Contribution ID: **45** Type: **Talk**

# Uncertainties in Direct Dark Matter Detection in Light of Gaia's Escape Velocity Measurements

*Thursday 26 March 2020 18:15 (15 minutes)*

Direct detection experiments have set increasingly stringent limits on the cross section for spin-independent dark matter-nucleon interactions. In obtaining such limits, experiments primarily assume the standard halo model (SHM) as the distribution of dark matter in our Milky Way. Three astrophysical parameters are required to define the SHM: the local dark matter escape velocity, the local dark matter density and the circular velocity of the sun around the center of the galaxy. This work studies the effect of the uncertainties in these three astrophysical parameters on the XENON1T exclusion limits using the publicly available DDCalc code. We compare limits obtained using the widely assumed escape velocity from the RAVE survey and the newly calculated escape velocity by Monari et al. using Gaia data. Our study finds that the astrophysical uncertainties are dominated by the uncertainty in the escape velocity (independent of the best fit value) at dark matter masses below 6 GeV and can lead to a variation of nearly 6 orders of magnitude in the exclusion limits at 4 GeV. Above a WIMP mass of 6 GeV, the uncertainty becomes dominated by the local dark matter density, leading to uncertainties of factors of ~10 (3) at 6 (15) GeV WIMP mass in the exclusion limits. Additionally, this work finds that the updated best fit value for the escape velocity based on Gaia data leads to only very minor changes to the effects of the astrophysical uncertainties on the XENON1T exclusion limits.

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**Session Classification:** Session 10

**Track Classification:** Dark matter theory