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Boosted dark matter in white dwarfs

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White dwarfs offer a compelling avenue for probing interactions of dark matter particles, particularly in the challenging sub-GeV mass regime. The constraints derived from these celestial objects strongly depend on the existence of high dark matter densities in the corresponding regions of the Universe, where white dwarfs are observed. This implies that excluding the parameter space using local white dwarfs would present a significant challenge, primarily due to the low dark matter density in the solar neighbourhood. This limitation prompts the exploration of alternative scenarios involving dark matter particles with a diverse spectrum of kinetic energies. In this work, we investigate how these dark matter particles traverse the star, interact with stellar matter, and ultimately get captured. To accomplish this, we approximate the dark matter flux as a delta function and we assume that fermionic dark matter interacts with stellar matter either through a vector or a scalar interaction. In our computations, we consider how interactions might vary across different energy regimes, from high-energy deep inelastic scattering and inelastic scatterings via the production of N− and Δ− resonances to lower-energy elastic interactions with nucleons and nuclei. Our study models these inelastic resonant interactions with dark matter and vector or scalar mediators for the very first time. We provide insights into the specific conditions required for successfully
boosted dark matter capture in white dwarfs. We found that, in general, dark matter capture is most likely to occur at low energies, as expected. However, in the high-energy regime, there remains a small window for capture through resonant and deep inelastic scattering processes.

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