes due to the disruption of one of the companions. These shapes are essentially time independent but they do depend on the initial structural parameters of the pair components. Collisions can represent a possible mechanism for the ellipticity observed in several star clusters in the Magellanic Clouds. As an example, the LMC cluster NGC 1831 (age$\simeq$ 500 Myr) shows an increase in ellipticity towards the outer parts, which has a counterpart in our model at an evolution time of 585 Myr. NGC 1831 could be the result of a pair encounter early in the cluster history. This scenario might be kinematically tested with large telescopes, since it produces velocity anysotropies.

Key Words: **CLUSTER PAIRS — MAGELLANIC CLOUDS — STELLAR DYNAMICS — TIDAL ENCOUTERS**

1. INTRODUCTION

In the past years star cluster pairs in the Magellanic Clouds have been extensively studied in a series of papers (Bhatia & Hatzidimitriou 1988; Rodrigues et al. 1994; de Oliveira et al. 1998). The evolution of physical pairs can provide fundamental insight into the past history of cluster formation in the Magellanic Clouds. In this work we study their long term behaviour using numerical models and compare the final stages of these simulations (isodensity maps, ellipticities, isophotal twisting) with the structure of isolated clusters.

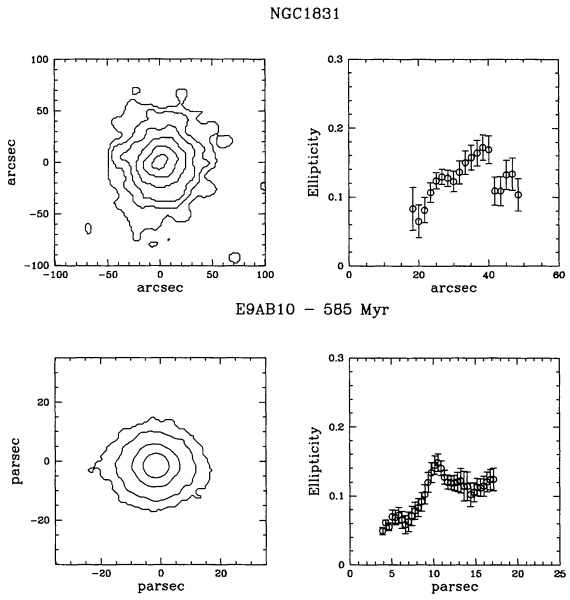

Fig. 1. Comparison of the LMC cluster NGC 1831 (upper panels) with an advanced stage model (t=585 Myr) in a XZ projection (lower panels).

2. STELLAR CLUSTERS

We have selected clusters with morphologies resembling those of the present models. We checked clusters with important ellipticity, as indicated in previous studies (Geisler & Hodge 1980; Zepka & Dottori 1987; Kontizas et al. 1989, 1990). The selected images were obtained from the Digitized Sky Survey (DSS).

We consider models in which the less massive cluster moves in elliptic orbits around the massive one. From the analysis of the evolution of each model, it is possible to observe the smaller cluster disruption by the massive one, partly merging into a single cluster at the end of the simulation, and partly being ejected to the field. Isopleth maps of projected planes at a given time can be compared to the observed isodensity maps of the Magellanic pairs to learn about their dynamics. In Fig. 1 we show a LMC isolated cluster (NGC 1831), with its respective isophote and ellipticity, compared with an advanced stage model. Similarities between the model and observations suggest that NGC 1831 could be the result of a cluster pair encounter.

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