The effect of large scale environment on galaxy properties

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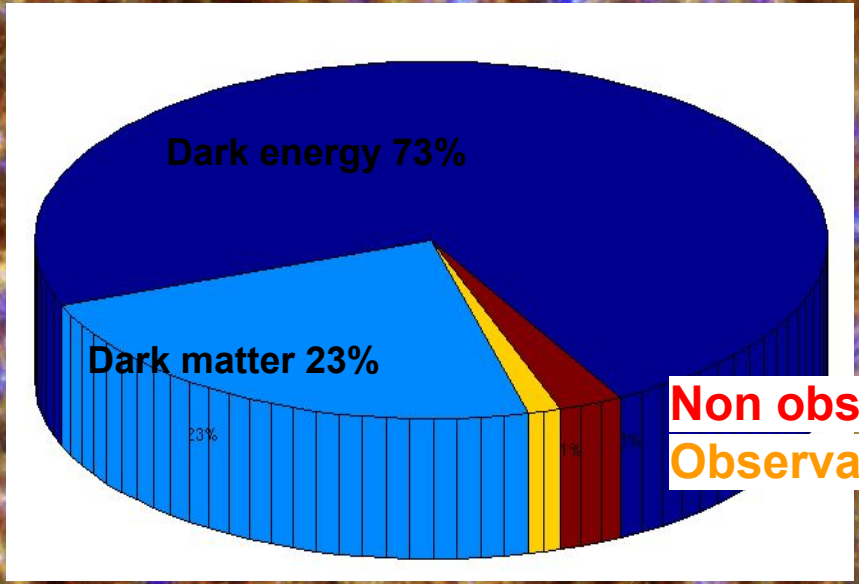
- The LSS baryonic component is composed by substructures of gas and galaxies embedded in dark matter halos.
- The majority of the baryonic material in the Universe has not been detected yet.
- Models and numerical N-body simulations suggest that from 1/2 to 2/3 of all baryons may be located in the intercluster medium.



CLUSTERS
Filaments
Groups
sheets

Goal

Study LSS environmental effects in the evolution of galaxies, groups and clusters.

Galaxy Clusters → S-Z effect

Filaments → optical galaxy positions

The most denser regions: Galaxy Clusters

They contain high density hot gas (1-10 keV):

- Cools radiatively and emits at X-rays wavelengths.
- It generate a distortion of CMB spectrum named Sunyaev-Zel'dovich (S-Z) effect.

Chandra X-ray · Composite image of X-ray and optical light of galaxy cluster Abell 1835.

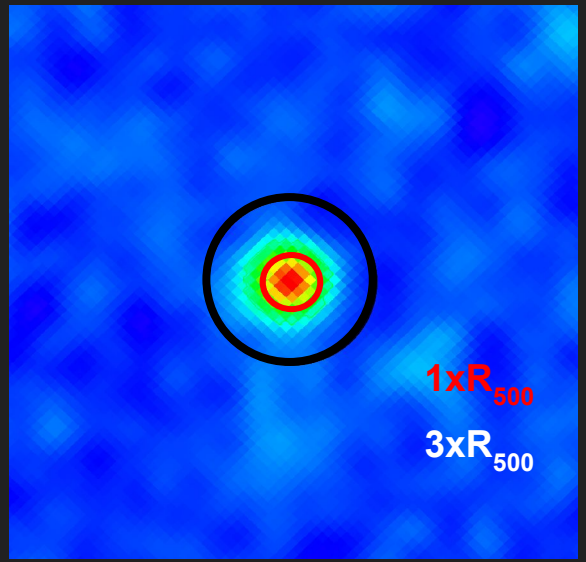
Galaxy cluster from Magneticum simulation

Measure the thermal pressure in clusters

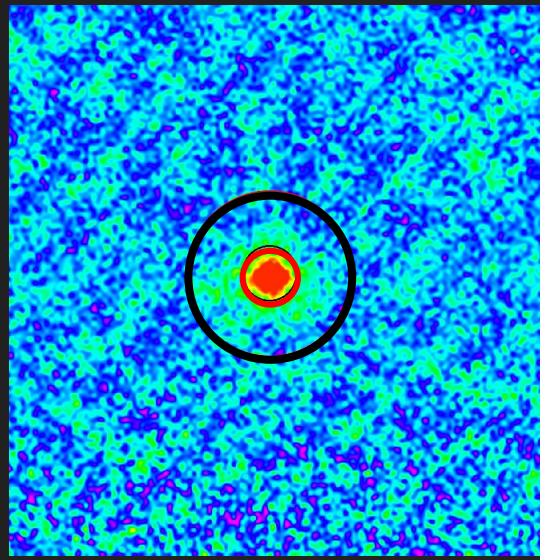
The gas is virialized in the inner part of the clusters, 1 R_{500}.

To characterize the gas contained inside galaxy clusters we employed a Planck and ACT (Atacama Cosmological Telescope) map composition.

The Planck+ACT (PACT) map provides an angular resolution of 1.4 arcmin.



Planck 10 arcmin



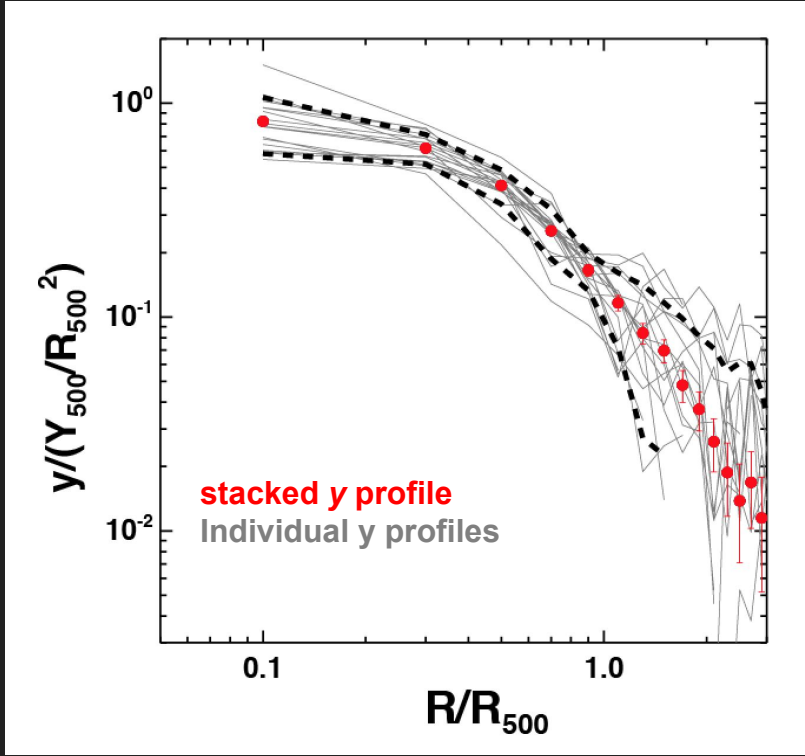
Planck+ACT 1.4 arcmin

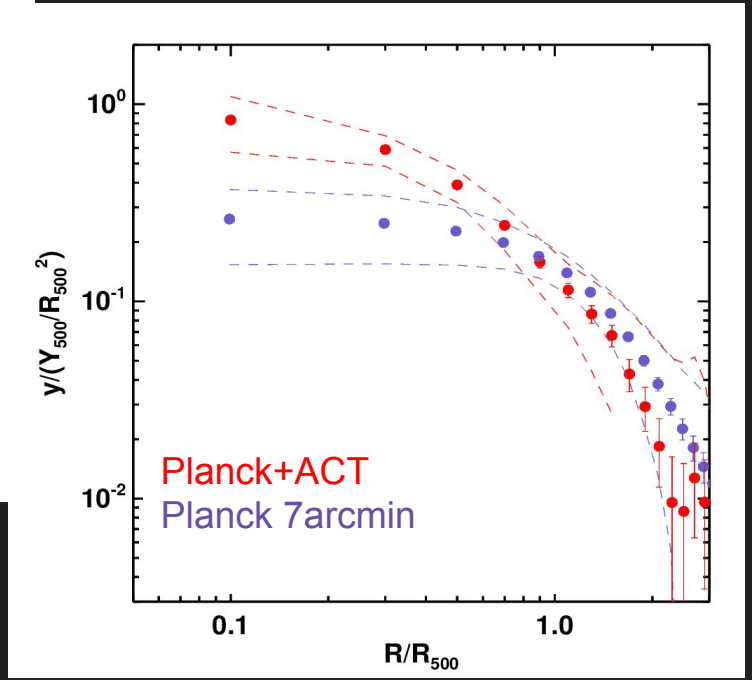
The ACT map is provided in two stripes ($\Delta\delta$~4^o) one for the equator (δ~0^o) and the other for the south (δ~50^o).

S-Z radial profile

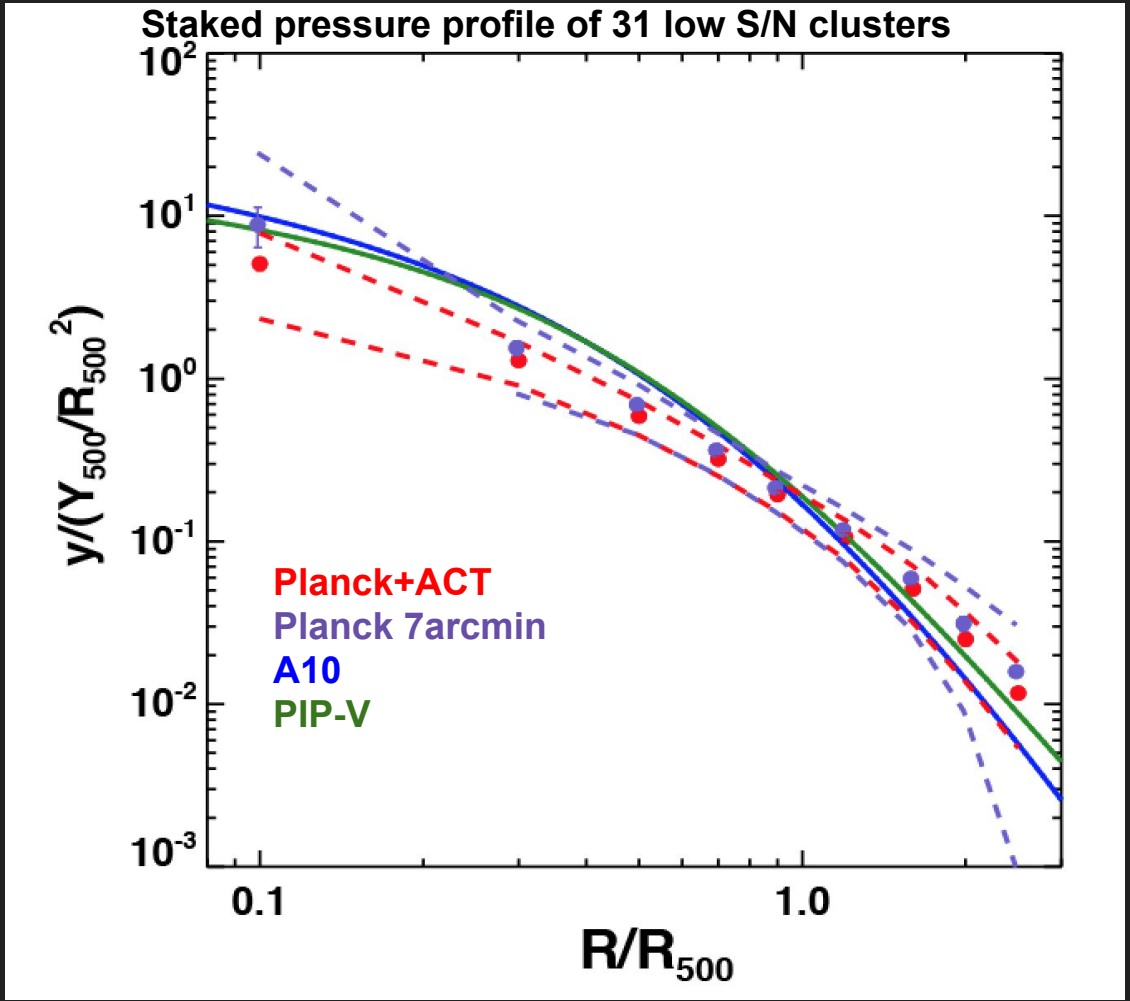
We selected a sample of 31 galaxy clusters in the ACT coverage area.

Extract the *S-Z* emission profile for each each cluster.





y stacked profile for the same 31 clusters.



We derived a pressure profile for each cluster by applying a deconvolution deprojection to the *y* profiles.

A similar work had been performed previously by the Planck collaboration, 2013 (PIP-V).

We staked the pressure profiles in order to compare with the previous results of Arnaud et al. 2010 (A10) and (PIP-V).

Less denser structures: filaments and sheets

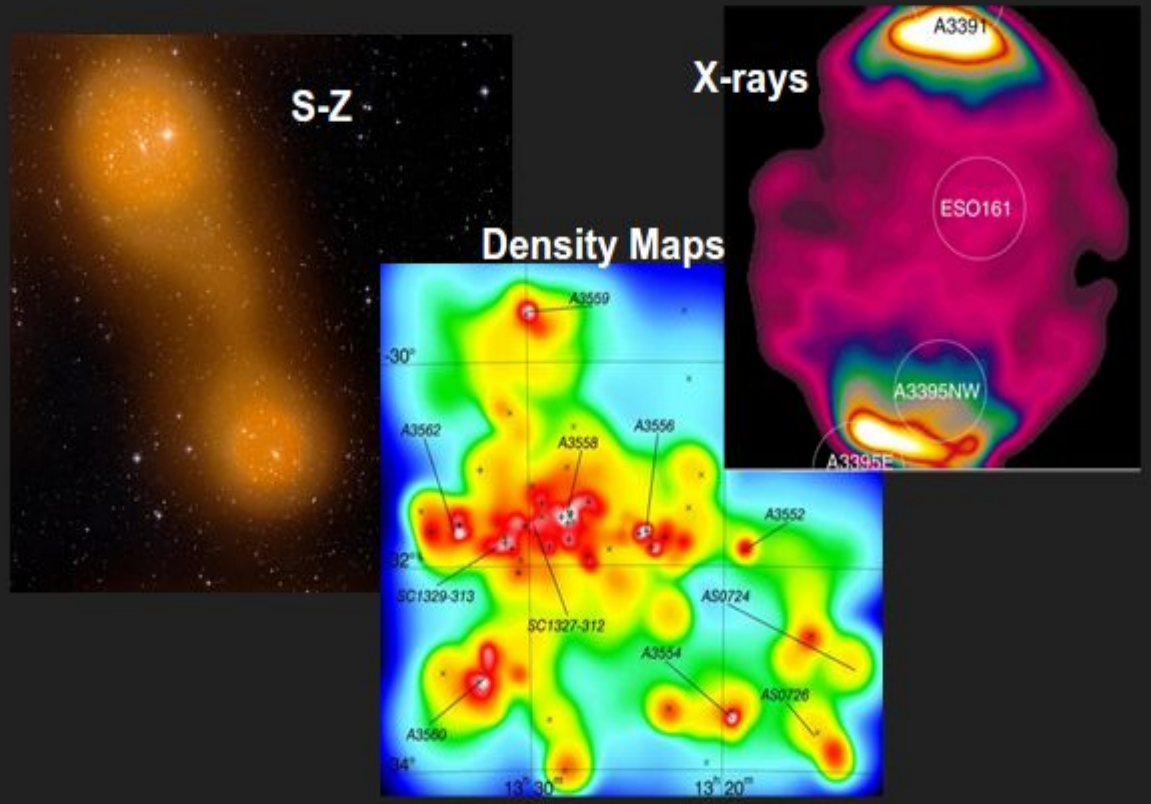
The baryons are likely in moderately hot gas phase (0.01-1 keV)

It is commonly known as warm hot intergalactic medium (WHIM).

The WHIM has been detected between pairs of clusters using X-rays and Sunyaev-Zel'dovich (S-Z) effect.

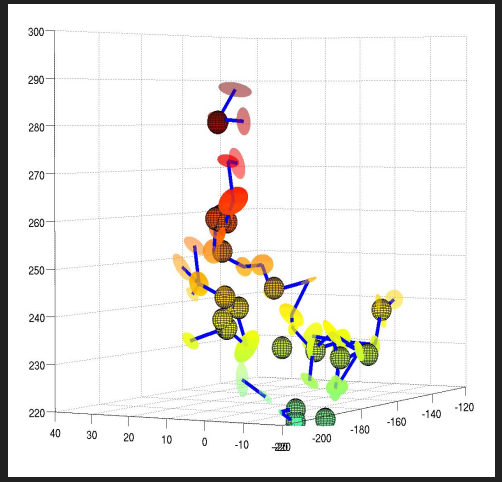
However, the detection of such gas is very difficult since it is diluted.

Longer exposures or new generation of instrumentation.

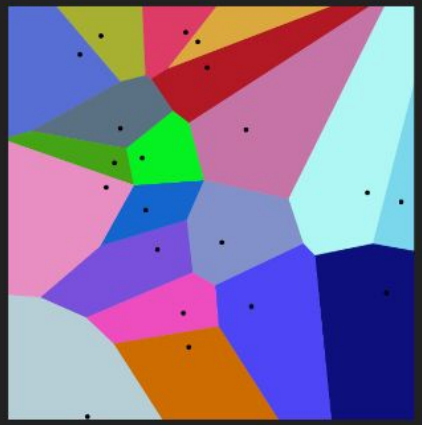


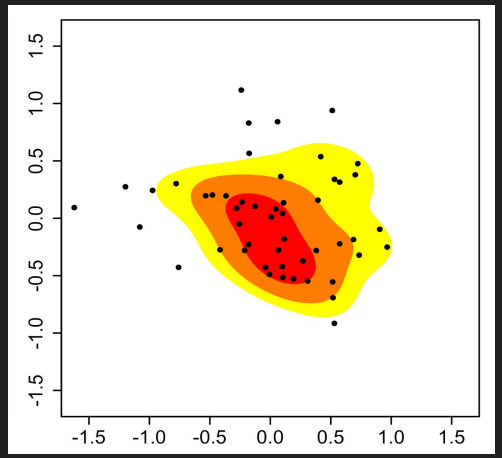
Filamentary structures

- Sample of ~20 filament candidates inside superclusters (z<0.2)
- Spectroscopic galaxies from **Sloan Digital Sky Survey (SDSS),** m_r ~18.
- Identification of large scale structures (2 - 20 Mpc).



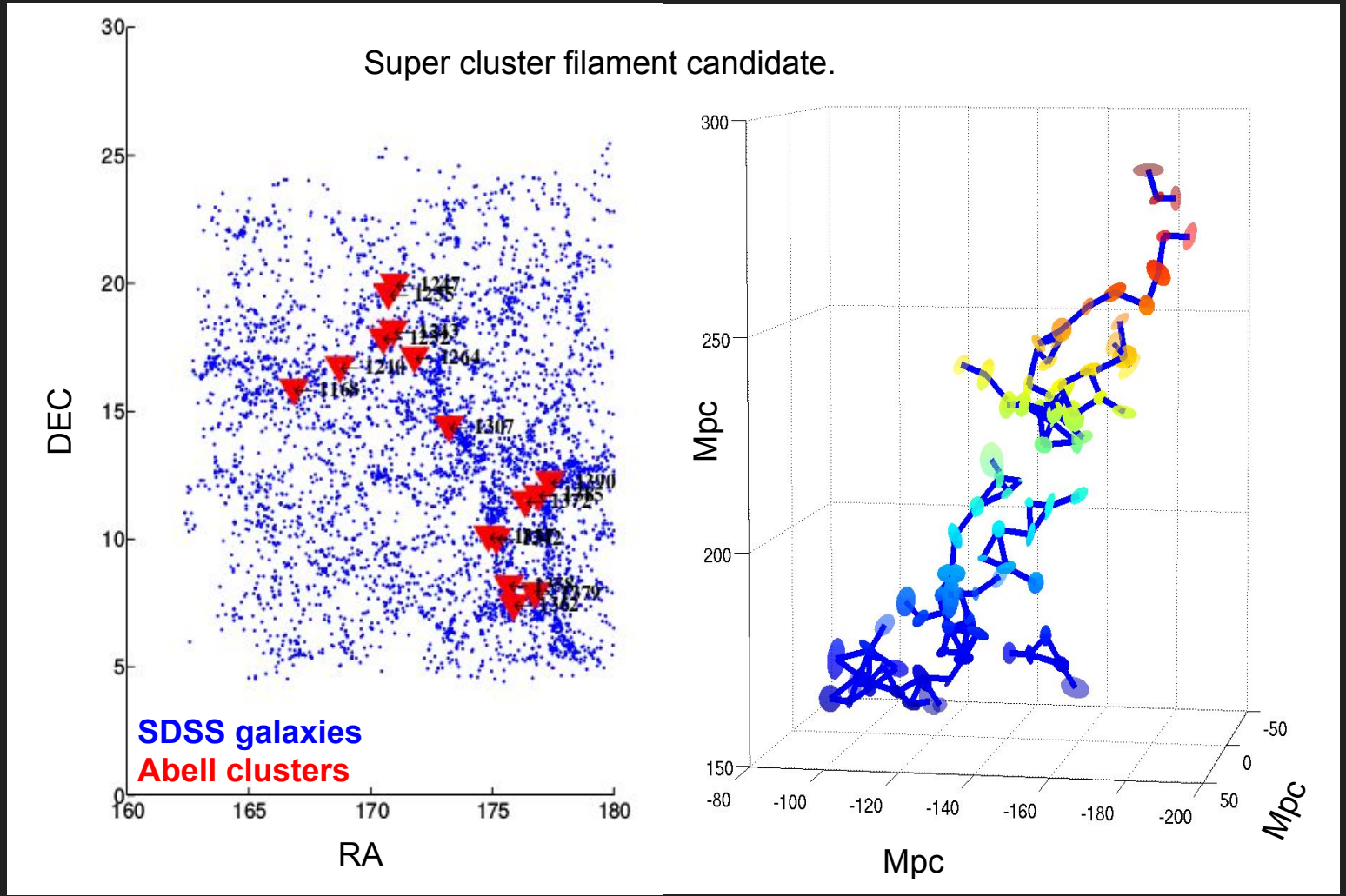
Apply an algorithm to search for spatial relations between galaxies.

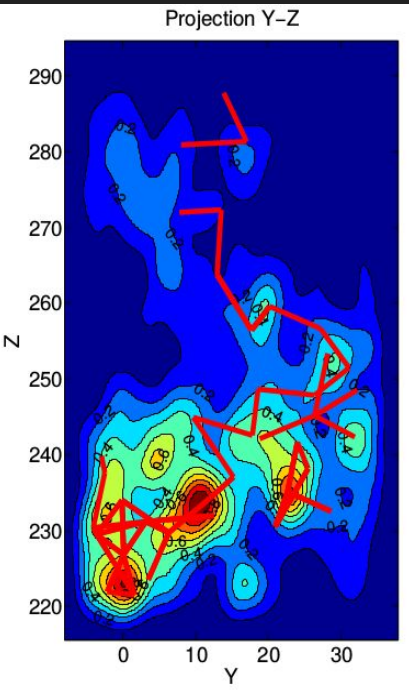


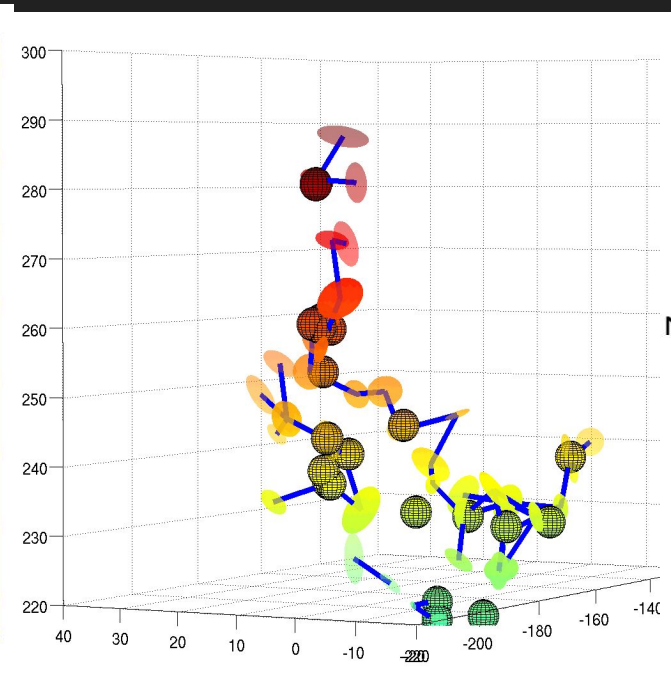


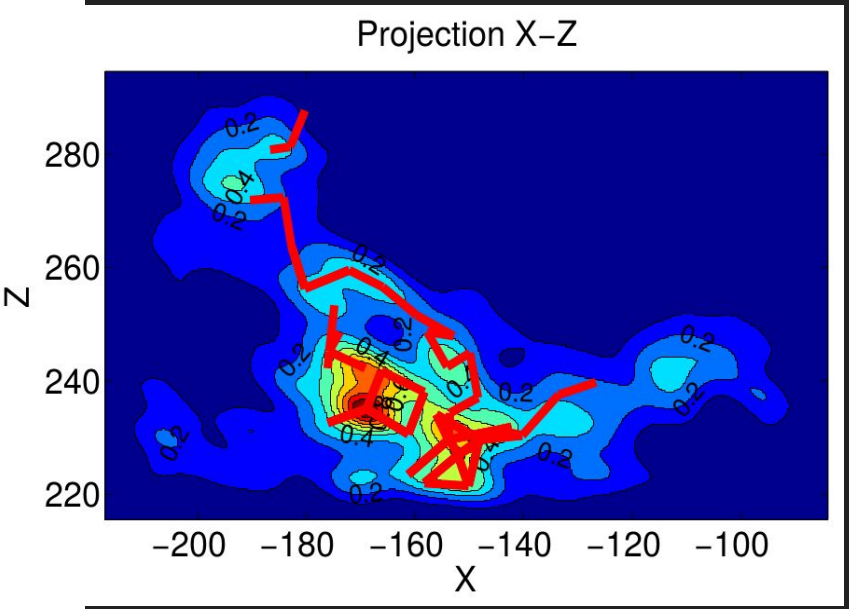
Map the density using kernels (KDE) and Voronoi tessellation (VT).

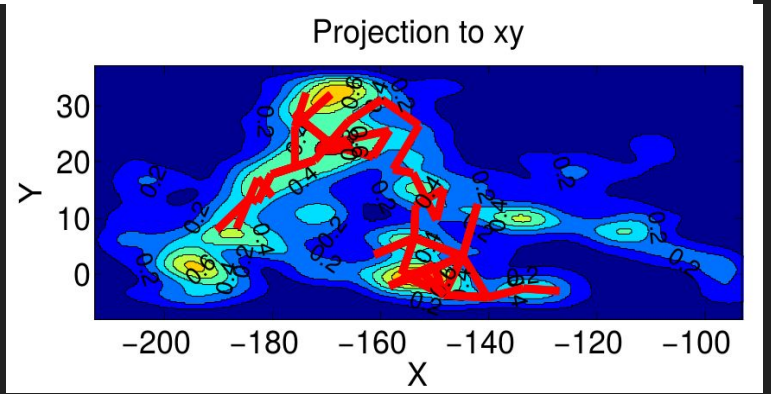
Study of filaments and sheets

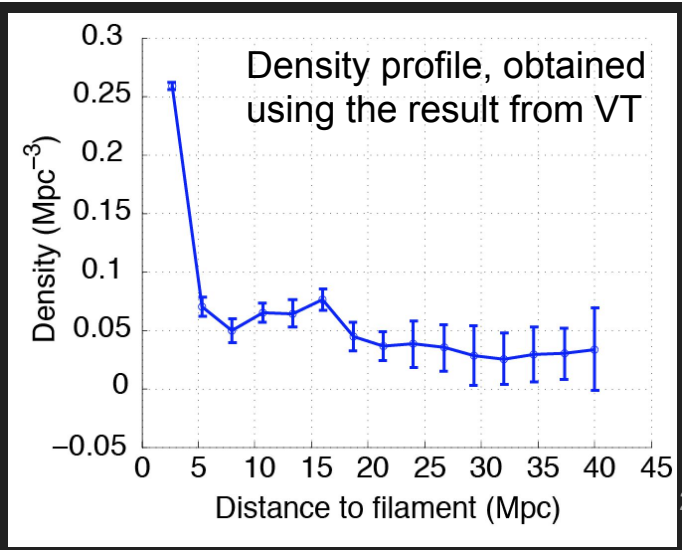



Projection Y−Z
Z
Y



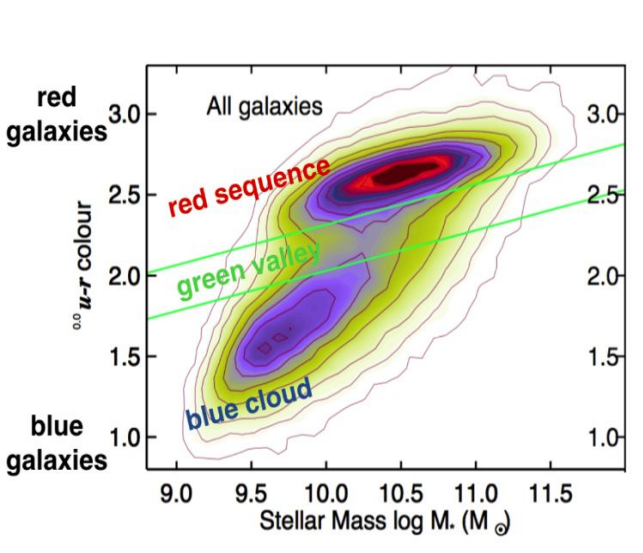

Projection X−Z
Z
X

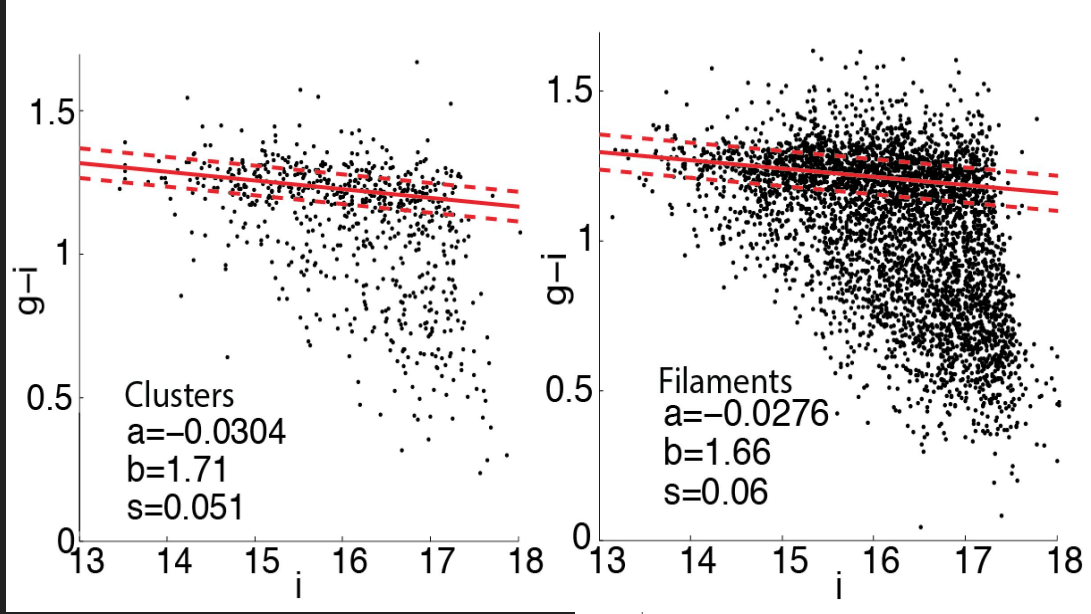

Projection to xy
Y
X


Density profile, obtained using the result from VT
Density (Mpc^{-3})
Distance to filament (Mpc)

Galaxy properties

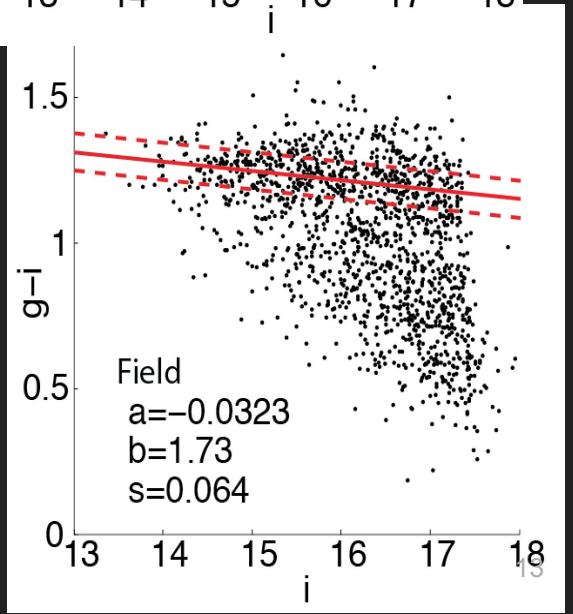
To analyse the effect of the structures over the galaxies evolution we construct the color-magnitude[1] and color mass diagrams for the clusters, filaments and field.





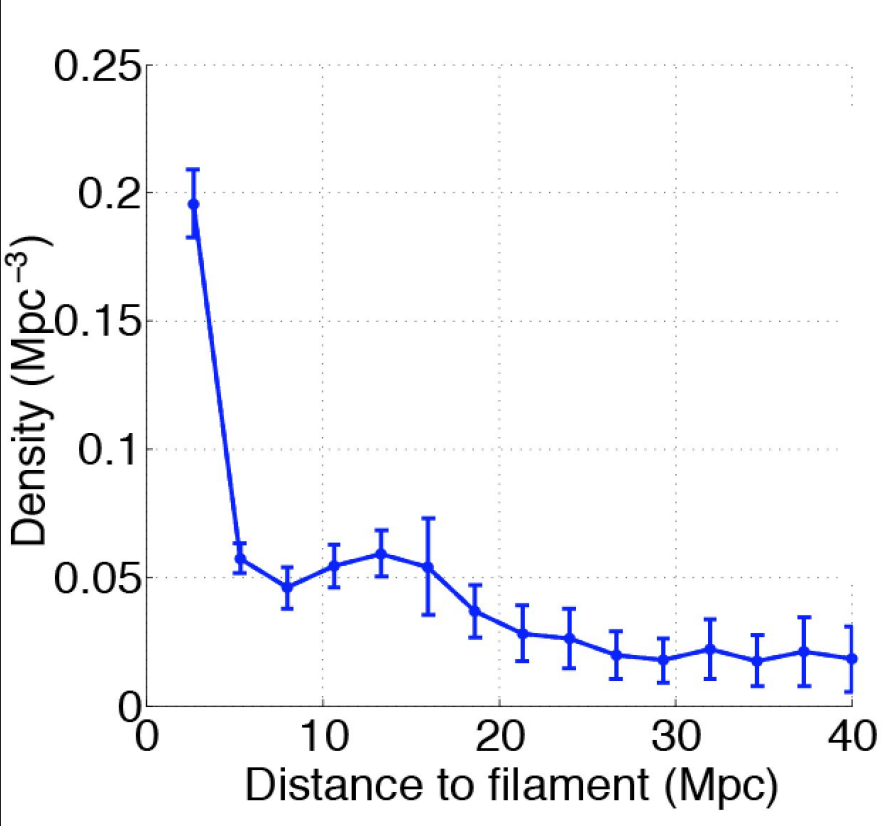
For the clusters, we consider galaxies inside a sphere of radius 2.5 Mpc.

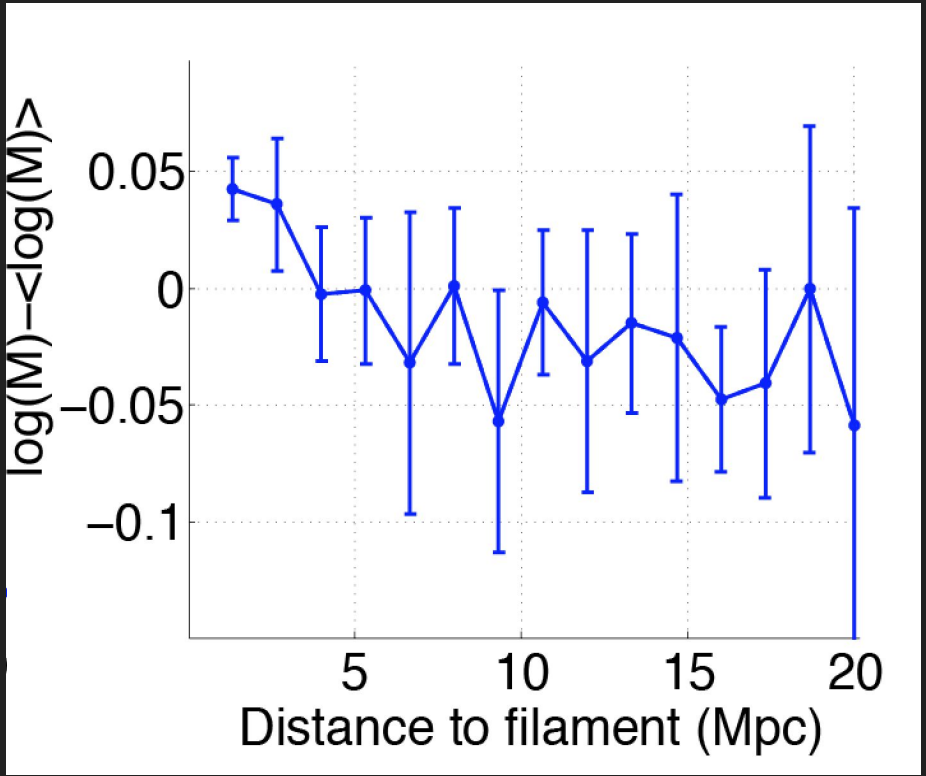
For the filament analysis we consider galaxies at a distance of 10~20 Mpc, galaxies inside clusters were excluded.



[1]For all the analysiswe used magnitudes corrected for extinction from SDSS PhotoObj catalog

We produced the mass and density profiles for the filament structures, excluding the clusters.





We observed that the galaxies are more massive near the filament than in the field.
The density profile shows that high density regions are extended up to 10 Mpc.

Perspectives

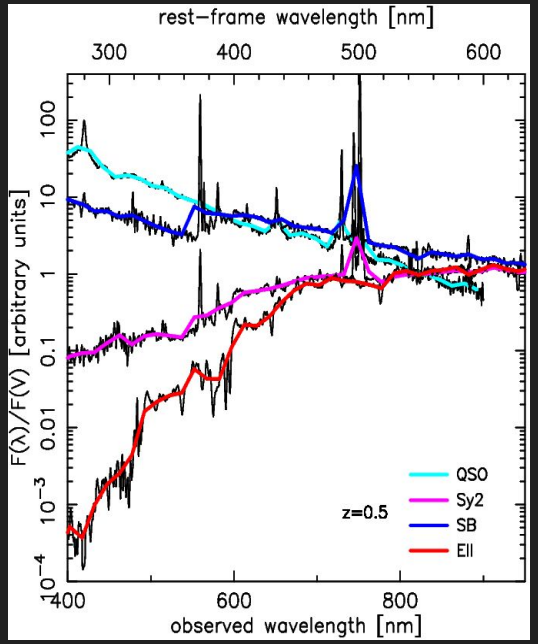
We will extend our analysis to the galaxy activity through

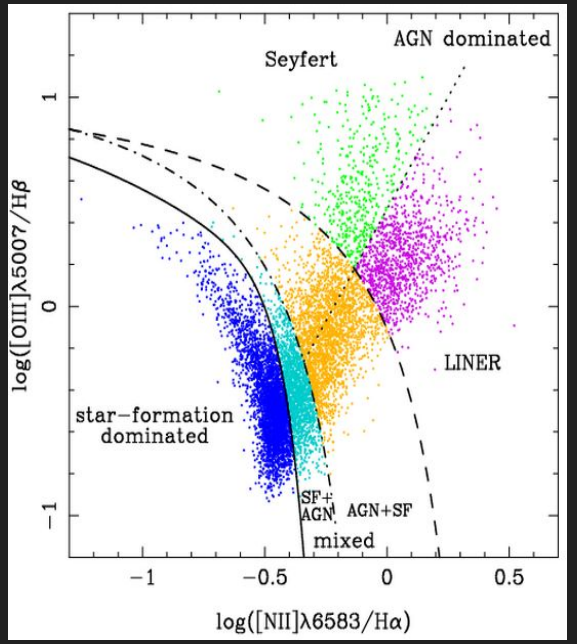
BPT diagnostics.

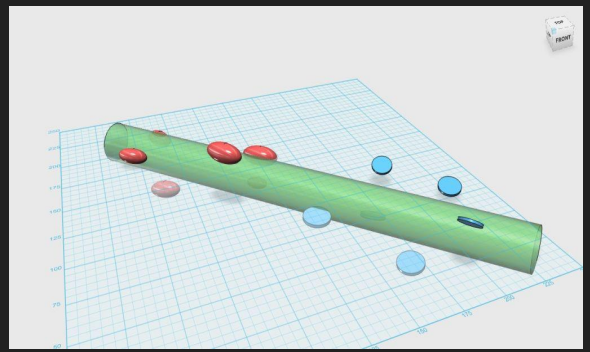
Galaxyzoo

Search for a correlation between the activity type, morphology, color,

We will develop an analysis using catalogs at other wavelengths.







Summary and conclusions

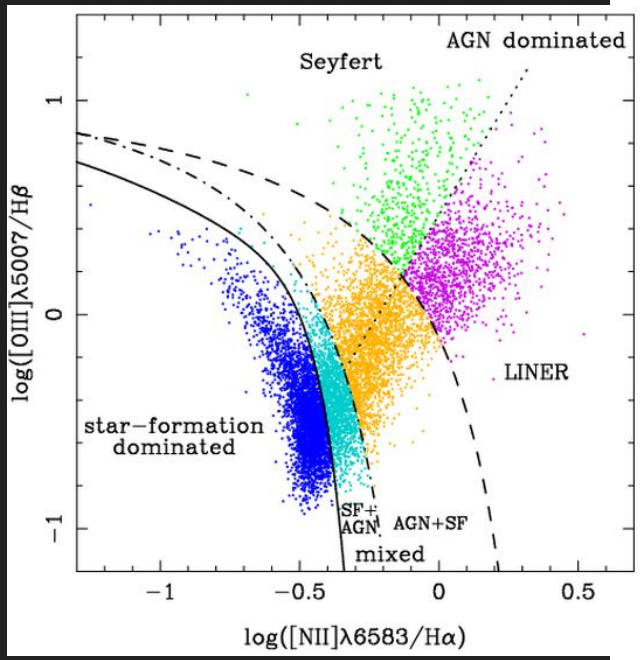
Our principal objective is to study the impact of the LSS environment over the galaxies and gas.

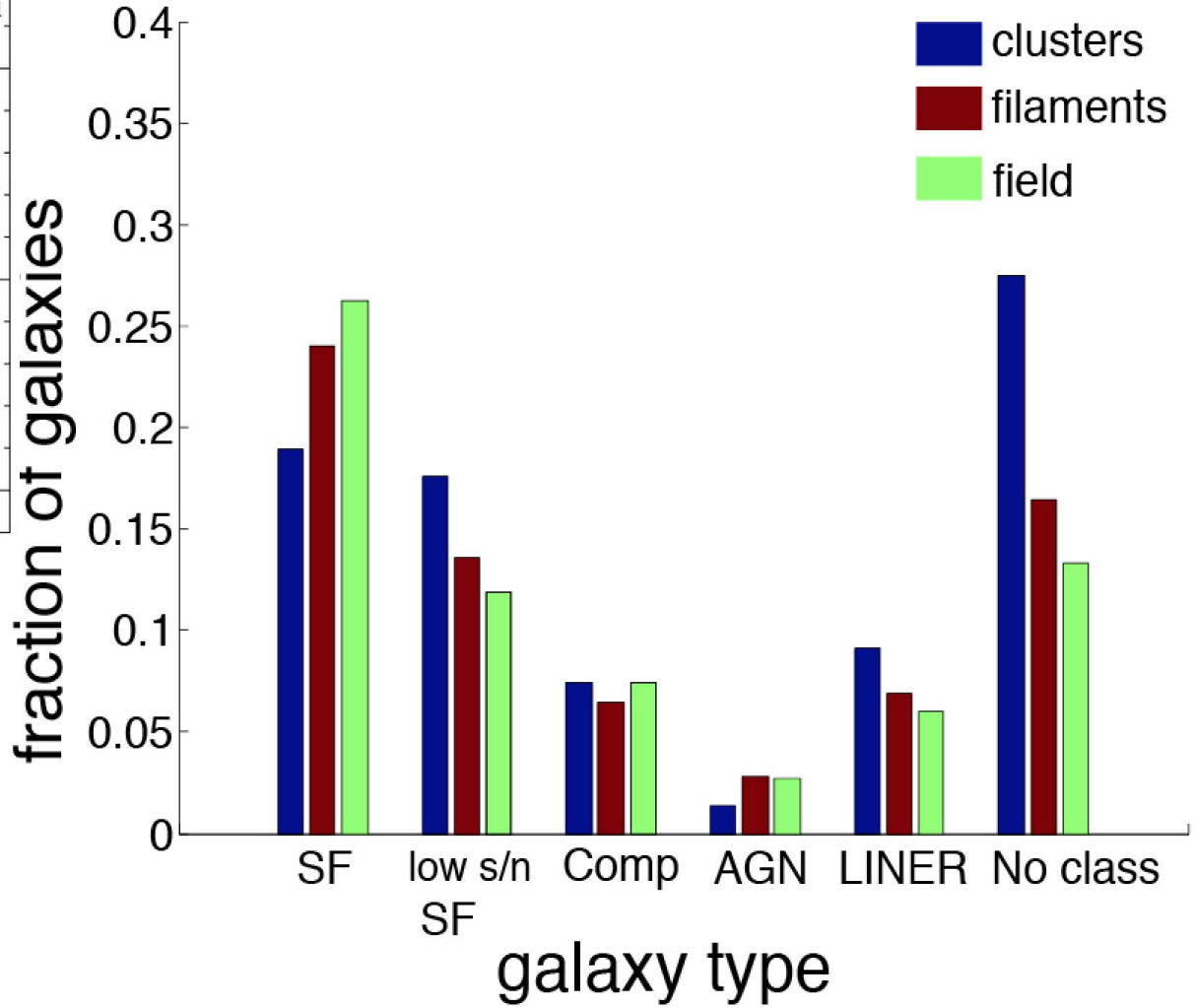
For the galaxies analysis:

- We develop and apply successfully a strategy to test the bona-fide structure of filaments.
- Our analysis suggest a relation between the galaxy color and mass with the environment.
- We need to study in detail the red sequence of filaments.

For analysing the gas:

- We reconstruct pressure profiles for a sample of 31 low S/N clusters using a Planck+ACT map.
- Further investigations of the shape of the pressure profile are needed.


AGN dominated
Seyfert
LINER
star−formation
dominated
SF+
AGN
AGN+SF
mixed
log([OIII]λ5007/Hβ)
log([NII]λ6583/Hα)
1
0
−1
−1
−0.5
0
0.5

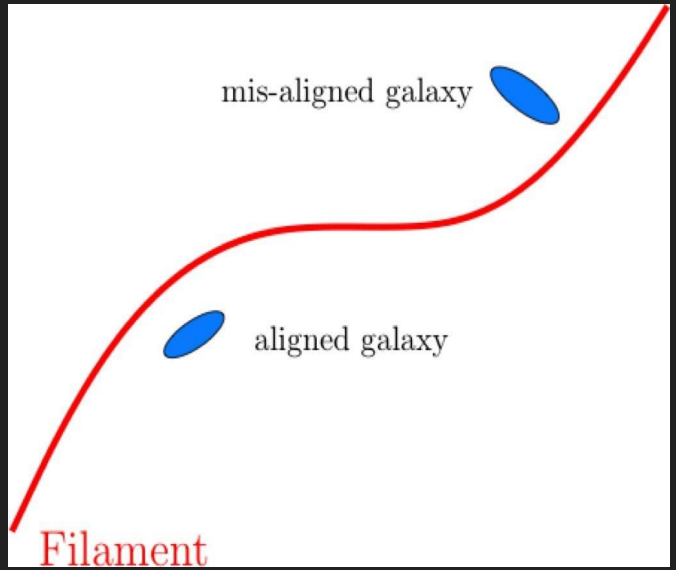

clusters
filaments
field
fraction of galaxies
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
SF
low s/n SF
Comp
AGN
LINER
No class
galaxy type

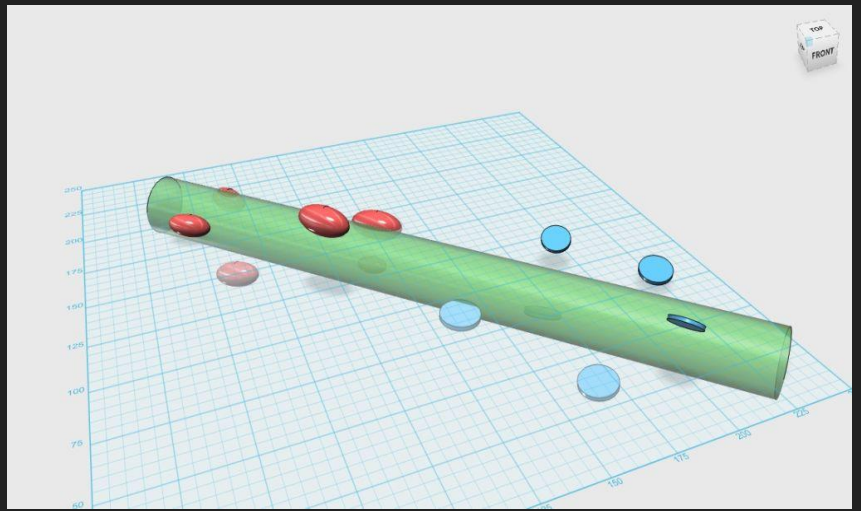
Perspectives

We will use the results from the previous analysis to:

Measure the alignments among the filament skeleton, systems and their most massive galaxies.

Then we aim to correlate the alignment signal with galaxy, group and cluster properties.



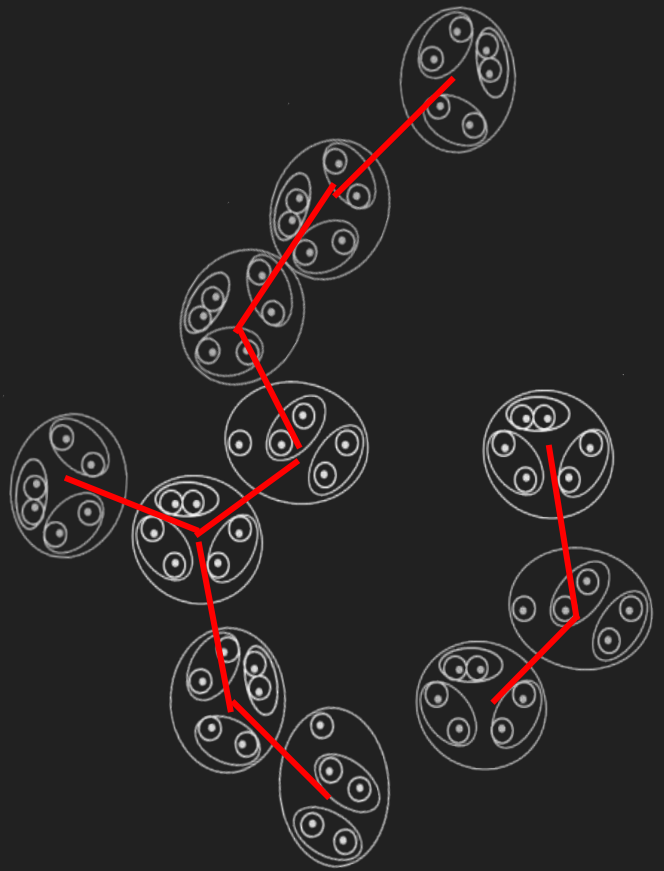


Filament characterization: re-group the galaxies

In order to search for connections between galaxies we apply a Hierarchical Clustering over the galaxy positions. This allows to:

- re-group galaxies,
- find the orientations and shapes of the groups,
- search for connections between groups

Galaxy position re-group of the galaxies



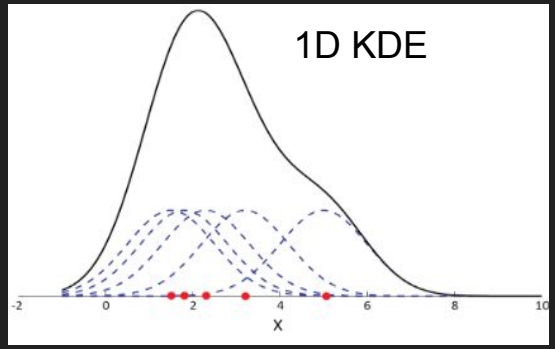
Density estimators

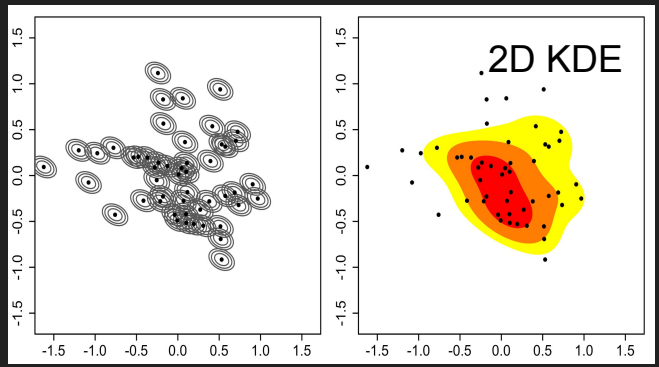
The Kernel Density Estimator (KDE) estimates the density using kernels, in a similar way to a smoothing process.

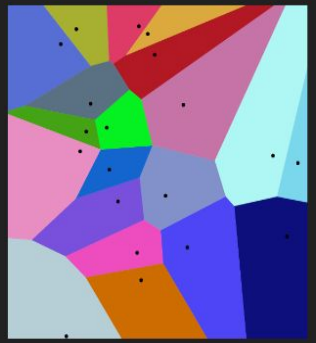
The KDE consider each observation as a component of the density function.

Voronoi tessellation (VT) is used to
find the density at each galaxy position based on its neighbors.

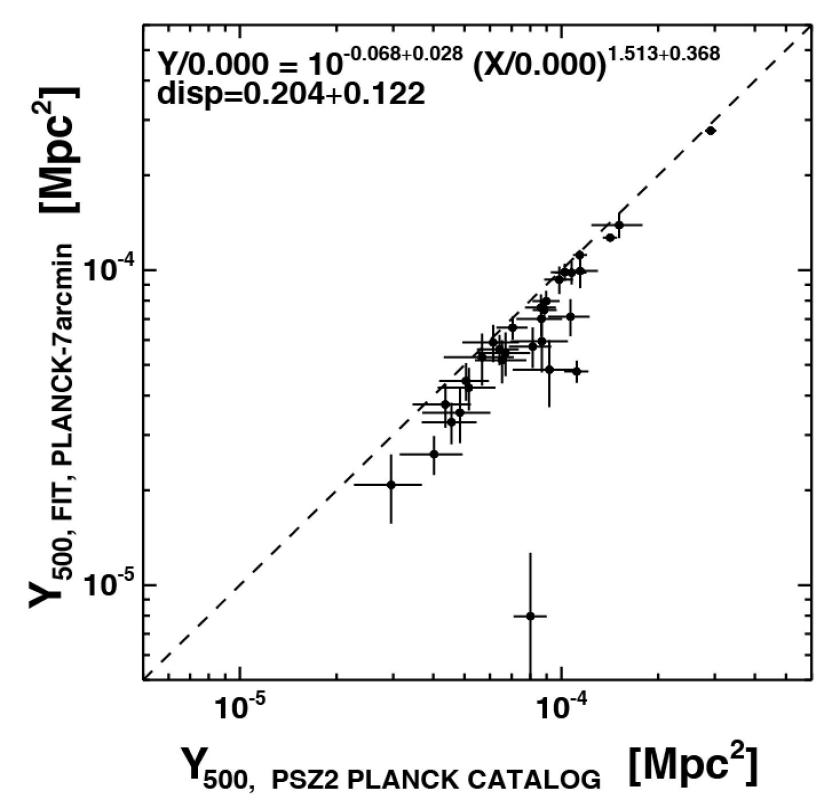
VT consists in partitioning the plane (or space) in optimal (maximized) regions; the simplest case of VT is using the euclidean distance.





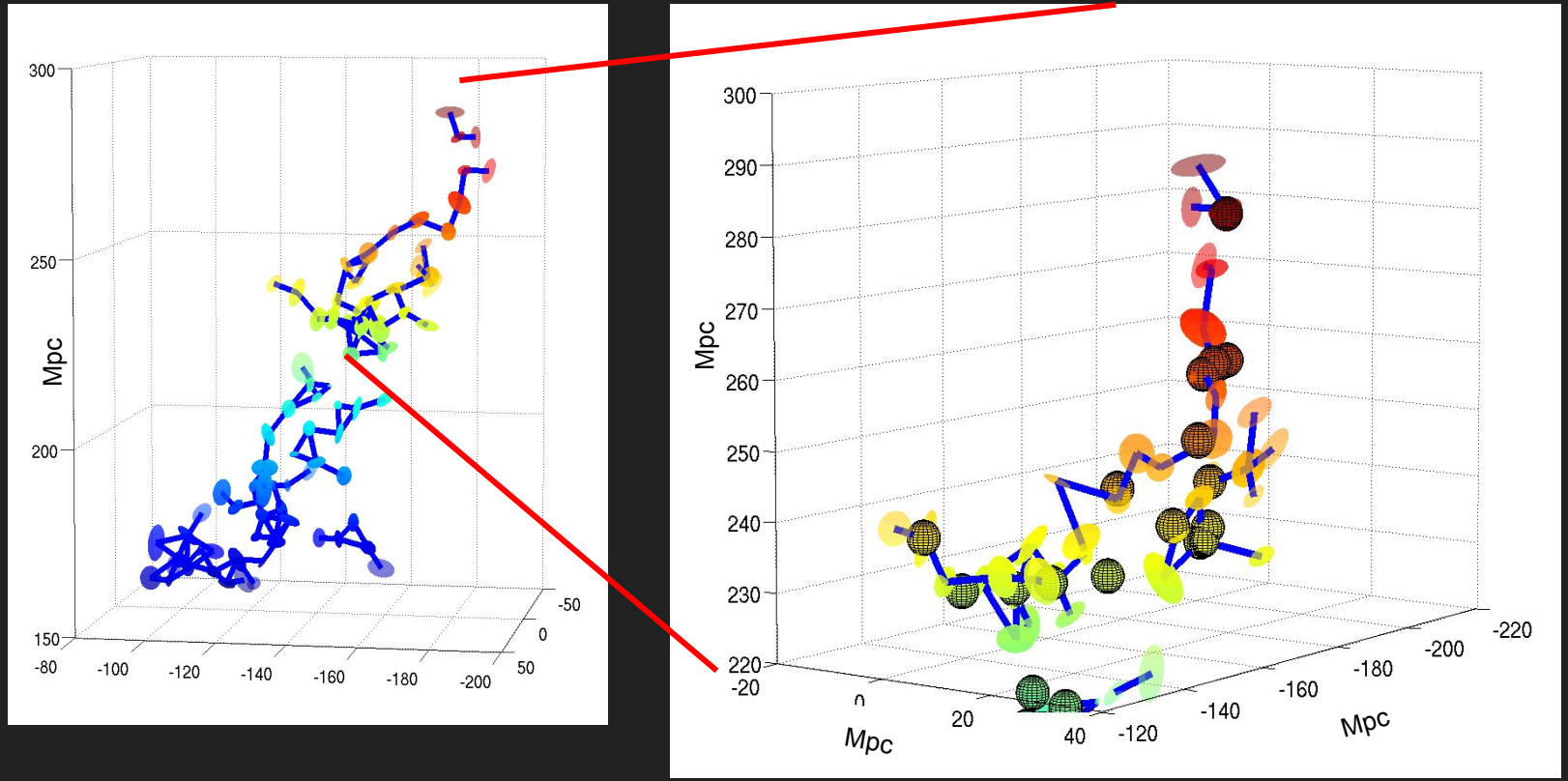


VT



Comparison of Y_{500} values for the Planck cluster detection method (MMF3) against the best FIT for each 31 clusters (from Planck map 7arcmin).
In both cases the distribution of the thermal pressure is assumed to follow a universal pressure profile, A10, for wich the scaled radius R_{500} is fixed.

Example of a structure skeleton identification



The color ellipsoids represent groups of galaxies. The blue lines connect groups at a maximum distance D<10 Mpc. The darker spheres represent Abell clusters or very populated groups.