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Project Title

Observing CEvNS with a NaI[Tl] Detector at the SNS

Project Objective

Observe Coherent Elastic Neutrino-Nucleus Scattering (CEvNS) with a 2-ton array of NaI[Tl] detectors at the Spallation Neutron Source (SNS)

Project Description

While Coherent Elastic Neutrino-Nucleus Scattering (CEvNS) was predicted over forty years ago, it has yet to be observed experimentally. The cross section for CEvNS is proportional to the number of neutrons in the target nucleus squared, which can make it potentially orders of magnitude greater than other neutrino cross sections. However, CEvNS is difficult to detect experimentally because of the low energy of the nuclear recoils involved. The COHERENT experiment aims to make the first experimental observation of CEvNS at the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory (ORNL).

Sodium is the lightest of COHERENT's target nuclei, and will provide confirmation of the N^2 scaling. The NaI[Tl] detector will be capable of simultaneously measuring the CEvNS cross section and the charged-current interaction in ^{127}I , measuring an electron-neutrino exclusive interaction as well as one in which all flavors of neutrinos participate. Additionally, the segmented nature of this detector will help reduce backgrounds.

Characterizing backgrounds is essential for observation of CEvNS at the SNS. Two background detectors I work on are the Iron Neutrino Cube, seeking to measure the background of neutrino-induced neutrons in iron, and the Multiplicity and Recoil Spectrometer (MARS), measuring neutron backgrounds at the SNS.

Project Relevance to Nuclear Nonproliferation

Neutrinos are emitted in large quantities from nuclear reactors, and are impossible to shield. Information about a nuclear reactor such as power status and fissile content can be determined non-intrusively by observing the neutrinos it emits. CEvNS will allow for smaller detector footprints, and the ability to monitor reactor neutrinos from further distances.

Products and Outcomes of Project

A 185-kg prototype array has been deployed to the SNS to measure the charged-current interaction on ^{127}I and beam-related backgrounds for a CEvNS search. While that is gathering data, work has been done to achieve a $\sim 3\text{keVee}$ threshold on the detectors to be used. The next steps are designing the shielding and DAQ for the 2-ton array, characterizing all 240+ NaI(Tl) crystals. The goal is to deploy the detector in 2018, and run until significant statistics are achieved and a cross-section can be reported.



Publications and Reports

D. Akimov, et al., "The COHERENT Experiment at the Spallation Neutron Source", arxiv 1509.08702 (2015).

D. Akimov, et al., "COHERENT Experiment: Current Status", Proc. *International Conference on Particle Physics and Astrophysics*, Journal of Physics: Conf. Series **798** 012213 (2017).

Presentations

S. Hedges, "Coherent Elastic Neutrino-Nucleus Scattering as a Means of Enabling Nonproliferation Efforts", *CNEC Workshop Poster Session*, Raleigh, North Carolina, Feb. 6-7, 2017.

S. Hedges, P. S. Barbeau, C. Awe, L. Li, B. Suh, "A NaI(Tl) Detector for Observing Coherent Elastic Neutrino-Nucleus Scattering," *University Program Review 2017 Poster Session*, Walnut Creek, California, June 6-8, 2017.