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Nuclear Star Clusters in Coma confirmation of an unusually high nucleation fraction

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Abstract. Nuclear star clusters (NSCs) are stellar systems similar in size to globular clusters (GCs) but extremely dense, comparable only to some GCs and ultra-compact dwarfs. They are present in galaxies with a wide range of masses, morphologies and gas content. There are several formation scenarios proposed for the formation of such objects, such as the merger of GCs or extreme star formation caused by the inflow of gas. Recent studies show that the presence of an NSC is related to galaxy stellar mass. Moreover, it has been suggested that NSCs are more often found in high density environments. In our work, we use deep imaging of the core regions of the Coma cluster down to an absolute magnitude of −8.2 and found that in this environment the nucleation fraction is higher than in the Virgo and Fornax clusters. We find nucleated galaxies in Coma as faint as −11.2 mag.

Keywords. galaxies:star clusters, galaxies:evolution, galaxies:nuclei

1. Introduction and Objectives

In the central regions of galaxies with a wide range of masses, luminosities and morphological types, there exists a class of compact stellar systems known as nuclear star clusters (NSCs). Such objects have half-light radii in the range of 1-50 pc and extreme stellar densities Drinkwater *et al.* (2000). The formation of NSCs has been suggested to derive from two non-exclusive scenarios: The dry merging of star clusters in the early stages of galaxy formation, and the inflow of gas to the central region of galaxies (Antonini (2013)). Sanchez-Janssen *et al.* (2019) showed that the fraction of galaxies that harbour NSCs is a strong function of galaxy stellar mass (see left panel of Fig. 1). A secondary dependence on environment has been suggested, since the nucleation fraction in the Coma cluster was higher at least in the range of $log(M/M\odot) = 10^7$ to 10^9. This work investigates the nucleation fraction in Coma with deep Hubble Space Telescope (HST) images, to detect NSCs even in very faint galaxies.

2. HST data and Photometry

The data used in this work were obtained with the WFC/ACS instrument on HST in both the F814W and F475W filters, centered on NGC 4874 and NGC 4889. To detect the faintest galaxies possible, we subtracted the brightest galaxies in the images and performed two SExtractor (Bertin *et al.* 1996) runs: a first one focusing on extracting point-sources and a second one on the *background* image generated from the first run.

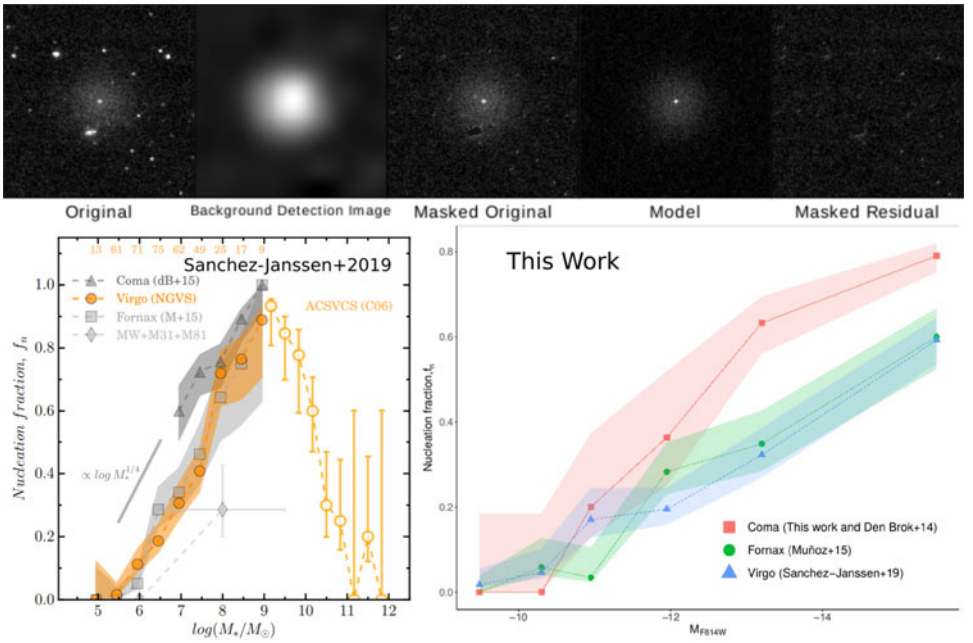

Figure 1. *Top:* Example of the detection and photometry method used in this work. *Bottom left:* Nucleation fraction for Virgo, Coma and Fornax clusters from Sanchez-Janssen *et al.* (2019). *Bottom right:* Results of this work, with the complete nucleation fraction in Coma down to the fainter galaxies, compared to Virgo and Fornax.

Then, we proceed to visual inspection. We were left with 57 galaxies that were modelled with GALFIT (Peng *et al.* (2002)). An illustration of the method is shown in the top panel of Fig. 1.

3. Results

We joined our data with those from Den Brok *et al.* (2014) and compared the nucleation fraction for galaxies in Coma with Virgo and Fornax (bottom right panel of Fig. 1). We found that the nucleation fraction in Coma is higher for galaxies with $M_{F814W} > -11$ mag. For fainter galaxies, the nucleation fraction between the clusters is equal within uncertainties. We consider this as a confirmation of an environmental influence on the formation and evolution of NSCs that might also be related to the host galaxy mass, such that the least massive galaxies are not affected. Further work is needed to better constrain the origins of this result.

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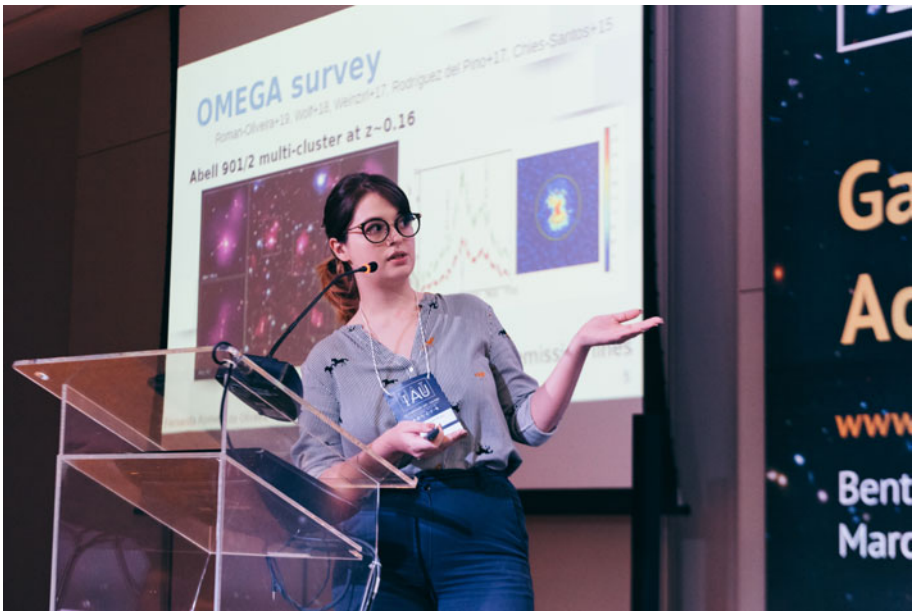

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