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The Connection Between dE and dI Galaxies

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Abstract. We combine specific globular cluster frequencies (S_N) with newly measured surface brightness profiles to identify dEs that may be stripped dIs. Luminous dEs generally have higher surface brightnesses and steep central light profiles. Conversely, fainter dEs have low surface brightnesses and flatter central light profiles. The most likely candidates for stripped dIs have low S_N and low central surface brightnesses.

1. Introduction

There is little consensus over how dwarf galaxies form or whether there is an evolutionary connection between gas rich dwarf irregular galaxies (dIs) and gas poor dwarf ellipticals (dEs). Yet, several factors point to such a connection. Within the Virgo and Fornax clusters, the non-nucleated dEs appear to form an extended population, with a spatial distribution similar to the spirals and irregulars rather than the bright ellipticals and the rest of the dEs (Ferguson & Sandage 1989). These non-nucleated dEs also have flattenings more like dIs than the rounder, nucleated dEs. A possible explanation for these differences is that the non-nucleated dEs are stripped dwarf irregular (dI) galaxies (e.g. Lin & Faber 1983). The most popular alternative scenario for dE formation (e.g. Dekel & Silk 1986) is that they formed in one monolithic collapse, and subsequently ejected their ISM via supernova winds.

Miller *et al.* (1998) have recently addressed these issues by studying the globular cluster systems of dE galaxies with the Hubble Space Telescope. The specific globular cluster frequency, $S_N = N_c 10^{0.4(M_V+15)}$, is a useful quantity for testing whether dEs are more like giant ellipticals or spirals and irregulars. They confirm the high mean value of specific frequency, $S_N \sim 5$, suggested by earlier studies and show that S_N in dE,Ns is about twice that in dE,noNs. Therefore, it seems that most bright dEs are more like giant ellipticals, which have $S_N \approx 2-6$, than spirals or irregulars with $S_N < 1$ (Harris 1991).

Yet, several of the non-nucleated dEs in Miller *et al.*'s sample have $S_N < 2$ and they could be stripped and faded dIs. If this is the case, then these galaxies should have structural parameters like dIs. Therefore, we have obtained ground-based V and I imaging of the 17 Leo and Virgo dEs in the HST sample. The new data allow us to check the HST surface photometry and yield more accurate total magnitudes for the lowest surface brightness galaxies. In addition, we obtained B-band imaging of some of the brighter galaxies in order to look for bluer nuclei.

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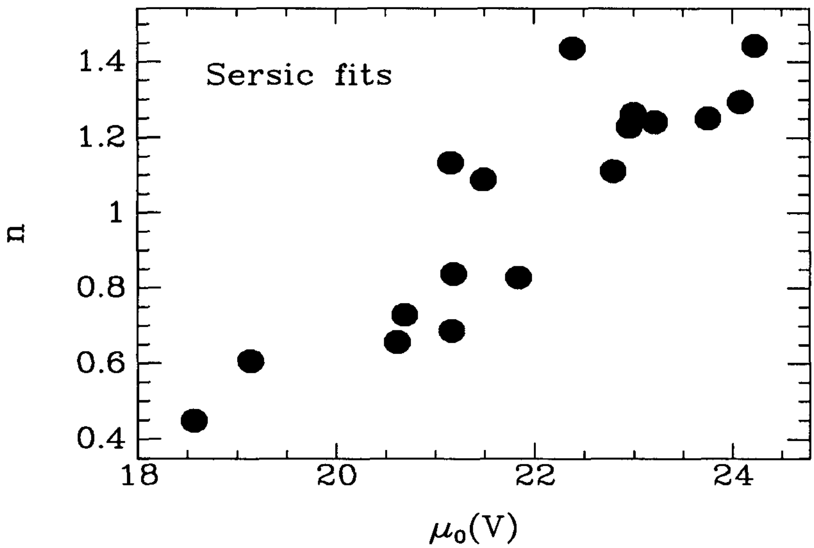

Figure 1. The correlation between μ_0 and n from Sérsic fits to the V light profiles of dE galaxies. Higher surface brightness galaxies also tend to be more luminous.

2. Observations and Procedure

The data were obtained 1–5 April, 1997 at the Las Campanas 40-in. telescope during photometric conditions. Calibration using Landolt (1992) standards shows a RMS scatter of < 0.03 mag. Surface photometry was performed with the GALPHOT routines kindly supplied by Wolfram Freudling. These routines make use of the ISOPHOTE ellipse-fitting package in STSDAS. We fit the light distributions to modified exponentials, or Sérsic profiles, of the form

$$I = I_0 \exp[-(r/r_0)^n]$$

Functions of this form have been shown to fit the light profiles of dEs more generally than simple exponential or $r^{1/4}$ laws (see Durrell 1997).

3. Results

Figure 1 shows the correlation between central surface brightness and exponent n from the Sérsic fits. More luminous galaxies have higher central surface brightnesses and $n < 1$. That is, their profiles are more "cuspy" than an exponential ($n = 1$). Lower luminosity galaxies have lower μ_0 and are flatter than exponentials ($n > 1$). An interesting exception is VCC 1876, which is the third most luminous galaxy yet has $n > 1$ and $\mu_0(V) = 21.15$. The faintest seven galaxies would be considered LSBs since they have $\mu_0(V) > 22.5$ ($\mu_0(B) > 23$).

Figure 2 shows how central surface brightness correlates with S_N. S_N increases with increasing μ_0 for the nucleated galaxies. For non-nucleated galaxies

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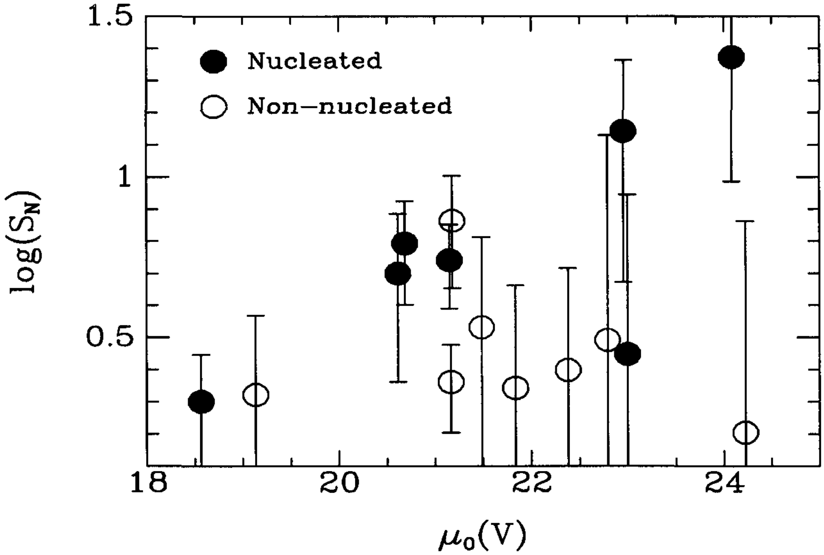

Figure 2. $\log(S_N)$ tends to increase with $\mu_0(V)$ for nucleated dEs. S_N is low and roughly constant for non-nucleated dEs.

S_N is roughly constant and relatively low. The exception is VCC 1577, which has a high S_N but whose most luminous cluster lies within 35 pc of the center. The orbit of this cluster may be decaying by dynamical friction so that the cluster will eventually be the nucleus (Miller *et al.* 1998). Galaxies with $S_N \approx 0$ and $\mu_0(V) > 22.5$ are the best candidates for being stripped dIs. Thus, galaxies like VCC 118, VCC 1651, and VCC 2029 are the best examples. VCC 503 has a very low value of S_N for a nucleated galaxy and has a low surface brightness, so it would be a useful comparison object.

More work is necessary to determine the early star formation histories of dEs and establish any connection with present-day dIs or BCDs. The combination of near-IR and optical colors may help us determine the ages of the dominant stellar populations. Stripped dIs may still show net rotation or residual HI gas. Also, velocity dispersions of the globular systems and the galaxies themselves are needed to constrain the intrinsic shapes and dark matter contents of dEs.

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