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A Search for M32-like Galaxies in the Fornax Cluster using FLAIR

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Abstract. Results of a spectroscopic search for M32-like compact elliptical galaxies in the Fornax cluster are presented. None were found, which suggests that these objects represent the low luminosity end of the giant elliptical luminosity function, rather than being formed by tidal stripping. The sample is used to investigate the large-scale distribution of bright ellipticals.

1. Introduction

The origin of compact elliptical (cE or M32-like, after the class prototype) galaxies was long ascribed to tidal stripping of normal ellipticals by larger companion galaxies (King 1962, 1966; Faber 1973). This theory is able to explain the major characteristics of the class (Nieto and Prugniel 1987a); however over the last decade several results have indicated that tidal stripping may not constitute a complete theory of the formation of cE galaxies. In particular, it appears that compact ellipticals may represent the low-luminosity end of the giant elliptical luminosity function. What follows is a brief review of arguments supporting this conclusion followed by new results which add additional weight.

2. Arguments against tidal stripping

Wirth and Gallagher (1984) found a "free-flying" cE which did not appear to have any possible companion galaxy nearby. As yet, a photometric study of this object has not been done. Binggeli, Sandage and Tammann (1985) and Ferguson (1989) have noted further examples of isolated cE galaxies.

Nieto and Prugniel (1987a) have re-evaluated the photometric profile of the cE type example, M32. They found that it fits a de Vaucouleurs $R^{1/4}$ law rather than a King (or tidally truncated) law. If true, this removes one of the major motivations for the tidal stripping theory of cE formation. Also, this might suggest that the cE and E/S0 populations are related in some way.

Nieto and Prugniel (1987a) also provided a theoretical argument against tidal stripping. They showed, using a simple model, that tidal stripping of giant ellipticals by known cE companions such as M87 is inefficient at creating a cE within a Hubble time. At most, the mass of the pre-cE is reduced by a factor of two, which suggests that compact ellipticals were low-mass objects before the stripping event took place. Hence tidal stripping would be only an incidental effect, due to selection effects (Wirth & Gallagher 1984; discussion following Nieto & Prugniel 1987b).

It now appears that compact ellipticals represent the low-mass end of the giant elliptical luminosity function. Kormendy (1985) found that M32 lies on the mean relations between surface brightness, core radius, luminosity and velocity dispersion followed by giant ellipticals (see also Wirth and Gallagher). There is also the re-evaluation of M32's photometric profile, as discussed above. (For counter-arguments to some of the above, see Nieto 1990).

3. Results of our search

Our sample is drawn from two major sources: an approximately complete ($B \lesssim 17.7$) subset of the cE candidates from Ferguson (1989), and a sample of high surface brightness blue compact dwarf candidates selected as part of another project. Ferguson classified his cE candidates as possible Fornax members on morphological grounds; since giant ellipticals in the background could have identical angular diameters and surface brightnesses, radial velocities are required to prove cluster membership. The data were obtained over two nights (25th and 26th November, 1992) using the UK Schmidt FLAIR-II multi-object spectrograph, and comprise some 156 spectra. The radial velocities were obtained using the IRAF[1] cross correlation package where emission lines were not available. The results are depicted, in graphical form, in Fig. 1. After excluding known Fornax members and contaminated spectra, no new members, and hence no compact ellipticals, were found.

3.1. Implications for tidal stripping

Our search should have found most compact ellipticals brighter than $B \sim 17.7$ in Fornax. If we assume that tidal stripping is responsible for the formation of compact ellipticals, then since Fornax is a dense cluster (Ferguson 1989), compact ellipticals would be relatively abundant due to the enhanced probability of tidal interactions. Alternatively, if compact ellipticals are low luminosity giant ellipticals, then few would be expected in Fornax, with its low E/S0 morphological fraction of 5.1% (Ferguson and Sandage 1988). Our result is consistent with the latter hypothesis.

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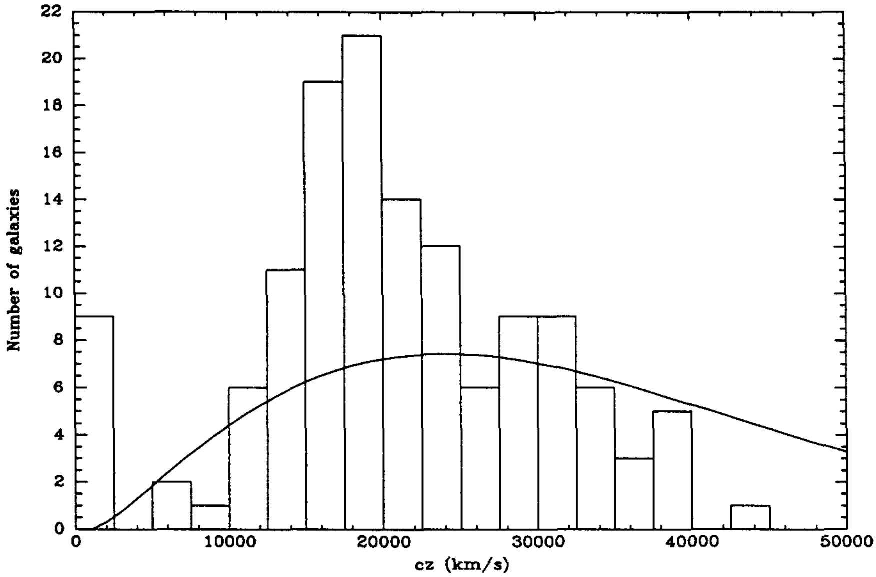

Figure 1. Redshift histogram for observed sample. The curve indicates the theoretical number-redshift relation.

4. Large-scale structure in the direction of Fornax

Practically all of the sample turned out to lie well behind the Fornax cluster, enabling it to be used to study the redshift distribution of bright elliptical galaxies over a large volume of sky. The distribution is shown in Fig. 1. Using $\Omega_0 = 1$ and a Schechter luminosity function with $M_* = -21$, we can predict the theoretical number counts versus cz relation for a limiting B magnitude of 17.7. This curve, with an appropriate normalisation, is also plotted in Fig. 1. There is an obvious mismatch between the theoretical and observational distributions. The first bin ($0 < cz < 2500$ km s^{-1}) consists of known Fornax members and spectra contaminated by Galactic stars. The region $2500 < cz < 10000$ km s^{-1} corresponds to a low density region behind the cluster noted by Ferguson. The extremely prominent peak in the distribution at $cz \sim 17500$ km s^{-1} corresponds well with a peak noted by Phillipps and Davies (1992) in their search for low surface brightness galaxies in Fornax. The sharp fall in counts at $cz > 40000$ is due to the Hα emission line passing out of the available spectral range at these redshifts.

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