Contribution ID: **51** Type: **not specified**

A Parametric Model for Self-Interacting Dark Matter Halos

Wednesday 28 June 2023 16:20 (20 minutes)

We propose a parametric model for studying self-interacting dark matter (SIDM) halos. The model uses an analytical density profile, calibrated using a controlled N-body SIDM simulation that covers the entire gravothermal evolution, including core-forming and -collapsing phases. By normalizing the calibrated density profile, we obtain a universal description for SIDM halos at any evolution phase. The model allows us to infer properties of SIDM halos based on their cold dark matter (CDM) counterparts. As a basic application, we only require two characteristic parameters of an isolated CDM halo at $z = 0$. We then extend the model to incorporate effects induced by halo mass changes, such as major mergers or tidal stripping, making it applicable to both isolated halos and subhalos. The parametric model is tested and validated using cosmological zoom-in SIDM simulations available in the literature. It can be integrated into semi-analytic CDM models to generate theoretical predictions at all scales.

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Session Classification: Parallel

Track Classification: DM