The connection between galaxies and superclusters of galaxies

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Abstract

We investigate the relation between morphological characteristics of large scale structures (LSS) and the stellar populations of galaxies with a sample selected from the Sloan Digital Sky Survey (SDSS/DR7). Distributing those galaxies in a Cartesian space, we identify large scale structures using the luminosity density field method with an adaptive kernel, taking into account the selection function. To identify regions of connected density field points, we use a *Friends-of-Friends* algorithm. Afterwards, we quantify the LSS morphology using the best-fit ellipsoid and Minkowski's Functionals. For the stellar populations data, we use parameters such as mean ages, metallicities and D_{n4000}, obtained with the code Starlight (Cid Fernandes et al. 2005). Most of LSSs are filaments and the richest objects tend to present significant triaxiality.

Data - SDSS sample

Our sample was extracted from the SDSS, Data Release 7. We restrict our sample to

- Stripes from number 10 to 37
- Petrosian magnitude 13.0 < *r** < 17.77
- Redshift range 0.003 < z < 0.2

Our final sample contains ~592000 galaxies. use the k-correction code from Blanton et al.(2003) and Galactic extinction from the SDSS database to correct the magnitudes. For cosmological calculations, we use Ω_m=0.3, Ω_Λ=0.7, and h=1.

Identification of Large Scale Structures

The luminosity density at a point *r* is

$$\rho(r) = \sum_i K(r - r_i, \sigma) L_i W_L .$$

The luminosity statistical weight (W_L), based on the luminosity function of galaxies, must be considered to take into account objects out of the magnitude range. We use the Schechter (1976) luminosity function with parameters α=-1.21 and M_r^* = -20.71 - 5log h (Hutsi et al. 2003). For the luminosity density field, we consider

- Grid cells with size l_{cel} = 4 h^{-1}Mpc.
- An Epanechnikov's kernel with a smoothing parameter σ = 8 h^{-1}Mpc.
- The threshold density D/D_0=6.5, making sure that the largest structure does not exceed the dimension of ~120h^{-1}Mpc

To find connected structures of density field cells, the *Friends-of-Friends* algorithm has been used, with a linking length l_{FoF} = 7 h^{-1} Mpc. With this approach we have finally identified 956 LSSs.

LSS Morphology

We use the best-fit ellipsoid method based on the inertia momentum to characterize the shape of LSSs. The parameter of triaxiality is defined as $T=(a^2-b^2)/(a^2-c^2)$, where *a*, *b*, and *c* are the axis of the best-fit ellipsoid. Figure 1 shows the distribution of triaxiality and the relation between the ellipicities e_1=1-b/a and e_2=1-c/b.

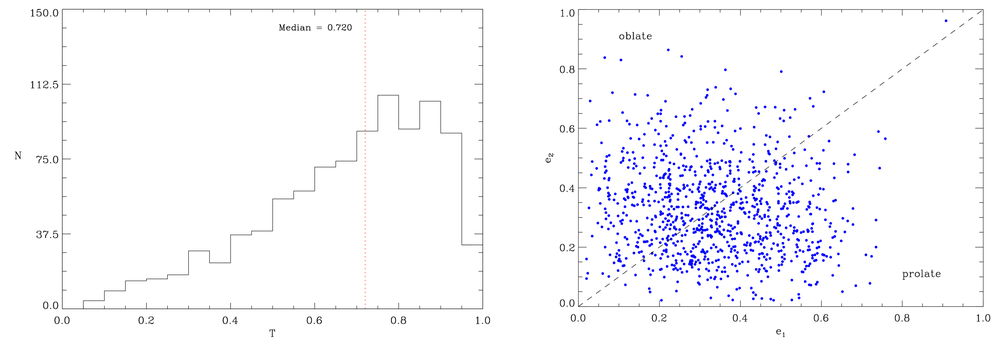

Figure 1: The distribution of triaxiality T (right panel) and ellipticities e_1 versus e_2 (left panel). The dashed line is the limit between oblate(452 objects) and prolate structures(504 objects).

To calculate the Minkowski's Functionals, we use the best-fit ellipsoid axis (a, b and c), following the formalism of Basilakos et al. (2003).

- S*hapefinders* parameters, K_1(*planarity*) and K_2(*filamentarity*).
- K_1/K_2 >1 represents pancake-like objects
- K_1/K_2 ≃1 represents ribbons
- K_1/K_2 <1 are filaments.

We found 473 filaments, 418 pancakes and 65 ribbons. Most of LSSs are filaments, as found by other authors (e.g. Basilakos et al., 2003).

Spectral Parameters

The *Starlight* code (Cid Fernandes et al. 2005) combines spectra from individual stellar populations in order to match the input observed spectra. The fitted-spectra provide us important information on the stellar populations of galaxies such as mean values of metallicity and age. Figure 2 shows the morphological parameter K_1/K_2 and metallicity (Z), Richness, Age and number density. The spectral parameters defined for each LSS are median values of galaxy parameters.

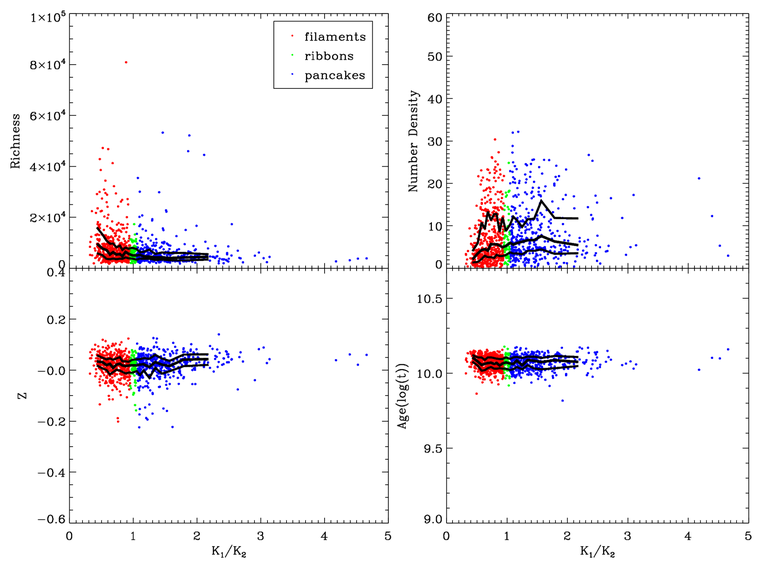

Figure 2: This panel shows the morphological parameter K_1/K_2 versus Richness, Number Density, Metallicity and Age. Different colors show the classification of LSSs as pancake-like (blue), ribbons (green) and filaments (red).

We conclude that

- Most of the LSS in our sample are filaments.
- Most of the objects tend to present high triaxiality.
- There is a trend for metallicity to increase with K_1/K_2

References

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