X59a Measuring the dark matter halo of a dwarf spheroidal galaxy through normalizing flows

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The kinematics of stars in dwarf spheroidal galaxies have been studied to understand the structure of the dark matter halo. However, the kinematic information of those stars is often limited to celestial position and line-of-sight velocity, making full-phase space analysis challenging. Conventional methods rely on projected analytic phase space density models with several parameters and infer the dark matter halo structure by solving the spherical Jeans equation. In this paper, we introduce an unsupervised machine-learning method for solving the spherical Jeans equation in a model-independent way as a first step toward a model-independent analysis of a dwarf spheroidal galaxy. Using continuous normalizing flows, we present that spherically symmetric stellar phase space densities and velocity dispersions can be estimated without model assumptions. As a proof-of-concept, we apply our method to Gaia challenge datasets for spherical models and measure the dark matter mass densities given velocity anisotropy profiles. Our method can identify the halo structures precisely, even with a small number of tracer stars.