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Towards a prototype paleo-detector for supernova neutrino and dark matter detection

Using ancient minerals as paleo-detectors is a proposed experimental technique with the potential to transform supernova neutrino and dark matter detection. In this technique, minerals are processed and closely analyzed for nanometer scale damage track remnants from nuclear recoils caused by supernova neutrinos and possibly dark matter. These damage tracks present the opportunity to directly detect and characterize the core-collapse supernova rate of the Milky Way Galaxy as well as the presence of dark matter. Current literature presents theoretical estimates for these potential tracks, however, there is little research investigating the experimental feasibility of this technique. We have located and analyzed damage tracks in halite to characterize the applicable backgrounds. We employed a non-destructive technique using laser confocal microscopy to identify and characterize the damage tracks in halite. Plasma etching of mineral samples was used to enhance the detectability of these damage tracks at the expense of altering some of their geometrical attributes. We utilized an etching rate model and automatic track detection via Python to reconstruct damage track lengths. Our data was compared to current theoretical predictions to pursue the practical implementation of paleo-detectors as local core-collapse supernova neutrino and dark matter detectors.

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