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Advancements in Single Barium Ion Capture and Imaging for Barium Tagging Sensors in NEXT Neutrinoless Double Beta Decay Studies

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Demonstrating a highly efficient single ion barium tagging sensor could reduce backgrounds in searches for neutrinoless double beta decay ($0\nu\beta\beta$) to negligible levels in ton to multi-ton scale experiments. The NEXT collaboration is pursuing a phased program aimed at searching for $0\nu\beta\beta$ utilizing high-pressure xenon gas time projection chambers (TPC) with the introduction of a future barium tagging phase using single molecule fluorescence imaging (SMFI). In the following, I will present recent advances in the development of single ion barium tagging technology based on SMFI using a novel high-pressure gas microscope and organic fluorophores for dry functionality, along with demonstration of single ion capture and imaging in a high-pressure xenon gas environment. This single-ion imaging microscope is a prototype sensor for future integration into a barium tagging high-pressure xenon gas TPC experiment. Lastly, outline the framework of a novel qubit-inspired ion sensor designed to integrate the sensing and transportation of the daughter ion produced in $0\nu\beta\beta$. This sensor will be realized through the utilization of advanced nanofabrication techniques, enabling the development of a photonic integrated chip. This framework aims to create a compact ion detector that is highly selective, dependable and adaptable for integration into a barium tagging TPC design.

Poster prize

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