CENNS-750: A Ton-Scale Liquid Argon Detector for CEvNS at the SNS

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Coherent-Elastic Neutrino Nucleus Scattering (CEvNS)

- Neutral-current process first predicted in 1974 by D. Freedman
- Low energy neutrino exchanges Z0 boson with target nuclei
  - \( E_{\nu} \leq 50 \text{MeV} \)
  - \( E_{\text{max}} \approx 50 \text{keV} \)
- Need low-threshold and low-background detectors
- Cleanly predicted by Standard Model
- Deviations could indicate new physics

Various neutrino processes cross-sections. CENNS orders of magnitude greater than IBD and \( \nu_e \) scattering

COHERENT at the SNS

- Spallation Neutron Source at Oak Ridge National Laboratory
  - Highest flux of pulsed neutrinos in the world:
    - \( 4.3 \times 10^7 \text{v/cm}^2/\text{s} \) at 20m
  - Timing used for background rejection
- Multiple detectors with target nuclei in basement of SNS, “neutrino alley”
  - Test \( N^2 \) dependence of cross-section
  - First observation of CEvNS in 2017, using CsI[Na] crystal scintillator
  - First observation of CEvNS on Ar in 2020
- See poster #49

Left: CEvNS cross-section vs. N
Above: Current and planned detectors at the SNS

CENNS-750

- Ton-scale single-phase liquid-argon detector
  - 610kg fiducial volume
  - TPB coated Teflon panels on sides
  - Planned same location as current CENNS-10
  - 27.5m from Hg target
- Currently in development phase
- Utilize lessons learned from building and running CENNS-10
- Expect same threshold as CENNS-10, ~20keVnr

CEvNS-750 and Dark Matter

- CEvNS is irreducible background for dark matter WIMP searches
- Development of CEvNS detection capabilities provides tools for direct dark matter WIMP searches
- Sub-GeV accelerator produced dark matter
- Also useful for sterile neutrino searches
- arXiv:1911.06422

Left: Direct dark matter searches with neutrino floor
Right: Predicted accelerator produced, sub-GeV dark matter signal in CENNS-750 after three years
Further Right: Expected constraints on accelerator produced, sub-GeV dark matter for three years running with CENNS-750

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References

2. D. Ahlen et al. (COHERENT), Science, 373, 1123–1126 (2021)
3. D. Ahlen et al. (COHERENT), arXiv:1803.09183

Test chamber for wavelength shifting tests and Hg doping at ORNL. Could lead to reduced threshold.
IU student Jacob Zettlemoyer

Above: SPE spectrum from 3” Hamamatsu PMT at LN2 temperatures. Plan to test 20keVnr threshold
Left: Optical measurement of TPB coated materials. Could lead to reduced thresholds