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Development of an accelerator-driven ion source for barium tagging in nEXO

Neutrinoless double-beta decay ($0\nu\beta\beta$) offers a way to probe for physics beyond the Standard Model. Observation of $0\nu\beta\beta$ would validate the Majorana nature of neutrinos, demonstrate violation of lepton number, and help explain the observed baryon asymmetry in the universe. In addition, $0\nu\beta\beta$ could also shed light on new mass generation mechanisms up to the GUT scale. The proposed nEXO experiment will search for $0\nu\beta\beta$ decay in ^{136}Xe with a projected half-life sensitivity exceeding 10^{28} years at 90% confidence level, using a time projection chamber filled with 5 tonnes of liquid xenon (LXe) enriched to $\sim$ 90% ^{136}Xe. In parallel, different approaches are being investigated within the nEXO collaboration to further suppress backgrounds in the region of the $0\nu\beta\beta$ signal. One such technique is called barium (Ba) tagging, which involves extracting and identifying the $\beta\beta$-decay daughter Ba ion. Ba tagging will ensure an irrefutable classification of each $\beta\beta$ event and further increase the experimental sensitivity of nEXO. To test and optimize the tagging techniques, an accelerator-driven ion source is currently being developed. Radioactive ions from TRIUMF's Isotope Separator and Accelerator (ISAC) facility will be implanted in a LXe volume, extracted electrostatically, and detected using γ spectroscopy. The motivation and overview of Ba tagging, and details of the ion source apparatus, development status and planned experiments will be presented.

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