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The MicroBooNE Experiment and the Impact of Space Charge Effects

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MicroBooNE is an experiment designed to both probe neutrino physics phenomena and develop the LArTPC (Liquid Argon Time Projection Chamber) detector technology. The MicroBooNE experiment, which begins data-taking this year, will be the first large LArTPC detector in the U.S. and second worldwide - an experiment that is the beginning of a path of detectors envisioned for the U.S. SBL (Short BaseLine) and LBL (Long BaseLine) programs. In order to interpret the data from these experiments, the impact of space charge effects must be simulated and calibrated. The space charge effect is the build-up of slow-moving positive ions in a detector due to, for instance, ionization from cosmic rays, leading to a distortion of the electric field within the detector. This effect leads to a displacement in the reconstructed position of signal ionization electrons in LArTPC detectors. The LArTPC utilized in the MicroBooNE experiment is expected to be modestly impacted from the space charge effect, with the electric field magnitude changing by roughly 5% (at a drift field of 500 V/cm) in some locations within the TPC. The flow of liquid argon within the detector may complicate matters even further. We discuss the simulation of the space charge effect at MicroBooNE as well as calibration techniques that make use of a UV laser system and cosmic muon events. A successful calibration of the space charge effect is imperative both to the success of the MicroBooNE physics program as well as to the development of LArTPC technology for future experiments.

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