Forbes, D. A. (2010). Isolated early-type galaxies.

Originally published in L. Verdes-Montenegro (ed.). *Proceedings of 'Galaxies in isolation: exploring nature vs. nurture', Granada, Spain, 12–15 May 2009.* (Astronomical Society of the Pacific conference series, Vol. 421, pp. 217-220). San Francisco: Astronomical Society of the Pacific.

FULL TITLE
ASP Conference Series, Vol. **VOLUME**, © **YEAR OF PUBLICATION**
NAMES OF EDITORS

Isolated Early-type Galaxies

Duncan A. Forbes
Centre for Astrophysics and Supercomputing, Swinburne University, Hawthorn VIC 3122, Australia

Abstract.
Isolated early-type galaxies are very rare, yet offer important leverage in terms of testing galaxy formation models free of environmental processes. They also act as a valuable control sample. Here I briefly summarise past samples of isolated early-type galaxies and a new well-defined sample. The morphology, stellar populations and scaling relations of these galaxies are compared to their high density counterparts.

1 Introduction

Why study isolated galaxies? Isolated galaxies are immune to some of the complex baryonic processes that operate in denser environments, and hence they act as an experimental control sample. Such processes could include ram pressure stripping, strangulation, high speed interactions and ongoing mergers. Isolated elliptical galaxies are particularly rare (a consequence of the morphology-density relation) but offer important leverage in terms of testing galaxy formation processes. In the extreme did isolated elliptical galaxies form long ago and remained passive ever since, or are they the result of a recent merger in which both of the progenitors have 'consumed' in the merger?

A number of studies of isolated early-type galaxies have been carried out. There is a trade off between small number statistics and strict isolation. Previous work has included:

- Stocke et al. (2004) 98 galaxies;
- Reduzzi et al. (1996) 42;
- Colbert et al. (2001) 30;
- Aars et al. (2001) 4;
- Kuntschner et al. (2002) 9;
- Smith et al. (2004) 32;
- Collobert et al. (2006) 30

It is important to be aware of catalogue limits – some previous studies have selected galaxies too close to the limits and hence falsely classified galaxies as isolated.

2 Our Isolated Elliptical Sample

• Elliptical galaxies;
• Nearby, V < 9000 km/s;
• Within catalogue limits, B < 14 (90% complete);

And no neighbours within:
• 700 km/s
• 0.67 Mpc in the plane of the sky
• 2 B mags (factor of 6 in mass)

This resulted in a sample of 36 isolated ellipticals and is described in Reda, Forbes et al. (2004). One of the galaxies (NGC 1132) could be regarded as a fossil elliptical with an extended X-ray halo of luminosity of $L_X = 10^{42}$ erg/s.

We performed elliptical isophote fitting to the galaxies and removed the model fit to search for any fine structure. We found plumes, shells and tails in some galaxies but also no evidence for fine structure in others.

A Lick style analysis of central ages and metallicities revealed some galaxies to be old, while others supported young stars, i.e. evidence for a central starburst within the last few Gyrs.

A kinematic study revealed a few cases of kinematically distinct cores. This is usually taken as a sign of a past merger event.

Most of the galaxies were consistent with the colour-magnitude and fundamental plane relations for ellipticals in clusters. However a number of galaxies deviated significantly from these relations. They deviated in the sense of lower M/L ratios, consistent with their younger stellar populations. These galaxies also tended to be the ones with evidence for morphological disturbance.

The X-ray properties of isolated ellipticals are limited due to the limited data available. However to first order the X-ray halos of isolated ellipticals appears to be similar to that of cluster ellipticals, and perhaps driven simply by the halo mass of the galaxy.

3 NGC 821

NGC 821 is the nearest isolated elliptical in the Reda et al. (2004) sample. It reveals a young centre but the age gets progressively older with galactocentric radius. It reaches the age of the universe at one effective radius (50% of the stellar mass of the galaxy). Thus the young stars appear to be a frosting of $\leq$5% in mass. Romanowsky et al. (2003) claimed NGC 821 to be a very low dark matter galaxy. This is supported by its faint X-ray halo. Our new kinematic mapping to $\sim$3 effective radii (Proctor, Forbes et al. 2009) indicates an initially falling but then flat velocity dispersion profile. This is suggestive of dark matter at large radii. Beyond 1.5 effective radii, the galaxy no longer rotates and so has a rare declining V/σ profile. In terms of rotation class, it changes from a fast rotator in the inner regions to a slow rotator in the outer ones. We also examined NGC 821 in terms of its globular cluster system (Spitler & Forbes 2009). We found it to have a normal globular system and one that scales with the halo mass. For a larger sample of galaxies, there appears to be no strong environmental trend in globular cluster system mass.

4 Conclusions

Isolated elliptical galaxies provide a useful control sample, free from cluster/group environmental processes. Such galaxies are a mixed bag of old passively evolving and recently assembled ellipticals. The X-ray luminosity of their halos, their globular cluster system mass and their assembly history may all depend more on halo mass than environment.

Acknowledgments. I would like to thanks the local organisors for holding a great meeting in a wonderful place. Gracias.

References

Aars, C., et al. 2001, AJ, 122, 2923
Colbert, J., et al. 2001, AJ, 121, 808
Collobert, M., et al. 2006, MNRAS, 370, 1213
Kuntschner, H., et al. 2002, MNRAS, 337, 172
Spitler, L. & Forbes, D., 2009, MNRAS, 392, 1
Proctor, R., et al. 2009, MNRAS, in press
Reda, F., et al. 2004, MNRAS, 354, 851
Romanowsky, A., et al. 2003, Science, 301, 1696
Smith, R., et al. 2004, ApJ, 617, 1017
Reduzzi, L., et al. 1996, MNRAS, 282, 149
Stocke, J., et al. 2004, AJ, 127, 1336