LANIAKEA IN A COSMOLOGICAL CONTEXT

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Recent observations used local cosmic flow information to define our local supercluster, Laniakea. In this work we present a study on large cosmological N-body simulations aimed at establishing the significance of Laniakea in a cosmological context. We explore different algorithms to define superclusters from the dark matter velocity field in the simulations. We summarize the properties of the supercluster population by their abundance at a given total volume and its shape distribution. We find that superclusters similar in size and structure to Laniakea are relatively uncommon on a broader cosmological context.

Tully et al. defined our home supercluster, Laniakea, as the region where the peculiar velocity flows converge. Laniakea is found to be contained in a 160 Mpc/h diameter sphere containing a very dense region called the Great Attractor. We designed a method to find superclusters in dark matter N-body simulations and tested our method in a simulation of boxsize 250 Mpc/h. We based our method on the analysis of the eigenvalues λ_1, λ_2 and λ_3 of the velocity shear tensor:

$$\Sigma_{\alpha\beta} = -\frac{1}{2H_0}\left(\frac{\partial v_\alpha}{\partial x_\beta} + \frac{\partial v_\beta}{\partial x_\alpha}\right). \quad (1)$$

From these eigenvalues we form two dimensionless quantities: the fractional anisotropy (FA):

$$FA = \frac{1}{\sqrt{3}}\sqrt{\frac{\left((\lambda_1-\lambda_3)^2 + (\lambda_2-\lambda_3)^2 + (\lambda_1-\lambda_2)^2\right)}{\lambda_1^2+\lambda_2^2+\lambda_3^2}}, \quad (2)$$

which tells us if a collapse or expansion is anisotropic (FA=1) or isotropic (FA=0) and the velocity divergence, normalized by the Hubble constant:

$$VDH = \lambda_1 + \lambda_2 + \lambda_3 = \frac{-\nabla\cdot\vec{v}}{H_0}, \quad (3)$$

which tells us if the velocity flows are collapsing (dense region, $VDH > 0$). We are looking for regions dense ($VDH > 0$), containing a highly dense locality ($VDH > 1.0$), as Laniakea, and bellow a certain threshold of FA. We use a modified Friends-Of-Friends algorithm, after an CIC interpolation and a finite elements calculation. We resume our results in **Figure 1** and find that: **Laniakea is atypically larger** than the detected superclusters and **our method is robust** as the largest regions are detected independently of the FA thresholds and modifying the grid size in the interpolation do not influence our results.

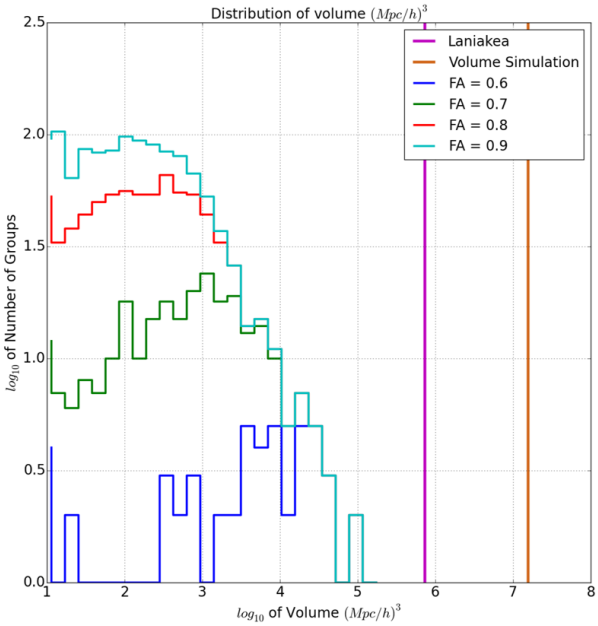

Fig. 1. Distributions of volumes for different seed FA thresholds.

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