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Analytic Approximations for the Velocity Suppression of Dark Matter Capture

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Dark matter (DM) characteristics can be explored via indirect detection through the observations of astro-physical objects which have captured DM. In this paper we analyze the role of stellar velocity on multiscatter DM capture rates. The addition of the stellar velocity with respect to its surrounding DM halo induces a suppression of this capture rate. We develop and validate an analytical representation of this suppression factor. It can be used to easily and directly re-scale previously-obtained bounds on the DM-nucleon cross section provided only with a stellar velocity. We demonstrate this using Population III (Pop III) stars, which are interesting candidates to study DM, as they would form and exist in high DM density environments and at high redshifts. We find that previous constraints for the DM-nucleon cross section using Pop III stars are essentially unchanged when accounting for the possibility of stellar velocities.

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