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Measurement of Lattice Quantum effects in phonon assisted solid state detectors

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Particle-induced crystalline defects are critical in various applications, from detecting dark matter and Coherent Elastic Neutrino-Nucleus Scattering (CEνNS) to enhancing quantum computing devices. Defects within crystals can store energy, which directly influences particle interaction spectra and detection sensitivity. Furthermore, pre-existing defects can anneal over time, potentially manifesting as backgrounds in low-threshold detectors or causing decoherence in quantum computing devices, such as qubits. Despite the predicted effects of these defects, a deep understanding of their behavior has been elusive. This challenge stems from the need for detectors with unprecedented low-energy resolution (below 1 eV) and reliable sources of low-energy nuclear recoil to accurately study these defects.

We will present results from defect simulations in the most common detector crystals and introduce a novel method that utilizes activated nuclei in the lattice, where the recoiling nucleus serves as a source of low-energy nuclear recoils. Additionally, we will share our recent progress in achieving a $\sim$eV-scale threshold to facilitate these measurements.

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