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Development of Superconducting Qubit-Based Sensors for meV Scale Detectors

Wednesday, 8 November 2023 14:00 (15 minutes)

The increasing maturity of superconducting qubits over the past few decades has allowed the field of superconducting quantum computing to flourish. In parallel, advances in detector technology which have built on this wave of qubit fabrication expertise have shown that this same technology can be applied to energy sensing at the THz (meV) scale, opening up a new regime of sensing leveraging the single quasiparticle sensitivity of qubit-derived structures. In this talk I will give a brief overview of the interesting HEP physics that can be done at the meV scale and talk about two recent sensor designs we have developed based on superconducting qubits.

The development of single electron-sensitive charge amplifiers is of interested to a wide array of experiments in HEP and beyond. To date, this sensitivity has only been achieved using fabrication techniques limited to specific detector substrates, e.g. Skipper CCDs (Si) and SuperCDMS HVeV (Si, Ge). I will give an overview of a recently funded project between LANL and SLAC to build a single electron-sensitive charge amplifier that will be compatible with any solid-state detector target. This will be achieved using Cooper pair box electrometers based on charge qubits, which can be externally coupled to a large variety of detector target materials. Additionally I will discuss an athermal-phonon sensitive qubit sensor which leverages quasiparticle trapping and amplification, based on the transmon architecture. I will detail our initial designs, quasiparticle trapping model, and R&D plan which will allow these sensors to achieve sensitivity to single meV phonons. Both of these sensor designs have the potential to have profound impacts on the direct detection of sub-MeV dark matter.

Early Career

Yes

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