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Sweating the small stuff: solving small-scale challenges to ΛCDM with dwarf galaxy simulations at the high resolution limit[1]

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The currently favored cosmological paradigm Lambda Cold Dark Matter Theory (ΛCDM) has been widely successful in predicting the counts, clustering, colors, morphologies, and evolution of galaxies on large scales, as well as a variety of cosmological observables. Despite these successes, several challenges have arisen to this model in recent years, most of them occurring at the smallest scales those of dwarf galaxies ($M_\star < 10^9 M_\odot$), of which the lowest mass are observed almost exclusively within the Local Volume. I will review several of these small-scale challenges, including the Missing Satellites Problem, the Cusp-Core Controversy, and the tension between the regularity of galactic scaling relations and the diversity of rotation curves. In reviewing current attempts to rectify these issues many of which rely on the inclusion of baryonic effects in simulations I will introduce a new set of high resolution cosmological hydrodynamic zoom-in simulations (GIZMO/FIRE2) of isolated dwarf galaxies the highest resolution ever run to z=0. This new generation of $m_{\rm bar} \sim 10 M_\odot$ simulations marks a transition point between simulations that treat star formation within a single stellar population in the aggregate, and simulations that model the individual collapse and fragmentation of a molecular clouds into individual stars, and will allow us to probe smaller physical scales than previously possible in a cosmological simulation.

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