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MORPHOLOGY OF LMC CLUSTERS

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ABSTRACT. It is well-known that LMC globular clusters have in general high ellipticities in counterpart to the galactic ones. For the LMC clusters an internal variation of ellipticity has been reported, but for axis orientation it is not confirmed up to now.

In order to get more conclusive data we used the best avaliable plates (ESO B Survey plates) and a full-image reduction method (PDS area-scanning). In this work we fit ellipses to the isophotal contours of the clusters. We agree with previous works concerning variation of ellipticity. We also found that position angles do vary in some of them. A pattern in the distribution of these parameters was observed. We believe that such variations (specially of position angles) may be evidence of the triaxility of the actual cluster shape.

Key words: GALAXIES-MAGELLANIC CLOUDS — CLUSTERS

I. INTRODUCTION

Globular clusters in our Galaxy present low ellipticities (hardly exceeding 1-b/a=0.2) and it seems to be also true for the M31's (Spasova and Staneva, 1983). On the other hand, many LMC globular clusters reach higher ellipticities, giving evidence that they are subject to special dynamical conditions. An accurate study of the morphology of these clusters is a pre-requisite to understand better the process of formation and how they mantain the dynamical equilibrium.

As usual we fitted ellipses to the isointensity curves (isophotes) and used the ellipticity (1-b/a) and position angle (semi-major axis orientation) of the fitted ellipses as the comparison parameters.

The ellipticity of the LMC globular clusters was studied by many authors (Geisler and Hodge, 1980; Frenck and Fall, 1982; Geyer et al., 1983). Geyer et al. (1983) claims that there exist a variation of ellipticity for many clusters, but variation of position angles are not significant within the quoted errors. An actual variation of axis orientation is of great physical importance, since it could mean that such clusters are flat not due to rotation, but that they could be actually triaxial structures in equilibrium (Kondrat ev and Ozernoi, 1979).

II. OBSERVATIONAL DATA

In order to obtain more conclusive data, we made use of the original glass plates of the ESO B Sky Survey. For the data reduction we used the PDS area-scanner at ESO, Munich. Clusters were scanned with a 20 μm pixel to obtain isophotal curves and the profiles of brightness along the E-W direction for each one. The profiles of brightness were calibrated in magnitude. The reduction system removes the contribution of bright stars from the isophotal curves,

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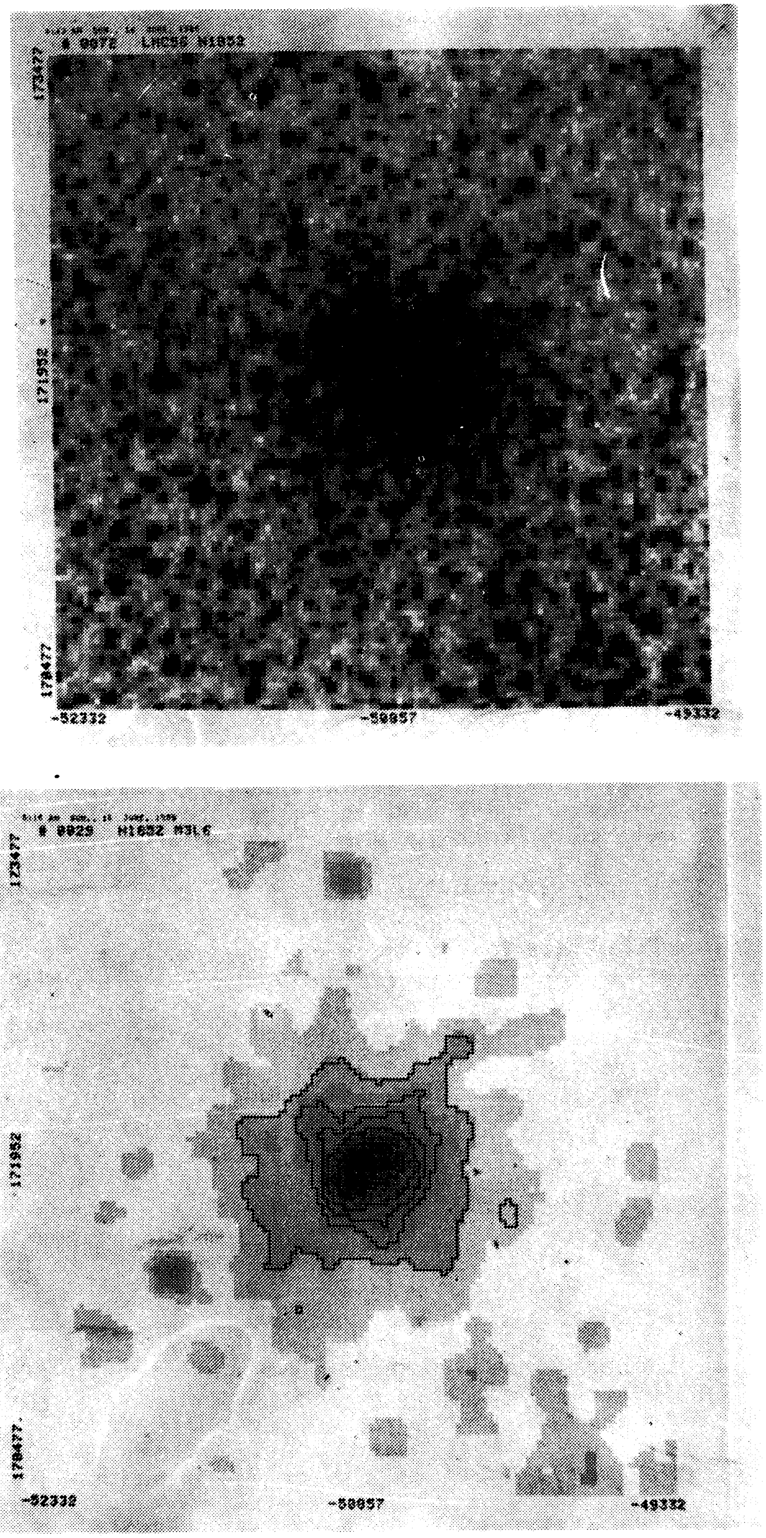


Figure 1a: cluster image for NGC 1852 obtained from the ESO B plate with the PDS of the ESO at Garching, Munich.
Figure 1b: Isophotal levels for the figure 1a after smoothing.

smoothing the cluster image within pre-fixed areas. Although this method does not yield many isophotal contours (as claimed as necessary to be conclusive about variation according Geyer et al.(1983), it covers a large part of the cluster, giving a good idea of the tendency of the desired parameter along the same. Besides, it is the method which yields the most precise isophotal contours. Therefore, our present work represents a noticiable improvement in the data reliability.

For the fitting of the isophotes (between 5 to 8 isophotes for each cluster) we used the approximation by an ellipse. At approximately regular angular intervals a number of points between 6 to 24 (depending on the isophote size) was picked up for each isophote. The number of points generally decreases from outer isophotes toward the inner ones. The center of the fitted ellipses was chosen as the geometrical center of the set of points of the correspondent isophote. Fixed the center, we fitted semi-major axis a, semi-minor axis b and position angle ψ . Cartesian coordinates x,y were transformed in cylindrical coordinates r,θ to fit the function:

$$r = \frac{b}{\left[1 - \left(1 - \frac{b^2}{a^2}\right)\cos^2(\theta - \psi)\right]^{1/2}}$$

A leas square method was iterated until the sum of the least squares not change by a factor of 10^{-6}.

III. RESULTS

Plots of the fitted isophotes are shown for a sample of eight clusters in figures 2a-9a. The correspondent distributions of ellipticity and position angles are shown in figures 2b-9b and 2c-9c respectively. In table 1 are the behavior of the distribution of both parameters in all cluster of the sample.

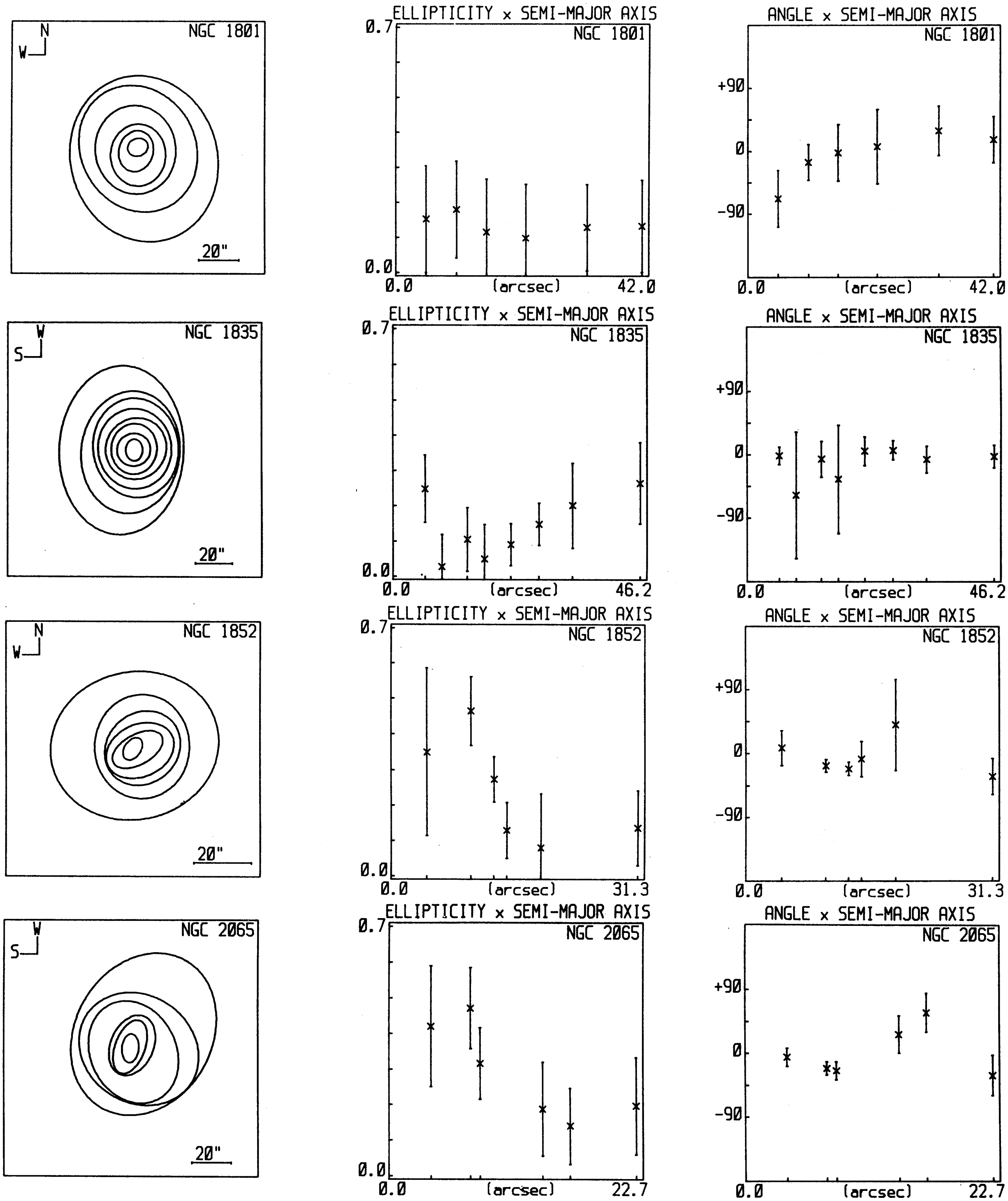
Table 1. **Distribution of Parameters in the Sample of Clusters.**

NGC	e var.	ψ var.	NGC	e var.	ψ var.
1697	yes	no	1994	no	yes
1704	no	no	2004	yes	no
1751	yes	no	2019	yes	no
1755	no	no	2031	yes	yes
1774	yes	yes	2051	no	no
1789	no	yes	2053	yes	yes
1801	yes	no	2065	yes	yes
1835	no	yes	2214	no	no
1852	no	yes	2214	no	no

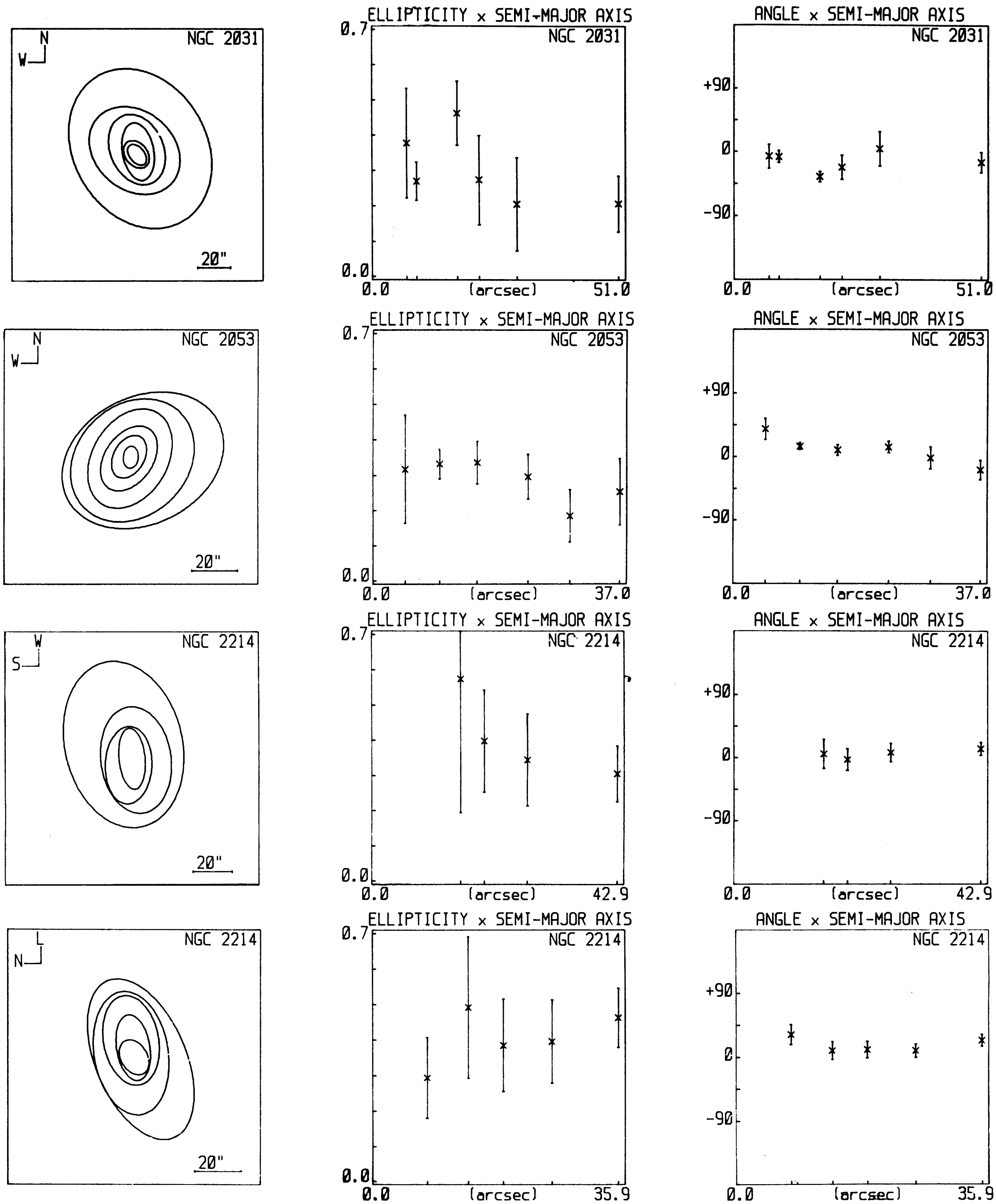
In order to check the method used, we made two different charts of isophotal curves in different scales for the same cluster, NGC 2214. The two charts were treated independently, showing a very good agreement (fig. 8 and 9).

From table 1 we notice that about a half of the sample clusters show variation of ellipticity. Also a half of the clusters present variation of position angles.

Mean errors in ellipticity and axis orientation in figures 2b-9b and 2c-9c were taken as three times the standard deviation (3σ). The standard deviation for the position angles is strongly linked to the ellipticity of the isophote (small ellipticity give large errors in the axis orientation). For the cluster ellipticity, large errors are consequence of a bad fitting of the real isophote by an ellipse.



Figs. 2a tp 5a: Ellipses interpolated to the isophotal levels for NGC 1801, 1835, 1852, and 2065.
Figs. 2b to 5b: Plots of the ellipticity versus semi-mayor axis.
Figs. 2c to 5c: Plots of the semi-major axis orientation.



Figs. 6a to 9a, 6b to 9b, and 6c to 9c: similar to previous ones, but for NGC 2031, 2053, and 2214. The two plots for NGC 2214 were obtained from chart of different scales and treated independently, showing a very good agreement.

For the clusters that present a large variation of ellipticity, we believe that the definition of a mean ellipticity is dubious.

IV. CONCLUSIONS

Variations of ellipticity were detected in about 50% of the studied clusters. For these clusters there is a general trend to decrease the ellipticity toward the outer isophotes, although NGC 1835 shows an opposite behavior.

We detected a variation of axis orientation within about a half of the sample. This would favour the triaxility of the clusters.

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