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Origin and evolution of the satellite system of Milky-Way-like galaxies

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The satellite galaxies of the Milky Way and other galaxies are important probes of the early evolution and nucleosynthesis in the cosmos. As such, an understanding of their formation and evolution is crucial in any study of the origin and evolution of matter. In this regard, there is a decades-old dilemma in our understanding of dwarf-galaxy evolution known as the Disks of Satellites (DoS) problem. In galaxies such as the Milky Way and Andromeda, the DoS problem is the observation that the satellite galaxies align to form a thin and coherent plane. It has been noted in the literature that this observation contrasts with predictions from simulations within ΛCDM cosmology framework, which anticipates a more isotropic distribution of satellite galaxies. This discrepancy raises fundamental questions about galaxy formation dynamics and challenges the standard cosmological model. Recent findings from the SAGA survey complicate this narrative by suggesting that Milky-Way-like DoS systems might not be as rare as previously assumed. In response to this ongoing debate, we have undertaken a study utilizing the high-resolution simulation suites from the IllustrisTNG project. In addition to high mass resolution, this study is distinguished by its comprehensive integration of dark matter and baryonic physics. In our initial survey of 186 Milky-like systems, only two exhibit a thin disk similar to that observed in the Milky Way, and none is rotationally supported. Further, our ongoing time series analysis of satellite catalogues, enabled by TNG's advanced merger tree features, tracks how these DoS form and evolve across various redshifts. Our study indicates that these structures tend to manifest at very low redshifts, suggesting that DoS may be transient phenomena, possibly arising under specific environmental or dynamical conditions. Moreover, our ongoing work applies a segmentation code to discern and quantify the large-scale structures surrounding these galaxies, assessing their potential role in shaping the formation of satellite disks.

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