Galaxy Clusters as Dark Matter Laboratories

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Abstract: The structure of dark halos carries signatures of their mass, dynamical state, and the nature of dark matter itself. Some of the most constraining signals can be found in the outskirts of galaxy clusters, which have recently become observationally accessible via satellite distributions and weak lensing. However, to harness the rapid progress promised by future instruments such as VRO/LSST and Roman, we need to understand which signals can realistically tell us about halos and dark matter. I will describe novel algorithms that analyze the dynamics of simulated dark matter particles in unprecedented detail. Based on these methods, I will discuss a more physical understanding of halo density profiles, more accurate modeling of the large-scale distribution of matter, and more reliable tracking of substructure. The ultimate goal of these efforts is to provide a practical, halo-based framework to infer cluster properties and fundamental physics from a combination of multi-wavelength observables.

Bio: Prof. Diemer specializes in computational astrophysics, focusing on large-scale computer simulations to study the universe's structure formation. His research explores the gravitational collapse of matter, leading to the formation of galaxies, dark matter halos, and other cosmic structures that shape our observable and inferred universe.