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Paleo-Detectors for Galactic Supernova Neutrinos

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Paleo-detectors are a proposed experimental technique in which one would search for traces of recoiling nuclei in ancient minerals. Natural minerals on Earth are as old as $\mathcal{O}(1)$ Gyr and, in many minerals, the damage tracks left by recoiling nuclei are also preserved for time scales long compared to 1 Gyr once created. Thus, even reading out relatively small target samples of order 100 g, paleo-detectors would allow one to search for very rare events thanks to the large exposure, $\varepsilon \sim 100\,\mathrm{g\,Gyr} = 10^5\,\mathrm{t\,yr}$. Here, we explore the potential of paleo-detectors to measure nuclear recoils induced by neutrinos from galactic core collapse supernovae. We find that they would not only allow for a direct measurement of the average core collapse supernova rate in the Milky Way, but would also contain information about the time-dependence of the local supernova rate over the past ~ 1 Gyr. Since the supernova rate is thought to be directly proportional to the star formation rate, such a measurement would provide a determination of the local star formation history. We investigate the sensitivity of paleo-detectors to both a smooth time evolution and an enhancement of the core collapse supernova rate on relatively short time scales, as would be expected for a starburst period in the local group.

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