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Neganov-Trofimov-Luke light detectors in 0vbb experiments

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In bolometric experiments searching for neutrinoless double-beta decay ($0\nu\beta\beta$), light detectors are used to identify and discriminate between particle interactions by simultaneously detecting heat and scintillation light. This dual-readout approach is crucial for suppressing background signals, particularly for distinguishing α particles from β/γ events, thereby enhancing sensitivity to rare decay signatures.
Luminescent bolometers—consisting of a primary energy absorber containing the double-beta decay isotope and an auxiliary cryogenic light detector—represent a leading technology in this field. They are central to experiments such as BINGO, CROSS, and CUPID.
To improve the performance of cryogenic light detectors in these experiments, the Neganov-Trofimov-Luke (NTL) effect is employed. By applying an electric field across a semiconductor absorber, the NTL effect amplifies the thermal signal through the drift of photo-generated charges. This significantly enhances the signal-to-noise ratio without introducing additional thermal noise, enabling the detection of extremely faint luminescent signals. This amplification is particularly valuable for improving background rejection, including efficient pile-up discrimination.
Ongoing R&D efforts focus on optimizing NTL light detectors (NTL LDs) to meet the performance requirements of CROSS, BINGO, and CUPID. These detectors are tested at cryogenic temperatures with various electrode designs to study their signal gain and their ability to sustain high voltage bias.

This poster presents the development of both Ge and Si light detectors, from bare wafers to fully functional devices incorporating NTL amplification. It highlights the fabrication processes, performance characterization, and key experimental results.

Collaboration you are representing

CUPID, CROSS and BINGO

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