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Lowering the low-energy threshold of xenon-based detectors

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The XENON10 Experiment has already reported exclusion limits for spin-independent, spin-dependent and inelastic couplings of nuclei to particle dark matter. Recently, there has been considerable (perhaps, renewed) interest in light-mass $\mathcal{O}(10)$~GeV dark matter candidates. In this mass range, the sensitivity of XENON10 drops sharply, due to the low-energy threshold. The low-energy threshold is limited by the collection of primary scintillation photons following a particle interaction, and begins to drop between $5-8$~keV nuclear recoil energy. We discuss recent modeling of that threshold, and show how this affects the resulting sensitivity of the experiment. The methods are applicable to other xenon-based detectors such as XENON100 and LUX. Finally, we explore the possibility of using only the proportional scintillation signal (the ionization channel). In so doing, traditional S2/S1 discrimination must be abandoned, but the resulting energy threshold of ~ 1~keV nuclear recoil energy leads to interesting constraints on viable dark matter models. This work will also be of interest to the possibile detection of coherent neutrino scattering.

Auteur principal: Dr SORENSEN, Peter (LLNL)

Co-auteur: XENON10, Collaboration ((multiple))

Orateur: Dr SORENSEN, Peter (LLNL)

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