Detecting Nuclear Star Clusters in Coma Cluster Dwarf Elliptical Galaxies

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Coma Cluster and the HST Treasury Survey

The Hubble Space Telescope (HST) offers unrivalled resolution and sensitivity making it ideal for studying the structural properties of faint, diffuse dEs. The Coma cluster is a rich dense cluster of galaxies at a distance of 100 Mpc containing thousands of dEs. Background image: Multi-wavelength image of the Coma cluster. Each green point represents a dE galaxy! The properties and location of the Coma cluster are ideal to study galactic structure and evolution.

What are Nuclear Star Clusters?

 Dense star clusters located at the centre of most galaxies. Recent studies find NSCs in as much as ~60% of galaxies[1]. All dE galaxies contain NSCs. Figure 1. shows the nearby, featureless dE galaxy, M32. This galaxy contains a NSC, however, without analysing the image this is impossible to tell!(see next section!)

Why are Nuclear Star clusters important?

- Central regions of galaxies are key in galactic evolution
- Studying the difference between nucleated and non-nucleated galaxies is important in understanding clustering processes
- Central clusters are closely related central to SMBH

Nuclear Excess Index

The index is designed to search for excess light in the galaxy centre. After model subtraction the index compares the nuclear flux (F(<2pix)) with the flux just outside the nucleus (F(<7pix)):

\[ \text{NEI} = 2 \times \langle F(<2.0pix) \rangle - F(<7.0pix) \]

\[ \langle \sigma_{\text{mag}} \rangle \]

NEI (Nuclear Excess Index) defines the degree of galaxy nucleation, \( \langle \sigma_{\text{mag}} \rangle \) is the average value of the noise on each pixel within the galaxy area.

Model galaxies: What can be detected?

Simulated galaxies with a NSC define what can be detected.

- The index cannot detect the very faint galaxies or galaxies with a very small radius
- Figure 4. absolute galaxy magnitude (M) vs. radius for the sample for Coma cluster galaxies
- The red lines mark what can be detected by the NEI (i.e. M < -12.5 \& r > 10 pix)

Model galaxies: Characterisation of the Nuclear Excess Index

The NEI index has been tested on various model galaxies. Simulated galaxies without a NSC define the not nucleated range. Figure 3. shows the distribution of galaxies without a NSC

Future Work

The NEI requires more model galaxies and more in depth analysis to fully characterise the limitations.

- The index should be tested on published data (e.g. the HST Virgo cluster survey) to reproduce results adding confidence to the NEI
- Test the index on other types of galaxies in other clusters to increase the increase the versatility of the NEI