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Observation of a nuclear recoil peak in Sapphire and molecular dynamics simulation of the Al recoil

The current generation of cryogenic solid state detectors used in direct dark matter and CEνNS searches typically reach energy thresholds of $\mathcal{O}(10\,\text{eV})$ for nuclear recoils. The energy calibration of these detectors is usually done via X-ray sources with energies in the $\mathcal{O}(\text{keV})$ region, requiring an extrapolation to the low-energy regime. Ideally, these detectors should be calibrated via mono-energetic nuclear recoils in the relevant energy range. To achieve this, a new method has been proposed which is based on the radiative capture of thermal neutrons on nuclei, which may be followed by a de-excitation via single γ-emission leading to a low-energetic nuclear recoil. The first experimental observations of this effect were accomplished with $_4$ crystals. In this work we report on the observation of a peak around 1.1 keV in the data of an Al_2O_3 crystal in CRESST-III, which was irradiated with neutrons from an AmBe calibration source. We attribute this mono-energetic peak to the radiative capture of thermal neutrons on ^{27}Al and the subsequent de-excitation via single γ-emission.

To investigate the impact of crystal defect creation on the observable energy, the INCIDENCE project is performing molecular dynamics simulation of the Al recoil within the crystal lattice of Al_2O_3. We will present first results that predict an energy loss of $\mathcal{O}(10\,\text{eV})$ for nuclear recoils at around 1.1 keV.

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