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Development of phonon-mediated particle detectors with meV to eV energy thresholds for sub-GeV dark matter direct detection

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Phonon-mediated particle detectors with sub-eV threshold reach have the potential to broadly scan the increasingly theoretically relevant sub-GeV dark matter parameter space. Two technologies we consider, Kinetic Inductance Phonon-Mediated detectors (KIPMs) and a novel scheme based on quantum computing style charge qubits called Quantum Parity Detectors (QPDs), exploit superconducting material physics via Cooper-pair breaking to sense phonons created by particle interactions within a crystalline substrate. These devices'inherent multiplexability, non-dissipative nature, and exponential suppression of quasiparticle population with temperature –assuming a reduction in residual quasiparticles - make them well suited for imaging the entire phonon flux. We discuss recent experimental efforts in validating KIPM designs and in achieving lower thresholds, including through LED based calibrations and successes in interfacing KIPMs with quantum-limited parametric amplifiers. We also show the first signals from a QPD sensor and discuss a roadmap to potential meV-scale detectability of particle interactions by this class of device.

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