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Exploring DSNB boosted sub-GeV dark matter: insights from XENONnT and LZ experiments

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Various cosmological observations suggest that 85% matter of the Universe is cold dark matter (DM), a non-luminous substance that does not interact with photons and interacts only "weakly"with ordinary matter. Despite no conclusive DM discovery, various experiments, including direct and indirect detection experiments and collider searches, have imposed very tight constraints on its properties. However, these experiments primarily explore the DM parameter space within the GeV-TeV mass range. Recently, interest in detecting sub-GeV DM has increased. However, their low momenta make detection challenging, as they fail to induce recoils above the thresholds of conventional direct detection experiments. Even strongly interacting DM within this mass range has been suggested to elude all observational bounds.

We explore a scenario where sub-GeV cold DM particles are accelerated to semi-relativistic velocities through their scattering with the diffuse supernova neutrino background (DSNB) in the galaxy |1|. This mechanism introduces a high-energy DM component capable of interacting with both electrons and nuclei in the detector, triggering a detectable recoil signal. We analyze data from the most advanced direct detection facilities in the contemporary world, namely the XENONnT |2| and LUX-ZEPLIN (LZ) |3| experiments, to derive constraints on the scattering cross-sections of sub-GeV boosted DM with both electrons and nucleons. Additionally, we emphasize the imperative nature of considering Earth's attenuation effects for both electron and nuclei interactions. Lastly, we present a comparison of our findings with existing constraints, illuminating the complementarity and significance of the LZ and XENONnT data in probing the sub-GeV DM parameter space.

|1| V. De Romeri, **A. Majumdar**, D. K. Papoulias and R. Srivastava, "XENONnT and LUX-ZEPLIN constraints on DSNB-boosted dark matter,"JCAP 03 (2024) 028, arXiv:2309.04117 [hep-ph].

|2| E. Aprile *et al.* **[XENON Collaboration]**, "First Dark Matter Search with Nuclear Recoils from the XENONnT Experiment,"Phys. Rev. Lett. **131** (2023) no. 4, 041003, arXiv:2303.14729 [hep-ex].

|3| J. Aalbers *et al.* **[LZ Collaboration]**, "First Dark Matter Search Results from the LUX-ZEPLIN (LZ) Experiment,"Phys. Rev. Lett. **131** (2023) no.4, 041002, arXiv:2207.03764 [hep-ex].

Track type

Dark Matter

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