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Unraveling Secrets of the Universe, One Barium Ion at a Time: A Barium Tagging Technique for the nEXO Experiment

Sunday, 18 February 2024 09:30 (15 minutes)

Barium-tagging is a technique being developed as a potential upgrade for an experiment called nEXO. The technique aims to identify single ions of the isotope Ba-136 to confirm the decay of its parent nucleus Xe-136. Due to the event localisation capability of the nEXO detector, with Ba-tagging, the detector volume can be probed for Ba-136. Identification of Ba-136 would serve as unambiguous proof for the observed event to be related to the decay of Xe-136 and not other backgrounds.

The main interest in this decay stems from the search of a lepton number violating process called neutrinoless double-beta decay (0vbb). If observed, this would be the first experimental evidence of the Majorana nature of neutrinos (i.e. neutrinos are their own antiparticles) which would have profound implications on fundamental physics. Xe-136 is one of the isotopes studied since it decays via the Standard-Model allowed two-neutrino double beta decay, hence, it could also exhibit the neutrinoless channel. Thus, the nEXO experiment will search for 0vbb using large quantities (5 tonnes) of liquid xenon (LXe) that is 90% enriched in Xe-136.

A successful Ba-tagging technique will greatly boost the discovery potential of nEXO. Several approaches to this technique are being actively investigated to achieve this feat of extracting and detecting a single ion from tonnes of LXe. The scheme being presented involves the use of a capillary for extracting some LXe from a potential 0vbb event location in the nEXO time projection chamber. After the transition of this LXe to gas phase, ion manipulation components isolate and identify the Ba ion. The talk will discuss the developments of a specific section of the Ba-tagging setup, the linear Paul trap, that is designed to trap and bunch ions extracted from gaseous xenon for identification. Results obtained from studies performed with LPT using a cesium ion source will be presented along with plans for future studies using a multi-element ion source.

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