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R&D for the observation of Coherent Neutrino Scatter at a Nuclear Reactor with a Dual-Phase Argon Ionization Detector

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Coherent scattering of neutrinos on nuclei is a well-known prediction of the Standard Model that has so far eluded all experimental attempts to detect it. Aside from validating core elements of the Standard Model, the detection of coherent neutrino scattering has other interesting applications as a flavor-blind monitor of neutrino flux for neutrino oscillation experiments, supernova explosions and nuclear reactors.

Detection of coherent neutrino scattering relies on the ability to measure the tiny recoil energy (few keV for reactor neutrinos) of the target nucleus. Dual-phase liquid-gas detectors using noble elements provide good sensitivity on low-energy nuclear recoils, as demonstrated in searches for dark matter. The ability to detect low-energy nuclear recoils is related to the amount of primary electrons produced by the recoiling nucleus. This quantity is described by the nuclear ionization quench factor, which is experimentally largely unknown at very low energy.

We have constructed a dual-phase Argon detector to measure the nuclear ionization quench factor of Argon at 8 keV using a neutron beam. We have also proposed a novel technique based on nuclear resonance fluorescence that could bring us down in the sub-keV range. These measurements will be very interesting also for dark matter experiments. Moreover, the detector is a prototype for a larger experiment to measure coherent neutrino scattering at a nuclear reactor.

We will present an overview of our program, the technical challenges we face in looking for coherent neutrino scatter at a nuclear reactor, and report on the commissioning of the dual-phase prototype, with details on the proposed techniques for the quench factor measurements.

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