Measuring the Shape of the Milky Way's Dark Matter Halo Using Millions of SDSS Halo Stars

I will present detailed evidence from the Sloan Digital Sky Survey (SDSS) for the presence of a dark matter halo within Milky Way (MW). Using the number density distribution and kinematics of SDSS halo stars, my collaborators and I probe the dark matter distribution to heliocentric distances exceeding ~10 kpc and galactocentric distances exceeding ~20 kpc. Our analysis utilizes Jeans equations to generate two-dimensional acceleration maps throughout the volume; this approach is thoroughly tested on a cosmologically derived N-body+SPH simulation of a MW-like galaxy. We show that the known accelerations (gradients of the gravitational potential) can be successfully recovered in such a realistic system. The SDSS observations reveal that, in Newtonian framework, the implied gravitational potential cannot be explained by visible matter alone: the gravitational force experienced by stars at galactocentric distances of ~20 kpc is as much as three times stronger than what can be attributed to purely visible matter. Leveraging the baryonic gravitational potential derived by Bovy & Rix (2013), we show that the SDSS halo stars also provide a strong constraint on the shape of the dark matter halo potential. Within galactocentric distances of ~20 kpc, the dark matter halo potential is well described as an oblate halo with axis ratio q_DM=0.7+/-0.1. Thanks to precise two-dimensional measurements of acceleration for halo stars, we can reject MOND model as an explanation of the observed behavior, irrespective of the details in assumed in the interpolating function and the value of characteristic acceleration. In the era of Gaia and LSST, these techniques can be used to map the MW dark matter halo with a much better fidelity, and to a much larger galactocentric radius.