



# Weekly Activity Report

## A Large Scale Structure Void Identifier for Galaxy Surveys Based on the $\beta$ -Skeleton Graph Method

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### ABSTRACT

The beta parameter graph, its definition.  
The testing catalogs.  
How the graph changes while varying  $\beta$ .

*Keywords:* Beta Skeleton Graph, Beta Parameter

### 1. THE ALGORITHM

The algorytm uses the NGL library to create the  $\beta$ -Skeleton graph of a given set of points. Then, the histogram of connection lenghts is created (in a similar fashion to the two-point correlation function) for hhe 0.90-Skeleton and 1-Skeleton graphs. The average lenght for points inside a structure is defined (using the 1-Skeleton), and then those small conections are removed from the 0.9-Skeleton graph. The remainig graph contains the points over the surface of the voids.

#### 1.1. *Mock Catalog*

In order to test the algorythm, two catalogs of points where created to emulate voids in the LSS.

The emulated space is a cubic region of 60 Mpc/h. There where placed  $\sim 5 \times 10^4$  points to have a similar volume density of points to the halo volumetric density in the AbacusCosmos simulations. ( $8.7 \times 10^6$  halos in a cubic box of 720 Mpc/h length,  $2.335 \times 10^{-2}$  halo/(Mpc/h)<sup>3</sup>). Points where placed using an uniform density probability distribution.

The first set of points has an spherical empty region of radius 20 Mpc/h centered in the middle of the volume.

The second catalog has four non-overlapping spherical empty regions of radius between 8 and 20 Mpc/h.

#### 1.2. *The $\beta$ -Skeleton Graph*

The  $\beta$ -Skeleton graph is defined by the relative distance between points and a geometrical criterion using a real parameter  $\beta \geq 0$ .

Two points are connected in the graph if there is an empty region between them, without any other point. The shape of the empty region is function of the  $\beta$ /parameter.

The authors define the  $\beta$ -skeleton as folows:

“The so-called lune-based  $\beta$ -skeleton is a one-parameter generalization of the RNG [Relative Neighborhood Graph] and GG [Gabriel Graph], defined as follows:

- For  $0 < \beta < 1$ , the empty region is the intersection of all d-balls with diameter  $d(p, q)/\beta$  that have  $p$  and  $q$  on the boundary.
- For  $\beta \geq 1$ , the empty region is the intersection of two d-balls with diameter  $\beta d(p, q)$  centered at  $(1 - \frac{\beta}{2})p + \frac{\beta}{2}q$  and  $\frac{\beta}{2}p + (1 - \frac{\beta}{2})q$ .

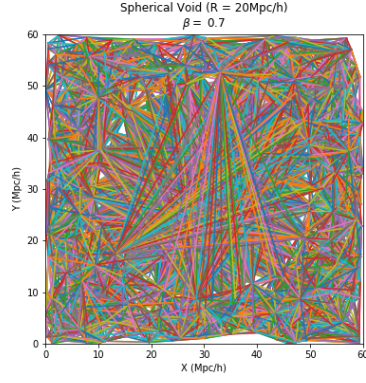
It follows that  $\beta = 2$  gives the RGN, while  $\beta = 1$  is the GG.”

In the limit when  $\beta$  tends to zero, every point is connected to each point on the set, it corresponds to the graph used in the classic two-point correlation function. Each point has  $N$  connections. (With  $N$  as the number of points in the set).

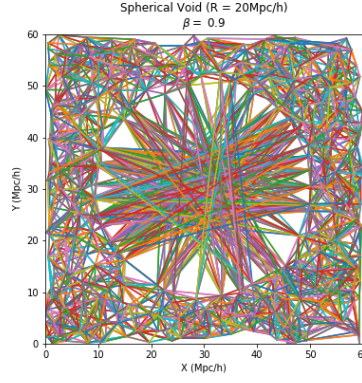
When  $\beta$  is increasing, the number of connections per point is reduced. The first connections to vanish are the longer ones, while the near connections persists.

### 1.3. *Structure dependence of $\beta$ parameter*

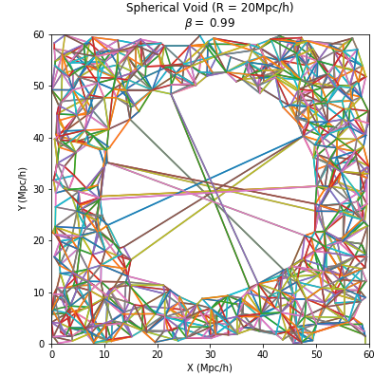
## REFERENCES



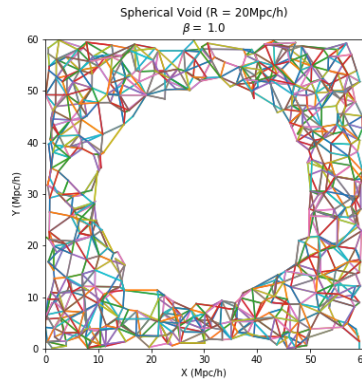
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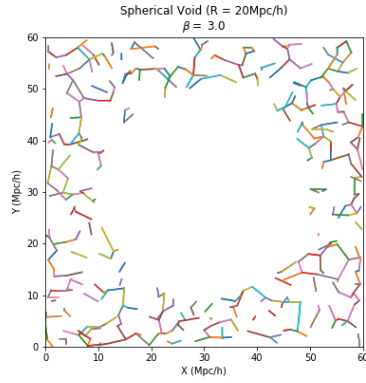
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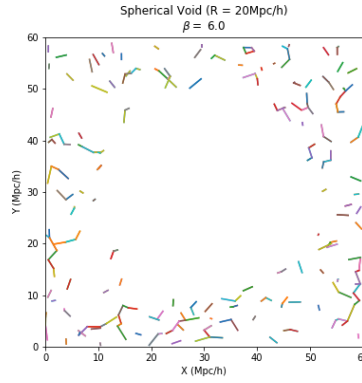
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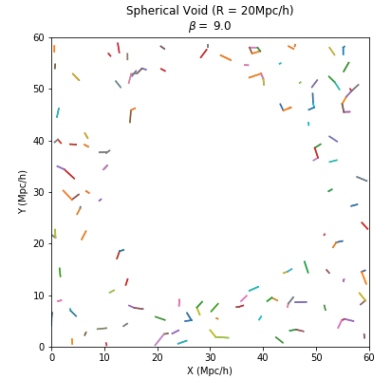
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(e)



(f)



(g)

**Figure 1.** Beta variations