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Untangling the local Cosmic Web with Caustic Skeleton Theory

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The cosmic web is a vast large-scale network of interconnected filaments, clusters, and sheet-like walls surrounding voids that compose our Universe. The cosmic web is pivotal in galaxy formation and evolution, as studies have demonstrated a connection between the large-scale cosmic environment of a galaxy and its observed properties.

Caustic Skeleton (CS) theory offers a promising new approach to classifying present-day observed large-scale structures according to their origins and formation history. It is a fully analytic mathematical framework to describe the formation of singularities (caustics) in the density field during non-linear gravitational collapse, and how these thereby outline the key structures like voids, filaments etc. However, the CS framework is relatively new and has thus far remained abstract and in the mathematical world, despite the fact that it has proven very effective at classifying structure in simulations.

Hence, we are pulling CS theory into reality by applying it to observational data. We have access to the Manticores project, which provides a successful reconstruction of the initial conditions from which the structure observed in the 2M++ galaxy survey of the local Universe evolved. By generating a detailed map of caustics in the local Universe, we can investigate the connection between the properties of galaxies in the large-scale structures of the constructed caustic skeleton and thereby implications for our Universe's underlying cosmology.

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