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Detectability of dark matter subhalo impacts in Milky Way stellar streams

Stellar streams are a promising way to probe the gravitational effects of low-mass dark matter (DM) subhalos. In recent years, there has been a remarkable explosion in the number of stellar streams detected in the Milky Way, and hundreds more may be discovered with future surveys such as LSST. Studies of DM subhalo impacts have so far focused only on a few of the thinnest and brightest streams, and it is not known how much information can be gained from the others. In this work, we develop a method to quickly estimate the minimum detectable DM subhalo mass of a given stream. Our work is based on an analytic model for subhalo impacts on circular streams, which allows us to simulate streams with a wide range of properties including width, length, distance, and stellar density. We consider several observational scenarios, based on current and future surveys including Gaia, DESI, Via, and LSST. We find that at 95% confidence level, a stream like GD-1 has a minimum detectable subhalo mass of $\sim 6 \times 10^6\ M_\odot$ in Gaia data and $\sim 8 \times 10^5\ M_\odot$ with LSST 10 year sensitivity. Applying our results to confirmed Milky Way streams, we rank order them by their sensitivity to DM subhalos and identify promising ones for further study.

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