CoCo 2o2o: Cosmology in Colombia

The cosmic web through the lens of graph entropy

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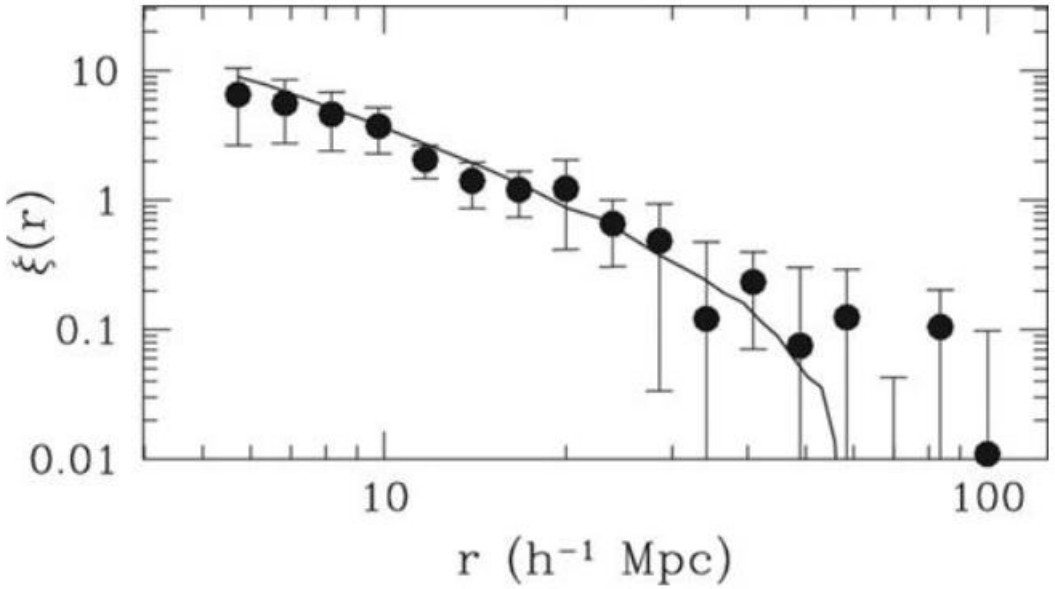
For more detail you can go to: The cosmic web through the lens of graph entropy, MNRAS: Letters, Volume 498, Issue 1, 11 October 2020, Pages L145–L149, 2008.08164

$$1 + \xi(r) = \frac{DD(r)}{RR(r)}$$

Two-Point Correlation Function



Basilakos et al., 2003

Represent the Large Scale Structure as a graph

García-Alvarado et al. (2008.08164)

Probability and Graph Entropy

Probability of having nodes with degree n:

$$Probability\ (p_n) = \frac{Nc}{Tn}$$

$Nc = Number\ of\ nodes\ with\ n\ connections$

$Tn = Total\ number\ of\ nodes$

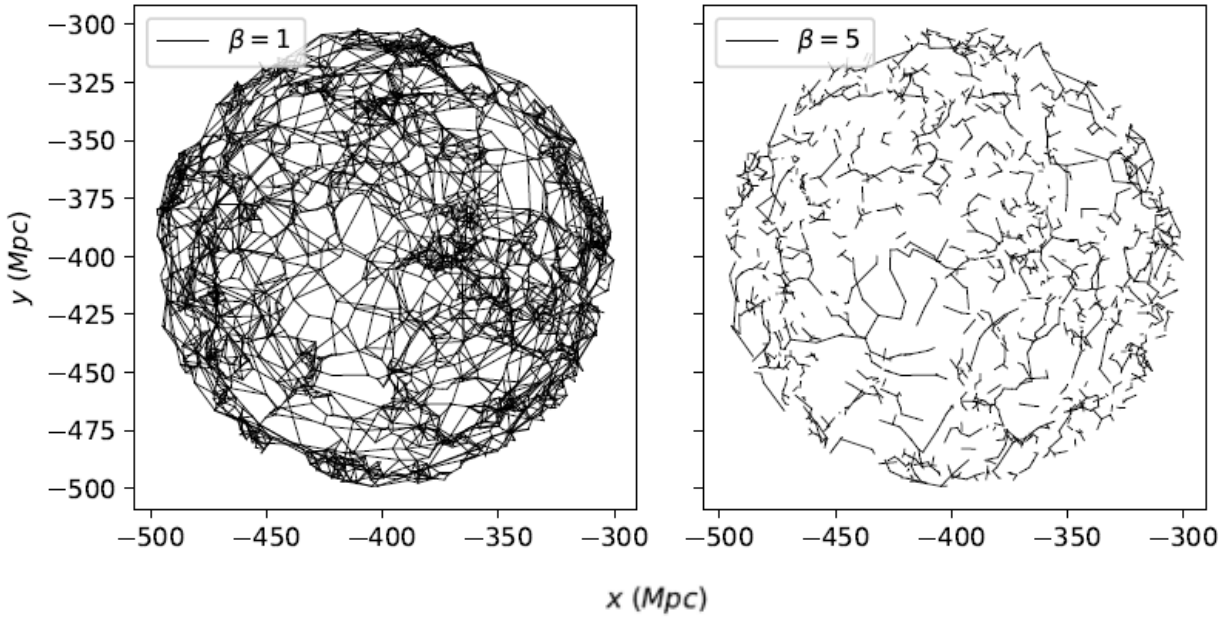
Graph entropy:

$$\sum_{p_n>0} -p_n log_2(p_n)$$

García-Alvarado et al. (2008.08164)

β-Skeleton

For a set of dark matter halos:



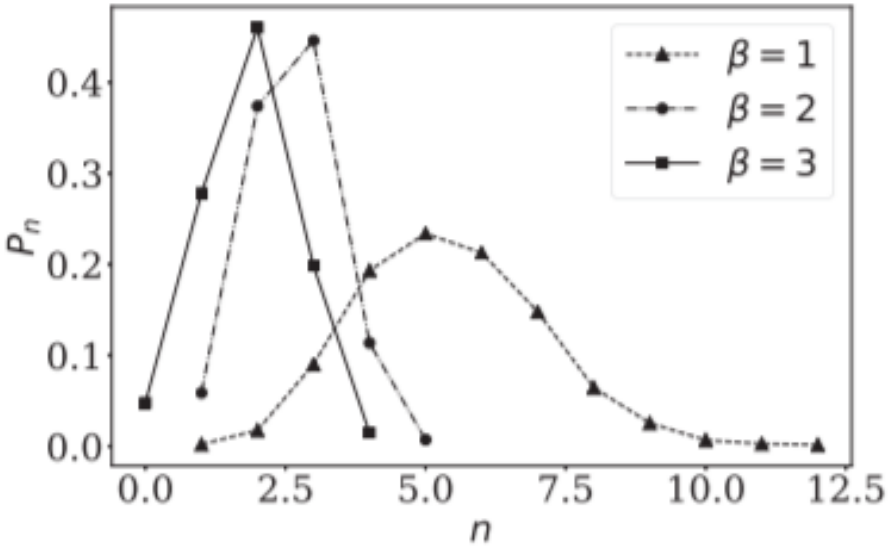


Figure 2. Probabilities of having n connections, P_n, for three different values of β. The graph entropy summarizes the changes in the P_n distribution as a function of β.

García-Alvarado et al., 2020

García-Alvarado et al. (2008.08164)

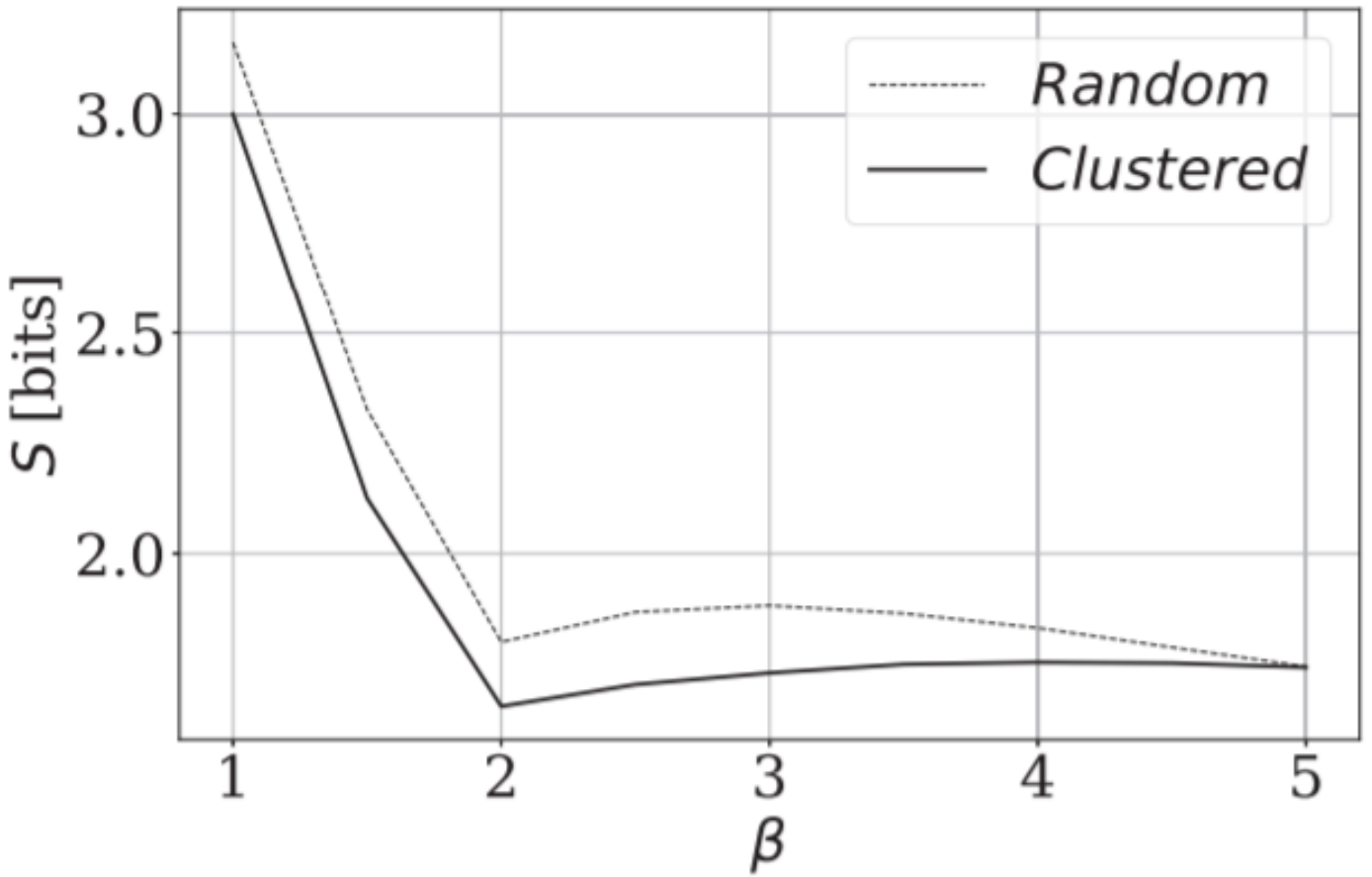


Figure 3. Graph entropy as a function of the parameter β for clustred and random points distributed inside a sphere.

García-Alvarado et al., 2020

García-Alvarado et al. (2008.08164)

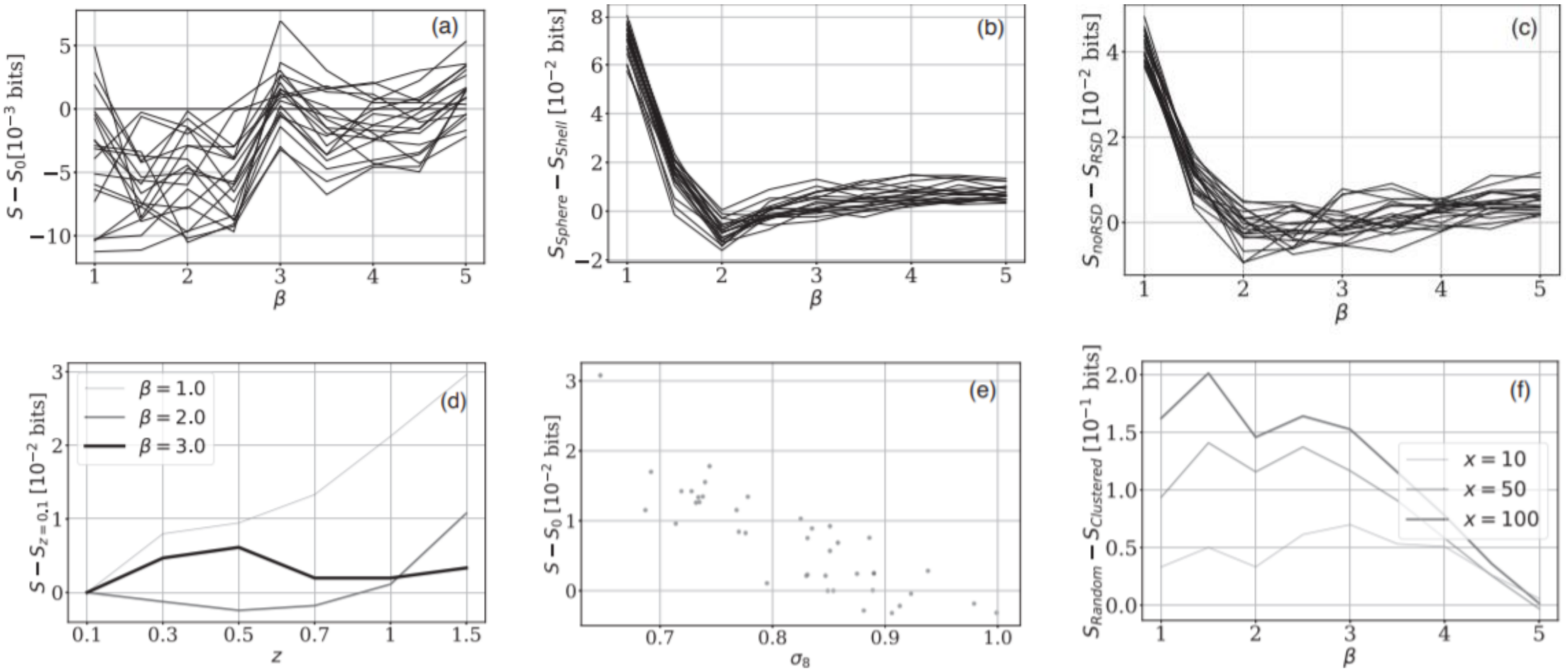


Figure 4. Influence of different effects on the graph entropy. In all cases, we report the changes in entropy from a reference value. Details are explained in the Section 4. (*a*) Cosmic variance. (*b*) Survey geometry. (*c*) Redshift space distortions (RSD). (*d*) Redshift evolution. (*e*) Cosmological parameters. We only show the results for σ_8, the parameter that shows the strongest correlation with the graph entropy. The plot corresponds to the entropy computed for the 1-skeleton at $z = 0.1$. (*f*) Number density. This calculation is performed on 20 different spheres at $z = 0.1$. A different percentage (shown in the caption) of these points are sampled. We show the difference with respect to the entropy measured on the spheres of sampled random points.

García-Alvarado et al., 2020

García-Alvarado et al. (2008.08164)

Conclusions

- Graph Entropy analysis allows us to distinguish between random and clustered points.
- The strongest influence on graph entropy comes from clustered points with different number densities.

- Further applications can be:
  - Measuring the entropy from different parts of the sky to check for isotropy.
  - Building graphs from other quantities (i.e. features in the cosmic microwave background, weak lensing peaks) to quantify its connectivity properties.
  - Tests for the applicability on observational data.

García-Alvarado et al. (2008.08164)

Thank you!