AXIAL RATIOS AND ORIENTATIONS FOR 100 GALACTIC GLOBULAR STAR CLUSTERS

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INTRODUCTION

The non-spherical appearance of globular clusters was first noted by Pease and Shapley (1917) and discussed in some detail by Shapley (1930) who analyzed cluster shapes determined from star counts made by Helen Sawyer on the Franklin-Adams star charts. This classic work has provided most of the data set used in all subsequent discussions of cluster shapes. A number of studies reporting cluster shapes have appeared in the years since we began this project, the most recent of which include Geyer, Hopp and Nelles (1983), Frenk and Fall (1982), and Kadla *et al.* (1976, 1977) .

The observational basis of our study has been the availability of a complete sample of photographic material and the availability of digital image processing techniques. The present reinvestigation of the shapes of the galactic globular clusters provides a large sample of cluster ellipticities on a uniform system.

METHODOLOGY AND DISCUSSION

The ellipticity analysis was performed on digitized images which were smoothed to resemble the smooth distribution of an elliptical galaxy (see Shawl and White 1980, 1986 for details). We have satisfied ourselves in two ways that the blurring process does no irreparable damage to the image geometry: first, we produced artificial star clusters of known axial ratio and subjected them to the identical procedures used on the actual clusters; second, our results compare favorably with both those of Geyer *et al.* (1983) and with that of Kadla *et al.* (1976, 1977).

The analysis provides us with values for a cluster's axial ratio, major axis orientation, and relative intensity, all as functions of the radial distance from the cluster center. Considerations of the correlation length within the blurred images, together with the typical error-value in (b/a) of ± 0.03, lead us to the conclusion that there are no significant variations of (b/a) with cluster radial distance within the ranges we have been able to analyze. The axial ratios determined in this

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work have been compared with those from Shapley (1930), Kholopov (1953), Frenk and Fall (1982) and Geyer (1983). In all four comparisons, the average differences are zero within 1 standard error of the mean. The comparisions are of *average* values, and are not, necessarily, made at the same distance from each cluster's center. Comparisons of our axial ratios as a function of radial distance from the cluster center with those of Geyer (1983) and Kadla *et al.* (1977) show excellent agreement. For 99 clusters (NGC 6273 is neglected because of nonuniform interstellar extinction) the average axial ratio is 0.93 ± 0.01. We find that 32% have (b/a)-values <0.90, while only 5% are flatter than $(b/a)<0.80$; hence, the clusters are systematically quite spherical. Following the example of van den Bergh (1984), we divided the cluster sample into two distinct groups on the basis of the total visual absorption A_V. A two-sample Kolmogorov–Smirnov test failed to demonstrate a clear distinction between the two groups of clusters. Our null hypothesis, that there is statistically no difference between the two subsamples may be rejected at a significance level no better than 20%. Such a value is insufficiently strong to be able to state categorically that the apparent cluster ellipticities are due solely to the effects of the interstellar absorption. Thus, our larger, more homogeneous, data set only weakly confirms the conclusion by van den Bergh (1984) that, because of the effects of foreground absorption, the *intrinsic* shapes of the clusters are even more spherical than previously thought. However, our data show that there are tendencies for greater cluster eccentricities both in the direction of the galactic plane and towards the Galactic Center.

From an analysis of the orientations relative to the Galaxy, we conclude that the observed distribution is consistent with that expected from randomly oriented clusters and that tidal effects do not dominate *within the range of radial distances from the cluster center we have been able to consider.*

A more detailed manuscript has been submitted to *The Astrophysical Journal.*

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