Detecting Charged-Current Neutrino-Nucleus Interactions on Oxygen in a Heavy Water Cherenkov Detector

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Abstract

At Oak Ridge National Laboratory (ORNL), the COHERENT collaboration has been building a heavy water Cherenkov detector to measure the neutrino flux coming from the Spallation Neutron Source (SNS). This detector is a steel cylinder filled with light water with an inner acrylic vessel holding heavy water and twelve PMTs lining the inside of the top lid. It began accumulating statistics in summer 2022 with light water only, since the inner acrylic tank and heavy water were not installed until summer 2023. The detector is expected to be fully completed and taking measurements in the summer of 2023. Although this heavy water Cherenkov detector was built primarily to measure the SNS neutrino flux, it can also be used to measure the cross section of neutrino-nucleus charged-current interactions on ^{16}O nuclei. Charged-current $^{16}O(\nu_e, e^-)X$ reactions produce recoiling e^- that will emit Cherenkov radiation within the detector with an energy threshold of about 5 MeV, well within the energy range of ν_e created at SNS. This charged-current reaction in oxygen has never been measured and has implications for supernovae neutrino detection and testing nuclear physics theories. This presentation describes methodology for detecting and measuring the cross section and event rate of this charged-current interaction between ν_e and ^{16}O nuclei.