# Abstract

It is qualitatively known that the Universe is homogeneous at large scales while on small scales the galaxies are distributed in an interconnected complex structure known as the Cosmic Web. Our aim is to provide a quantitative understanding of these qualitative features. We have used multifractal analysis to verify the assumption of large scale homogeneity. We find the galaxy distribution in a volume limited subsample of Sloan Digital Sky Survey Data Release six (SDSS DR6) to be homogeneous with the transition to homogeneity occurring at around 70 $h^{-1}$Mpc.

We have developed a statistical measure to quantify the structure of the Cosmic Web at small scales. We consider the Local Dimension D, defined through $N(< R) = AR^D$, where $N(< R)$ is the galaxy number count within a sphere of comoving radius $R$ centered on a particular galaxy. This is a tool to locally quantify the shape in the neigbourhood of different galaxies along the Cosmic Web. We expect $D \sim 1$, 2 and 3 for a galaxy located in a filament, sheet and cluster respectively. We have applied the method to a volume limited subsample of SDSS DR6. Considering the range of length-scales $0.5 - 5\,h^{-1}$ Mpc we find that values of $D$ are peaked around $D = 1.5$. Increasing the range of length-scales to $1 - 10\,h^{-1}$ Mpc, we find that the peak shifts to $D = 2$, and the peak is at $D = 2.5$ if we consider $5 - 50\,h^{-1}$ Mpc. This indicates a transition from filaments to sheets and then three-dimensional structures as we progressively shift to larger length-scales. We also find evidence for correlations between the relative abundance of different structural elements with the local density environment.

We have also considered the eigenvalues of the deformation tensor as another possible tool for analysing the Cosmic Web. Applying this to idealised structures on a grid, we find that this method correctly classifies galaxies as being part of either a filament, sheet or a cluster. However, applying this to the SDSS DR6 we find that it predicts a very low abundance of sheets, in disagreement with our earlier results and also at odds with the currently believed picture of the Cosmic Web. The reason for this discrepancy is at the moment not clear.



**Keywords**: large-scale structure of the Universe, galaxies, galaxy redshift survey, Local Dimension, homogeneity,