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Study of the accuracy of common modeling of Cherenkov light emitted by MeV electrons

Cherenkov light is used in a wide variety of neutrino detectors for observing the secondary charged particles produced after neutrino interactions. The SNO+ experiment has reported a discrepancy between data and Monte-Carlo in the isotropy of the Cherenkov light emitted by electrons with energies of a few MeV. SNO+ relies on Geant4, a widely used simulation package, to approximate the trajectory of charged particles assuming full coherence of the Cherenkov radiation they emit. These assumptions may not hold for MeV electrons. In this work, we explore the influence of the scattering model used for particle propagation on the resulting Cherenkov light distribution. We also evaluate a possible loss of coherence of the radiation along the particle' s path caused by the scattering of the electron in the matter.
As a result, we develop a new Cherenkov radiation model for Monte-Carlo simulations and tune it in the 2.2 - 6.1 MeV energy range using SNO+ calibration data. Tuning the model removes the discrepancy between simulated and measured light distributions in SNO+.
The presented method considers the physical processes that are taking place during electron propagation more accurately and could be relevant to new, more precise experiments that use Cherenkov light imaging.

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