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A Model of Nuclear Recoil Scintillation Efficiency in Noble Liquids DONGMING MEI, The University of South Dakota, ZHONGBAO YIN, LAURA STONEHILL, ANDREW HIME, Los Alamos National Laboratory — Scintillation efficiency of low-energy nuclear recoils in noble liquids plays a crucial role in interpreting results from some direct searches for Weakly Interacting Massive Particle (WIMP) dark matter. However, the cause of a reduced scintillation efficiency relative to electronic recoils in noble liquids remains unclear at the moment. We attribute such a reduction of scintillation efficiency to two major mechanisms: 1) energy loss and 2) scintillation quenching. The former is commonly described by Lindhard's theory and the latter by Birk's saturation law. We propose to combine these two to explain the observed reduction of scintillation yield for nuclear recoils in noble liquids. Birk's constants kB for argon, neon and xenon determined from existing data are used to predict noble liquid scintillator's response to low-energy nuclear recoils and low-energy electrons. We find that energy loss due to nuclear stopping power that contributes little to ionization and excitation is the dominant reduction mechanism in scintillation efficiency for nuclear recoils, but that significant additional quenching results from the nonlinear response of scintillation to the ionization density.

Dongming Mei
The University of South Dakota

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