New Models of the Milky Way's Dark Matter Distribution for the Era of High Precision Astrometry

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Theory: Yes

Abstract

Understanding the assembly history and dark matter distribution of our Milky Way (MW) is a major challenge for astrophysics. Thanks to the unique capabilities of HST, proper motions of satellite galaxies, globular clusters and stellar streams have been measured with accuracies of order ~0.05 mas/yr (~10 km/s) at distances of 50-300 kpc. When combined with detailed models of the MW's halo potential, such measurements become high-precision tools to constrain the dark matter mass profile of the MW and compute accurate orbital histories of satellites. However, the MW hosts a pair of massive dwarf galaxies, the LMC and SMC, that contribute to its dark matter distribution and change the shape of the potential in a non-symmetrical, time evolving manner. To date, these effects have not been accounted for in existing models of the MW halo. We propose to develop high resolution simulations to quantify the time evolving structure of the MW's dark matter halo owing to the influence of the LMC and SMC. These novel models will enable rapid orbital integration of halo objects (satelllites, globular clusters, stellar streams), using high accuracy HST proper motions, while also capturing the complex halo potential resulting from the LMC-SMC-MW interaction. The era of high-precision astrometry has arrived, yet we do not currently have an appropriate theoretical framework to study the assembly history of MW-like galaxies in the presence of massive satellite perturbers. Our proposed program is thus critical to ongoing HST programs and all efforts to understand the structure and evolution of the dark matter halo of our Galaxy and analogous systems like M31 and its massive satellite, M33.