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At the 100 eV Frontier: Calibrating Nuclear Recoils with CRAB

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Low-threshold detectors for coherent elastic neutrino-nucleus scattering (CEvNS) and light dark matter (DM) searches rely crucially on understanding their response to sub-keV nuclear recoils, which is difficult to access using conventional calibration techniques. The CRAB collaboration proposed a new method based on mono-energetic nuclear recoils in the 100 eV - 1 keV range induced by the emission of MeV-γ rays following thermal neutron capture. We performed simulation studies on the expected energy spectrum which include in detail the involved nuclear physics for typical detector materials, e.g., Si, Ge, $CaWO_4$, and Al_2O_3. Recently, we reported a major breakthrough with the first direct observation of a nuclear recoil peak at the 100 eV scale measured with a NUCLEUS $CaWO_4$ detector.

Currently, the CRAB collaboration prepares precision measurements with a clean thermal neutron beam at a research reactor at TU Wien. The sensitivity of the CRAB method is further increased by the detection of the emitted γ-ray in coincidence with the subsequent nuclear recoil and by the interplay of the timing of the γ-cascade and the nuclear recoil. With its novel idea, CRAB provides a direct and accurate calibration of nuclear recoils and will enable future quenching factor measurements in the region of interest of light DM and CEvNS experiments. This is essential for finding and studying new physics. The latest results and the experimental strategy will be presented.

Submitted on behalf of a Collaboration?

Yes

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