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Motivations for a Large Self-Interacting Dark Matter Cross Section from Milky Way Satellites

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Self-interacting dark matter is a compelling idea because it could solve the small-scale structure formation problems and it arises generically in new physics models with dark sectors. We explore the properties of Milky Way subhalos in self-interacting dark matter models for moderate cross sections of 1 to 5 cm^2/g using high-resolution zoom-in N-body simulations. We include the gravitational potential of a baryonic disk and bulge matched to the Milky Way, which is critical for getting accurate predictions. Using an analytic model to extend the simulation results, we are able to show that the most massive subhalos in models with cross sections between 1 and 5 cm^2/g are not dense enough to match the densest ultra-faint and classical dwarf spheroidal galaxies in the Milky Way. We also show that these subhalos have not entered the core collapse regime. This motivates exploring velocity-dependent cross sections with values larger than 5 cm^2/g at the velocities relevant for the satellites such that core collapse would occur in some of the ultra-faint and classical dwarf spheroidals

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