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Analysis & multiscale morphology of the cosmic web

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Major characteristics of the gravitational formation and evolution of cosmic structure and the emergence of the cosmic web are its 1) hierarchical nature, 2) the anisotropic morphology of forming structures and 3) the emergence of large near-empty void regions.

Each of these three aspects are successfully analyzed by means of DTFE based structure identification techniques. The Delaunay Tessellation Field Estimator (DTFE), is a fully self-adaptive method for processing and extracting information on structure and dynamics of discretely sampled structures exploiting the natural adaptivity of Voronoi and Delaunay tessellations.

The DTFE forms the basis for the Multiscale Morphology Filter formalism for identifying filamentary and sheetlike matter concentrations. The Watershed Void Finder for the detection and analysis of the voids in the cosmic matter distribution and the Cosmic Spine formalism for tracing the filamentary and sheetlike structures are practical translations of Morse theories' critical web defined by the singularities in the density field. In the presentation we will describe these formalisms, along with recent results enabled by their application and current efforts to work directly on the adaptive Delaunay grid itself.