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Characterising track length distributions of dark matter induced nuclear recoils in paleo-detectors with SRIM

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Paleo-detectors have been proposed to search for new physics through damage tracks formed by traversing recoiled nuclei in minerals deep underground, leveraging its high exposure time (~Gyr). Paleo-detection is expected to have a very low signal-to-background ratio, it is therefore particularly important to accurately model the expected signals. In previous studies, a one-to-one relationship between recoil energy and the length of the damage tracks was assumed. We used SRIM, a Monte Carlo simulation program that models the transports of ions in lattices, to characterise the track length distributions at various recoil energies. We found that a single track length could be resulted from a wide range of recoil energies. Consequentially, low energy recoils, which with the one-to-one assumption would otherwise result in tracks below currently achievable read-out resolution, in fact could now have measurable contributions to longer, detectable tracks. We used this improved calculation to model nuclear recoils by WIMPS and to search for new physics with light mediators through neutrino-nucleus scatterings.

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