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(Can you) Infer the dark matter profile of the Milky Way from its circular velocity curve

The circular velocity curve, one of the first pieces of evidence for dark matter (DM), is a direct probe of the Galaxy's potential, which allows studies of the nature of DM. Recent large surveys have provided valuable information for determining the Milky Way circular velocity curve.

In this talk, I will describe our recently derived circular velocity curve of the Milky Way out to ˜30 kpc, which shows a sharp decline at R greater than 20 kpc. We find that a cored Einasto profile with slope parameter 1.13 +/- 0.06 is a better fit to the data than a generalized or contracted Navarro-Frank-White (NFW), as was argued in previous studies. We also find the virial mass of the DM halo to be significantly lower than previous estimates, but the corresponding local DM density at the solar position is consistent with the literature.

To better understand potential systematics underlying the measurement, we conduct follow up tests using the FIRE simulation and synthetic surveys. We specifically replicate the sample selection and Jeans'equation calculation. We find that higher-order drift correction, non-axisymmetry, and dynamical disequilibrium induced by merger events can introduce biases in the measured curve. As a result, the circular velocity curve of the Milky Way should be interpreted with caution, and additional systematic uncertainties must be incorporated when inferring the dark matter profile.

Future studies will focus on incorporating other dynamical probes such as the escape velocity, as well as employing forward modeling methods of the stellar phase space distribution directly instead of applying the various simplifying assumptions.

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