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Caught in the web: A tale of filament galaxies

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Abstract. The Coma supercluster is one of the largest, nearby ($\sim 100h^{-1}$Mpc) gravitationally bound structures known in the universe. It comprises two large clusters of galaxies and several galaxy groups intersected by a complex network of filaments, providing the perfect laboratory for studying the evolution of galaxies in a range of 'continuous' environments. We characterised the different components of the environment to study the properties of galaxies in the optical and ultraviolet (UV) wavebands. Our analysis shows that galaxies experience accelerated evolution as they approach the spine of the filament, suggesting that the intermediate-density environment prevalent in the filaments can accelerate the evolution of galaxies.

Keywords. galaxies, galaxy-environment, star-formation

1. Introduction

Observations suggest that most of the galaxies reside in large-scale filaments. Yet the intermediate-density environment prevalent in the filaments is poorly studied due to their large angular size on the sky. In Mahajan *et al.* (2018) we explore the impact of the filament environment on the properties of galaxies in the Coma supercluster, and compare it to the other components of the environment which are clusters and groups and, voids.

2. Method

We use the optical spectroscopic and photometric data from the Sloan digital sky survey (SDSS) data release 12 and ultraviolet data from the GALaxy evolution EXplorer (GALEX) mission, to characterise different environments in the $\sim$500 sq. deg. region of the Coma supercluster. We employed the Hierarchical Density-Based Spatial Clustering of Applications with Noise (HDBSCAN) algorithm (McInnes *et al.* (2017)) for identifying groups, while the filaments were characterised using the Discrete Persistent Structures Extractor (DisPerSE; Sousbie *et al.* (2011)). Galaxies belonging to neither of the above environments were classified as void galaxies (Figure 1).

3. Results

Figure 2(a) shows the distribution of galaxies in different environments in the colour-magnitude plane. The spectroscopically-selected star-forming galaxies (EW(Hα) $\geqslant 2$Å) can be well distinguished from their passively-evolving counterparts in all environments. Our main finding is displayed in Figure 2(b) which shows the median trend in the broad-band colours $g-r$ and $FUV-NUV$ and the EW(Hα) for galaxies as a function of their distance from the spine of the filaments. We statistically confirm that the galaxies become redder and less star-forming as they approach the spine of the filaments.

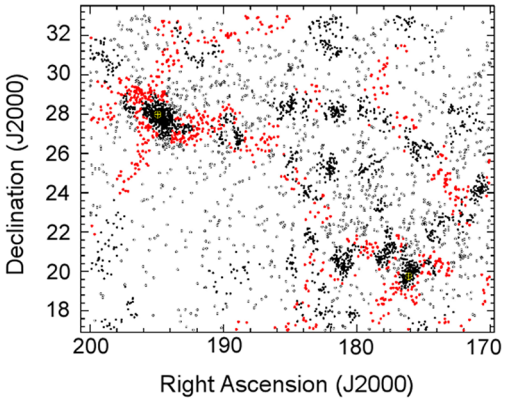

Figure 1. Environments in the Coma supercluster. The grey open circles, red points, and black points represent the galaxies in the voids, filaments and clusters or groups galaxies, respectively.

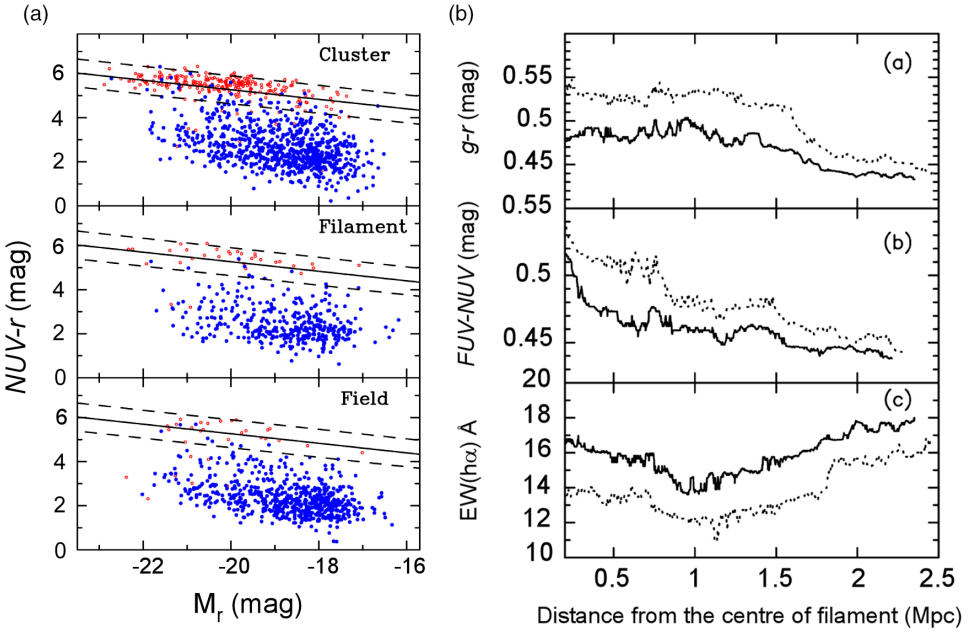

Figure 2. (a) The distribution of galaxies in the colour-magnitude plane. The red points represent passively-evolving galaxies (EW(Hα) ≤ 2Å), while their star-forming counterparts are represented by blue points. (b) The $g-r$ and $FUV-NUV$ colours, and the median EW(Hα) of all (dotted line) and non-AGN (solid line) galaxies are shown as a function of their distance from the spine of nearest filament.

4. Epilogue

The availability of multi-wavelength data from large all-sky surveys provides a great opportunity to study the large-scale environment of galaxies at $z \sim 0$. It remains to be seen whether the properties of the cosmic-web as found in the Coma supercluster duplicate themselves in other nearby superclusters, and at other redshifts. However, our finding that the intermediate density environment prevalent in the filaments influences

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the galaxies at least out to a radius of 1 Mpc, lays the ground for exploring the properties of the cosmic-web and its impact on the properties of galaxies in simulations, and encourage deeper observations of galaxies spanning all environments.

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