SURFACE PHOTOMETRY OF BRIGHT ELLIPTICALS

James M. Schombert
Palomar Observatory
California Institute of Technology

ABSTRACT. Surface brightness profiles of bright ellipticals ($M_V < -17$, $H_o = 100$) in rich clusters and the field are reduced to structural parameters. Most fitting functions are found to be inadequate in describing the overall shape of profiles with only the $r^{1/4}$ law providing a good match over the range of surface brightness from 19 to 24 mag arcsec^{-2}. The systematic deviations in structure of first-ranked ellipticals from normal ellipticals (i.e. enlarged characteristic radii and shallow profile slopes) are well explained by comparison to the N-body simulations of merging systems from Duncan, Farouki, and Shapiro (1982).

I. PROFILE MORPHOLOGY

Photometry for this study (Schombert 1986) consists of 277 galaxies obtained in 71 rich and poor clusters plus 27 field ellipticals. The photometry is in the Johnson V band bounded by an inner radius of 2 kpc and light levels corresponding to 28-29 mag arcsec^{-2}.

The structures of the morphology types gE, D, and cD are clearly defined from their profile shapes. D and cD galaxies are diffuse and enlarged in characteristic radii compared to normal ellipticals (Thuan and Romanishin 1981, Malumuth 1984) and cD galaxies also have a characteristic extended envelope (Oemler 1976) (see also article by Tonry in this collection). Classification by profile occasionally differs from visual estimates, especially for cD systems whose envelopes are often below the 24 mag arcsec^{-2} level. NGC 6034 in Hercules is an example of a cD galaxy which was classified as a normal elliptical because it is not a brightest cluster member (BCM), nor at the center of a cluster system.

II. TEMPLATE PROFILES AND THE $r^{1/4}$ LAW

The structure of normal ellipticals was best described by a set of template profiles which were drawn from the entire sample, excluding BCMs, and displayed a smooth change in structure with luminosity (Schombert 1986). From inspection of the templates, the following comments can be made about the $r^{1/4}$ law and bright ellipticals: (1) the $r^{1/4}$ law is only valid for ellipticals with $M_V < -21$, (i.e. there are systematic deviations from $r^{1/4}$ at low luminosities; see also Binggeli, Sandage,

T. de Zeeuw (ed.), Structure and Dynamics of Elliptical Galaxies, 383–384.

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and Tammann 1984), (2) and is valid only for intervals of $19 < \mu < 24$ mag arcsec^{-2}.

In Figure 2 the effective surface brightness (μ_e) and effective radius from $r^{1/4}$ fits under the above restrictions are plotted along with the relation found by Kormendy (1980). Notice that BCMs lie to the right of the relation indicating that they are more diffuse than normal ellipticals (i.e. larger characteristic radii).

III. MERGER EFFECTS

A large number of recent theoretical studies (May and van Albada 1984) have made similar predictions about the structure of merger remnants (i.e., larger characteristic radii, $r^{1/4}$ profile shapes, and anisotropic velocity distributions). These are the same properties seen for brightest cluster members in this sample. Even in the more extreme cD galaxies with "nested" satellite companions, there exists a fairly uniform $r^{1/4}$ region in their inner profile.

Shallow profiles for brightest cluster members, as found by Malumuth (1984), are confirmed by this study. This result, together with enlarged characteristic radii and the shape of D and cD profiles, matches in form and size the profiles predicted by the N-body merger simulations of Duncan, Farouki, and Shapiro (1982). As much as 16 L_* growth is estimated for some of the more extreme cD systems such as A1413 and A2670.

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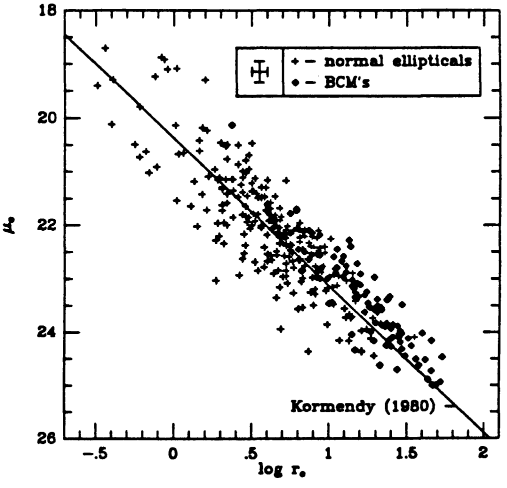

Figure 1. Effective radius versus effective surface brightness for all bright ellipticals (Schombert 1986) with linear fit from Kormendy 1980.

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