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The Mochima Simulation: Baryonic physics impact on detailed DM distribution and dynamics on the host halo and subhalos of five realizations of the same Milky-Way-like galaxy.

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Cosmological simulations provide a self-consistent framework to study the complex dynamics within galaxies. These simulations are crucial as they examine the interconnected evolution of galactic components. Recent advancements in numerical simulations have significantly enhanced our understanding of baryonic physics —such as stellar processes and interstellar medium dynamics—and their role in shaping galaxies. While the astrophysics community actively investigates the impact of increasingly complex baryonic descriptions on galaxy structures, studies focusing on their effects on dark matter (DM) distributions are less developed. This study utilizes the Mochima simulation, a high-resolution (35 pc) cosmological zoom-in hydrodynamic simulation, which has tested several baryonic models on a Milky Way-like galaxy, resulting in five different galaxy realizations. We examine the DM distribution in these scenarios alongside an additional dark matter-only run. Our analysis highlights changes in halo morphology, geometry, and phase space distributions due to baryonic influences, showing significant variability in mass density profiles and velocity distributions, such as the inner power index varying from 1.3 to 1.8 and broader speed distributions (arXiv:2301.06189). We also explore how the baryonic models affect subhalo distributions, the subhalo mass function, and the impact of baryonic mass on subhalo survival and dynamics in the local DM velocity field. These factors are crucial for dark matter research, especially in direct and indirect detection efforts, making the understanding of baryon-related uncertainties essential. Thus, improving baryonic physics modeling in cosmological simulations is vital not only for understanding galaxy formation but also for enhancing our predictions about dark matter properties and behavior.

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