Emulating the void density profile and the void-size function

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Abstract

Cosmic voids — large under-dense regions of the Universe that make up most of its low-redshift volume - have gained more and more popularity in the last ten years, thanks to their proven sensitivity to cosmology. In this talk we present two emulators, each reproducing one of the basic void-statistics i.e. void density profile and void-size function. While a simple formula to fit the void density profile is well-known, no tool to predict the density profile shape given only a typical void-size and a set of cosmological parameters is currently available. Furthermore, the current modelling of the void-size function fails to fully capture the dependency of this observable on cosmology. We resort to emulation to bridge these gaps. The emulators are both constructed from the *Aemulus* simulations, a suite of 40 N-body simulations with snapshots from z=1 to z=0. These simulations cover the flat wCDM parameter space allowed by recent Cosmic Microwave Background, Baryon Acoustic Oscillation and Type Ia Supernovae results, varying the parameters w, Ωm, Ωb, $\sigma 8$, $Neff$, ns and $H0$. We carry out several tests that show the good performance of our density-profile emulator and we demonstrate the improved accuracy of our void-size function emulator relative to state-of-the-art models. We validate the emulators using five realisations of seven different cosmologies, for a total of 35 test simulations. These test simulations were not used in constructing the emulators, and were run with fully independent initial conditions. Finally, we confirm our results probing the emulators on a completely independent simulation. By instantaneously reproducing the basic void observables given a set of cosmological parameters, these tools will be extremely useful to fully explore the power of cosmic voids in constraining cosmological parameters in view of the upcoming generation of surveys.

Keywords: Cosmology, Large Scale Structure, Cosmic Voids, Numerical Methods, Statistical Methods

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