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Nucleation efficiency of nuclear recoils in bubble chambers

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Bubble chambers using liquid xenon (and liquid argon) have been operated (resp. planned) by the Scintillating Bubble Chamber (SBC) collaboration for GeV-scale dark matter searches and CEvNS from reactors. This will require a robust calibration program of the nucleation efficiency of low-energy nuclear recoils in these target media. Such a program has been carried out by the PICO collaboration, which aims to directly detect dark matter using C_3F_8 bubble chambers. Neutron calibration data from mono-energetic neutron beam and AmBe source has been collected and analyzed, leading to a global fit of a generic nucleation efficiency model for carbon and fluorine recoils, at thermodynamic thresholds of 2.45 and 3.29 keV. Fitting the many-dimensional model to the data (34 free parameters) is a non-trivial computational challenge, addressed with a custom Markov Chain Monte Carlo approach, which will be presented. Parametric MC studies undertaken to validate this methodology are also discussed. This fit paradigm demonstrated for the PICO calibration will be applied to existing and future scintillating bubble chamber calibration data.

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