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Constraining cosmological parameters with cosmic environments

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The spatial distribution of matter depicts a complex pattern commonly referred to as the 'cosmic web' in which massive nodes are linked together by elongated filaments found at the intersection of thin mildly-dense walls, themselves surrounding large and empty voids.
The intrinsically different gravitational dynamics history that each environment experience leaves an imprint on the present matter distribution. One of the main objective of the forthcoming galaxy redshift surveys is to accurately constrain cosmological parameters, in particular the sum of neutrino mass, using clustering statistics.

In this work, using N-body simulations from the Quijote suite, we classify the matter into the different cosmic environments depending on their level of local tidal anisotropies. Focusing on the power spectrum multipoles and using a Fisher analysis, we find that the constraints on five cosmological parameters and the sum of neutrino mass show a sizeable gain in information when combining different cosmic environments rather than using all the particles. This gain is observed in both real and redshift space as the combination of power spectrum multipoles of different cosmic web environements is able to break some key degeneracies (e.g. the summed neutrino mass - σ_8).

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