Magnificent CEvNS 2019

Saturday 9 November 2019 - Monday 11 November 2019

The PIT

Book of Abstracts

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Observation of Supernova Neutrino Bursts via CEvNS

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Coherent elastic neutrino-nucleus scattering (CEvNS) is a neutral-current process in which a neutrino scatters off an entire nucleus, depositing a tiny recoil energy. The process is important in core-collapse supernovae and also presents an opportunity for detection of a burst of core-collapse supernova neutrinos in low-threshold detectors designed for dark matter detection. Here we present an ongoing study of prospects for supernova burst detection via CEvNS in existing and future large-scale detectors.

Theory/pheno/nuclear / 2

CP violating effects in coherent elastic neutrino-nucleus scattering processes

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Assuming light vector mediators, we discuss the effects of CP violation on the coherent elastic neutrino-nucleus scattering (CEvNS) process in the COHERENT sodium-iodine, liquid argon and germanium detectors. We show that in some regions of the parameter space, the presence of a dip in the event rate spectrum can be used to constraint CP violating effects. In other regions, we find that CP violating parameters can mimic the Standard Model CEvNS spectra induced by real parameters. We point out that the interpretation of CEvNS data in terms of a light vector mediator should take into account possible CP violating effects.

Current reactor experiments and CCDs / 3

RED-100 status update

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The RED-100 is a two-phase emission detector created to investigate coherent elastic neutrino scattering off xenon nuclei. Its active volume has a cylindrical shape with sizes of ˜ 40 cm. The total mass

of liquid xenon in the detector equals 200 kg. The detector performance provides sensitivity down to a single ionization electron while allows operation at a ground surface environment. In this talk, the current status of the RED-100 detector is presented. During the engineering run, the electron lifetime of several milliseconds was achieved. Technical decisions aimed on reduction of a single electron noise are discussed. Ongoing work on construction of low-background shield is presented. The plan of the experiment at Kalinin Nuclear Power Plant is given.

Current reactor experiments and CCDs / **4**

New Directions in Detector Development at MIT Lincoln Laboratory

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The Advanced Imager Technology group at MIT Lincoln Laboratory designs and fabricates detectors and readout circuits for imaging applications in support of National Security and scientific exploration. The group has a long history of supplying silicon charge-coupled devices (CCDs) for the astronomy community, including detectors for the Transiting Exoplanet Survey Satellite (TESS), the Advanced CCD Imaging Spectrometer (ACIS) on Chandra, and the 1.3 gigapixel array for Pan-STARRS at the University of Hawaii. Our CCD imagers are designed in-house, and fabrication is done in the Microelectronics Laboratory (ML), an ISO-9001 certified, 90-nm node semiconductor fabrication facility at the laboratory. In addition to continuously improving the capabilities of our silicon CCDs, our group has recently begun exploring other imager materials and devices, taking advantage of the advanced prototyping capabilities offered by the ML, with the ultimate goal of providing breakthrough imaging devices to enable new scientific observations. In this talk, we outline our progress in two of these new directions: fabricating imaging devices, both CCDs and hybrid active-pixel sensors, with germanium absorbers; and developing superconductor-based detectors for photon and particle detection.

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Neutrino Physics Opportunities at the J-PARC MLF

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The J-PARC Material and Life Science Experimental Facility (MLF) is a pulsed spallation neutron source in Tokai, Japan. 3 GeV protons produced by the Rapid Cycling Synchrotron (RCS) are directed onto a mercury target at 25 Hz to produce an intense source of neutrons and decay-at-rest neutrinos. In this talk, I will describe the MLF facility with a particular focus on the neutrino source characteristics. I will also describe an upcoming experiment called JSNS2 which will use the MLF neutrino flux to directly test the LSND anomaly and make various cross section measurements.

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PREX/CREX Overview

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This talk will provide a brief description of the experimental methods and for PVES scattering, particularly for neutron skin measurements. It will also summarize the theoretical motivation for this type of measurement.

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The CYGNUS Directional Dark Matter Experiment and Neutrino-Nucleus Scattering

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CYGNUS is a coordinated effort by dark matter direct search groups interested in directional signals, working towards design and build of a global network of directional WIMP experiments able to probe below the neutrino floor. As such, sensitivity is required to detection and measurement of Solar neutrino-nucleus scattering with directional information. The proposed technology is that of low pressure gas time projection chambers. Recent design work on CYGNUS to achieve this will be reviewed including new results on the essential issue of electron background discrimination and intrinsic backgrounds. The potential use of the UK's 1.5 GW Hartlepool reactor for a test run is outlined as well as other efforts in CYGNUS considering the potential for neutrino-nucleus scattering at low energies.

New experiments and technology / 8

Microwave multiplexed readout of transition edge sensors for neutrino detection

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Neutrino detectors have the proven capability to monitor nuclear reactor power levels and fuel consumption by observing the energy spectrum of neutrinos emitted by the reactor. However, conventional neutrino detection techniques require massive detectors that would be difficult to deploy in

the field for nuclear monitoring applications. A new detection method, Coherent Elastic Neutrino-Nucleus Scattering, requires significantly smaller target mass—kilograms instead of kilotons. Therefore, a deployable nuclear monitoring system based on coherent neutrino scattering would have significantly lower size, weight, and power requirements than competing systems based on conventional neutrino detection techniques. Coherent scattering was recently demonstrated for high-energy neutrinos from a spallation source. However, detecting the low-energy neutrinos produced in nuclear reactors will require significant improvements in sensor technology.
The Ricochet collaboration aims to perform the first detection of reactor neutrinos via coherent neutrino scattering. Our approach relies on arrays of TES bolometers specifically optimized to measure extremely low recoil energies in the range of 10-50 eV. In this talk, we will describe our efforts at MIT Lincoln Laboratory to develop circuits for microwave multiplexed readout of these highly-sensitive bolometric detectors.

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Neutrino transition magnetic moments and sterile neutrinos from CEvNS

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We discuss new physics opportunities that are accessible from CEvNS measurements. Specifically, we explore the potential of probing neutrino transition magnetic moments and the existence of sterile neutrinos. We present the relevant constraints extracted from the existing COHERENT data as well as we estimate the projected sensitivities at future CEvNS experiments

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CEvNS in multi-ton scale dark matter experiments: Confronting vector and scalar interactions new physics signals

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We classify new physics signals in coherent elastic neutrino-nucleus scattering (CEvNS) processes induced by B8 solar neutrinos in multi-ton xenon dark matter (DM) detectors. Our analysis focuses on vector and scalar interactions in the effective and light mediator limits after considering the constraints emerging from the recent COHERENT data and neutrino masses. In both cases we

identify a region where measurements of the event spectrum alone suffice to establish whether the new physics signal is related with vector or scalar couplings. We identify as well a region where in addition measurements of the recoil spectrum are required so to establish the nature of the new interaction, and categorize the spectral features that enable distinguishing the vector from the scalar case. We demonstrate that measurements of the isospin nature of the new interaction and thereby removal of isospin related degeneracies are possible by combining independent measurements from two different detectors. We also comment on the status of searches for vector and scalar interactions for on-going multi-ton year xenon experiments.

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Coherent elastic neutrino nucleus scattering with the CONUS experiment

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The CONUS experiment is located at the nuclear power plant of Brokdorf, Germany, at 17m distance from the reactor core. It aims at detecting coherent elastic neutrino nucleus scattering with four high-purity point contact Germanium detectors with a noise threshold in the range of 300 eV inside an elaborate shield. Proximity to a reactor core requires an in-depth understanding of the neutron background. The thorough characterization of the background with Bonner sphere measurements and a non-shielded Ge spectrometer will be presented and the successful suppression of all reactor-correlated background contributions within the CONUS shield will be shown. The remaining background contributions are examined with the help of Monte Carlo simulations. The special requirements for a detector close to a nuclear power plant will be discussed and the solutions will be presented. In the talk it will be illustrated how these challenges are met for the CONUS experiment. The long-term performance of the detectors and the latest results will be shown.

New detectors and applications / 12

Paleo-Detectors for Galactic Supernova Neutrinos

Author: Patrick Stengel[1]

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Paleo-detectors are a proposed experimental technique in which one would search for traces of recoiling nuclei in ancient minerals. Natural minerals on Earth are as old as $\mathcal{O}(1)\,\mathrm{Gyr}$ and, in many minerals, the damage tracks left by recoiling nuclei are also preserved for time scales long compared to $1\,\mathrm{Gyr}$ once created. Thus, even reading out relatively small target samples of order $100\,\mathrm{g}$, paleo-detectors would allow one to search for very rare events thanks to the large exposure, $\varepsilon \sim 100\,\mathrm{g\,Gyr} = 10^5\,\mathrm{t\,yr}$. Here, we explore the potential of paleo-detectors to measure nuclear recoils induced by neutrinos from galactic core collapse supernovae. We find that they would not only allow for a direct measurement of the average core collapse supernova rate in the Milky Way, but would also contain information about the time-dependence of the local supernova rate over the past $\sim 1\,\mathrm{Gyr}$. Since the supernova rate is thought to be directly proportional to the star formation rate, such a measurement would provide a determination of the local star formation history. We investigate the sensitivity of paleo-detectors to both a smooth time evolution and an enhancement of the core collapse supernova rate on relatively short time scales, as would be expected for a starburst period in the local group.

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Prospects of CEvNS Detection with the XENON100 Detector

Author: Kaixuan Ni[1]

[1] *University of California San Diego*

Two-phase xenon detectors are being actively developed over the last decade and made substantial improvement of search sensitivity for WIMP dark matter. These detectors, operated in time projection chamber (TPC) mode, strongly suppress the electronic recoil background, making it possible to detect CEvNS of neutrinos at the Spallation Neutron Source (SNS). In addition, two-phase xenon detectors operated in electron counting (EC) mode are sensitive to single-electron signals, making it possible to detect CEvNS from reactor neutrinos and Solar neutrinos. Drawing experience from the XENON10, XENON100 and recent XENON1T experiments, we will discuss the prospects of detecting coherent scattering of neutrinos from SNS, reactors and the Sun using an improved and movable XENON100 detector.

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Effects of energy accumulation in materials: Self-Organized Criticality dynamics in low energy threshold ionization detectors for coherent neutrino scatter, dark matter searches and in superconducting sensors and qubits.

Authors: Sergey Pereverzev[1]; sergey pereverzev[1]

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Abstract.
In experiments aiming on low-interaction energies—exemplified within the low energy neutrinos coherent scatter and quest for low-mass dark matter particles—researchers must understand the underlying noise mechanisms in their detectors. We observed patterns among low-energy detector backgrounds, which invited questions about condensed matter effects in materials under energy flow. Residual radioactivity and cosmogenic radiation lead to slow energy accumulation in detector materials, so we hypothesize that when the relaxation of this energy occurs in a non-steady manner, the avalanche-like events mimic interactions with particles. Though production mechanisms for excitations, their interactions and destructions processes interplay differently across materials, the properties of this dynamic—called self-organized criticality—appear in sectors ranging from particle physics detectors to quantum sensors and qubits, two of which we discuss here. In some cases, these noise mechanisms may be suppressed and mitigated. In this sense, studying the condensed matter effect in particle detectors can provide useful feedback for designing qubits and quantum sensors, yielding an unexpected crosspollination between quantum information and high energy physics. Side-by side comparison of this on a first glance disparate fields allows to understand common problems and see how these fields are merging in studying space microwave background, serches for axions and coherent scatter of low energy neutrinos with low and ultra-low temperature sensors.
This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344; we acknowledge LDRD grant 17-FS-029. LLNL-ABS-793661-DRAFT.

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Results of a CEvNS Search with the CENNS-10 Liquid Argon Detector

Author: Jacob Zettlemoyer[1]

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The first observation of coherent elastic neutrino-nucleus scattering (CEvNS) was made by the COHERENT collaboration at the Oak Ridge National Laboratory (ORNL) Spallation Neutron Source (SNS) in August 2017 with a 14.6 kg CsI(Na) detector. One of the physics goals of the COHERENT experiment is to test the N^2 dependence of the CEvNS cross section predicted in the Standard Model by observing CEvNS in multiple low-threshold detectors. To that end, the $\sim$24 kg CENNS-10 liquid argon detector was deployed at the low-background Neutrino Alley at the SNS. An observation of CEvNS with CENNS-10 would provide a low N measurement to begin to map out the CEvNS cross section. CENNS-10 was deployed in December 2016 for an initial Engineering Run ending in May 2017 and subsequently upgraded for a Production Run beginning in July 2017. In this talk, I will present the latest results from a CEvNS search with the CENNS-10 liquid argon detector.

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Searching for Dark Matter Signals COHERENT Way

Author: Doojin Kim[1]

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I will discuss the usefulness of timing information in the COHERENT experiment in the search for dark matter signals.

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Last results from the CONNIE collaboration and prospects for next generation of experiments based on Skipper CCD

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Last results from the CONNIE collaboration and prospects for next generation of experiments based on Skipper CCD.

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Welcome

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Nuclear form factors, nuclear structure, and neutron stars

Author: Jorge Piekarewicz[1]

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Neutron stars are cosmic laboratories uniquely poised to answer fundamental questions about the nature of dense neutron-rich matter. However, knowledge of the equation of state of neutron-rich matter is hindered by uncertainties in the neutron distribution of neutron-rich nuclei. Electroweak probes of ground state densities provide a clean and model-independent tool to mitigate these uncertainties. In this presentation I aim to provide compelling connections between nuclear form factors and neutron stars.

Neutrino sources, complementarity, and related physics / **20**

Neutrinos at ORNL

Author: Marcel Demarteau[1]

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Neutrinos at ORNL

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Reactor antineutrino fluxes and CEvNS

Author: Patrick Huber[None]

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Reactor antineutrino fluxes and CEvNS

Neutrino sources, complementarity, and related physics / **22**

Neutrino flux measurement at the SNS with a D2O detector

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Neutrino flux measurement at the SNS with a D2O detector

Neutrino sources, complementarity, and related physics / **23**

Neutrino source simulations for the SNS and STS

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Neutrino source simulations for the SNS and STS

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CsI[Na] effort of the COHERENT collaboration

Author: Alexey Konovalov[None]

CsI[Na] effort of the COHERENT collaboration.

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The COHERENT CEvNS Program

Author: Matthew Green[1]

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COHERENT Experimental Overview

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Searching for Light Dark Matter with Fixed Target Neutrino Experiments

Author: Patrick deNiverville[1]

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We consider a model of light (sub-GeV) dark matter that escapes many of the bounds placed by current dark matter searches. Such low mass dark matter candidates, if produced as a thermal relic in the early universe, must be accompanied by light mediators in order to reproduce the dark matter abundance observed in the present-day universe. These light mediators provide new channels for the production and detection of dark matter at fixed-target neutrino experiments, and proton beam dumps. Detectors sensitive to neutrinos could detect the resulting relativistic dark matter beam through neutral-current-like interactions. Coherent neutrino-nucleus scattering experiments such as COHERENT and Coherent Captain-Mills could produce these dark matter candidates through neutral pion decay at a rate similar to that of neutrinos. Low energy, coherent scattering channels can significantly enhance the expected dark matter signal beyond that expected at higher

energy fixed-target experiments and provide unique sensitivity to light dark matter candidates.

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Inelastic neutrino interactions on nuclei

Author: Suhonen[None]

Inelastic neutrino interactions on nuclei.

Noble-element detectors and dark matter / 32

Future LAr program in COHERENT

Author: Rex Tayloe[1]

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Future LAr program in COHERENT.

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The Snowmass process and the CEvNS community

Authors: Kate Scholberg[1]; Louis Strigari[2]

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Panel discussion of the Snowmass process, its influence on US high-energy physics funding, and the opportunities for the CEνNS community to organize itself and participate effectively.

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Summary of Snowmass discussions and CEvNS-community efforts

Authors: Kate Scholberg[1]; Grayson Rich[2]; phil barbeau[None]; Louis Strigari[3]

[1] *Duke University*

[2] *University of Chicago*

[3] *Texas A&M*

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Summary of the discussions had over the course of the workshop and any plans developed for CEνNS-community efforts to participate in the Snowmass process.

New experiments and technology / 35

MINER

Author: Andrew Michael Kubik[1]

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The MINER collaboration effort to observe CEνNS.

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COHERENT sensitivity to DM

Author: Daniel Pershey[1]

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We will discuss the sensitivity of the COHERENT experiment to test sub-GeV dark matter candidates that may be produced by the SNS and highlight the advantages of using CEvNS detectors for these searches. We also will show strategies within reach of the next generation of detectors that maximize discovery potential for such detectors.

Quenching factors / 37

Measurement of low-energy nuclear recoil quenching factors in liquid xenon

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Measurement of low-energy nuclear recoil quenching factors in liquid xenon.

New detectors and applications / 38

Emerging Technology and Nonproliferation

Author: Ferenc Dalnoki-Veress[1]

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Emerging technology and nonproliferation.

Quenching factors / 39

Quenching Factor Measurements for Germanium Detectors at Triangle Universities Nuclear Laboratory (TUNL)

Author: Long Li[1]

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The Coherent Elastic Neutrino-Nucleus Scattering has been observed by the COHERENT collaboration using a 14.6-kg CsI[Na] scintillator at Oak Ridge National Laboratory. This indicates a new way to build a compact neutrino detector and unlocks new channels to test the Standard Model. One challenge is to understand the neutrino-induced low energy nuclear recoils. It is commonly known that the signals from nuclear recoils can be quenched in many types of detectors, resulting in less light or ionization. This phenomenon is referred to as the "quenching factor". It is defined as the ratio of the signal yield from the nuclear recoils to the signal yield from comparable electron recoils with the same energy. The quenching factor highly depends on the detector materials, so different detectors require their own quenching factor measurements. The next step for the COHERENT experiment is to use different nuclear targets e.g. Ar and Ge. Aside from the COHERENT experiment, many dark matter experiments (CoGeNT, LUX, and etc.) trying to directly detect weakly inter- acting massive particles (WIMPs) also attempt to observe elastic scatterings between WIMPs and nuclei. In this work, we will present the quenching factor measurements for germanium detectors at TUNL in the [0.8,4.9] keVnr range.

Noble-element detectors and dark matter / 40

Status and future plans of SuperCDMS

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Status and future plans of SuperCDMS.

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CEvNS in effective field theory

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CEvNS in effective field theory.

Quenching factors / 42

Low-energy nuclear recoil calibrations for SuperCDMS

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Low-energy nuclear recoil calibrations for SuperCDMS.

Noble-element detectors and dark matter / 44

Progress and plans for DARKSIDE and QF measurements in LAr

Author: Claudio Savarese[None]

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Progress and plans for DARKSIDE and QF measurements in LAr.

New detectors and applications / 45

Plans towards CEvNS observation with LAr detectors at nuclear reactors and possibilities in nuclear safeguards

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Plans towards CEvNS observation with LAr detectors at nuclear reactors and possibilities in nuclear safeguards.

Current reactor experiments and CCDs / 46

Progress and plans for the Ricochet experiment

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Progress and plans for the Ricochet experiment.

New experiments and technology / 47

Exploring coherent neutrino-nucleus scattering with the NUCLEUS experiment

Author: Raimund Strauss[None]

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The detection of coherent-neutrino nucleus scattering (CEvNS) opens a new window to study the fundamental properties of neutrinos and to probe physics beyond the Standard Model of Particle Physics. NUCLEUS is a novel cryogenic neutrino experiment at a nuclear power reactor which allows for precision measurements of CEvNS at unprecedentedly low energies. It is based on recently demonstrated ultra-low threshold cryogenic detectors with nuclear-recoil energy thresholds in the 10eV regime. Accessing these energies enables to fully exploit the strongly enhanced cross section of CEvNS which leads to a miniaturization of neutrino detectors. NUCLEUS is fully funded and will be installed at a new experimental site in between the two 4GW reactor cores of the CHOOZ nuclear power plant in France. In this talk I will present recent results from a prototype detector and discuss the experimental strategy as well as the extensive physics program of NUCLEUS.

New experiments and technology / 48

Potential for CEvNS measurements with cryogenic scintillators

Author: Liu Jing[None]

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Potential for CEvNS measurements with cryogenic scintillators.

New detectors and applications / 50

Topics from Tokyo workshop ”Dark matter searches in the 2020s - At the crossroads of the WIMP”

Author: Kentaro Miuchi[1]

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Topics from Tokyo workshop “Dark matter searches in the 2020s - At the crossroads of the WIMP”.

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Elucidating the electromagnetic properties of neutrinos with CEvNS

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Elucidating the electromagnetic properties of neutrinos with CEvNS.

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Coherent elastic neutrino-atom scattering

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Coherent elastic neutrino-atom scattering.

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Measurement of the weak-mixing angle with CEvNS

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Measurement of the weak-mixing angle with CEvNS.

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Testing Neutrinophilic Dark Matter at Direct Detection and Neutrino Experiments

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Testing Neutrinophilic Dark Matter at Direct Detection and Neutrino Experiments.

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Neutrino non-standard interactions and signatures in CEvNS experiments

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Neutrino non-standard interactions and signatures in CEvNS experiments.

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Searching for Sterile Neutrinos with Coherent Captain Mills

Author: Edward Dunton[1]

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Despite evidence from LSND and MiniBooNE for sterile neutrinos at m^2 = 1 eV^2 in electron neutrino appearance experiments, corresponding muon-neutrino disappearance experiments have shown no anomalies. However, these experiments have been performed at a different energy scale compared to LSND and MiniBooNE. Coherent CAPTAIN Mills (CCM) is an experiment at the Lujan Center at LANSCE that uses a 10-ton liquid argon scintillation detector and the coherent elastic neutrino-nucleus scattering (CEvNS) process to measure muon neutrino disappearance at the LSND energy scale. The Lujan Center delivers a 100-kW, 800 MeV, 290 ns wide proton pulse onto a tungsten target at 20 Hz to generate a stopped pion source. The fast pulse is crucial for isolating the 30 MeV monoenergetic muon neutrinos in time and reducing neuron background. In this talk I will describe the CCM detector and show results from our Fall 2018 commissioning run and preliminary results from our Fall 2019 operating run.

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Axion-like particle at CEvNS experiments

Authors: Shu Liao[1]; Bhaskar Dutta[1]; Doojin Kim[2]

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In this talk, I will show the discovery prospects of Axion-like particle (ALP) at CEνNS experiments. We consider the ALPs that couples to the standard model through the $a\gamma\gamma$ interaction. The CEνNS experiments, utilizing reactors and high-intensity proton beam at stopped pion experiments, produce a large number of photons that will be converted to ALPs via the Primakoff process in the target/core. We find that the current facilities at CEνNS experiments can provide constraints on the unexplored parameter space compared to existing/future ALP experiments.

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Measuring the coherent elastic neutrino-nucleus scattering with an high intensity 51Cr radioactive source

Author: Lea Di Noto[1]

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The idea of measuring the coherent elastic nuclear scattering of neutrinos emitted by a high intensity ^{51}Cr radioactive source is investigated.
To produce a high-intensity source, the radioactive material used in the GALLEX experiment (36 kg of Chromium 38.6 % enriched in ^{50}Cr) could be reactivated to the intensity of a few MCi.
The advantages of this source are that the activity can be measured at a few per mill level and that the neutrino spectrum is well known. With a target volume of 2 dm^3 of low-threshold detectors, if the background is limited, the cross-section might be measured with few percent precision.
In this talk, the requirements for the experiment will be shown and the envisioned experimental challenges will also be discussed.
The work is based on arXiv:1905.10611.

Quenching factors / 60

NEWS-G: status and quenching factor measurements.

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NEWS-G (New Experiments With Spheres-Gas) is a rare event search experiment using Spherical Proportional Counters (SPCs) that aims to extend the sensitivity of direct dark matter searches from 0.1 to few GeV mass range. The talk will cover the current status of the experiment and the recent commissioning at LSM.
Primarily designed for the direct detection of dark matter, this technology also has appealing features for Coherent Neutrino-Nucleus Scattering (CEνNS) studies using nuclear power plants as a neutrino source. For both applications, an important property of the gas to characterize is the ionization yield, or quenching factor, defined as the ratio of the measured energy induced by a nuclear recoil and an electronic recoil of the same energy. Quenching factor measurements in Neon based gas mixtures are being performed at TUNL (Triangle Universities Nuclear Laboratory) using a neutron beam and an array of backing detectors. We will present the set-up and techniques for quenching factor measurements and the last results obtained from measurement campaigns.

Neutrino sources, complementarity, and related physics / 61

Complementarity of Short-Baseline Neutrino Oscillation Searches with CEvNS

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Various anomalies exist in reactor and accelerator based neutrino experiments. CEvNS experiments are well-positioned to probe possible connections of a short-baseline neutrino oscillation effect to

existing anomalies. Considerable complementarity in the flavor and mass space is possible by a combination of experimental efforts.

COHERENT / 62

Status of the COHERENT NaI[Tl] Detector

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One of the signatures of coherent elastic neutrino-nucleus scattering (CEvNS) is the predicted scaling of the cross section with number of neutrons in the recoiling nucleus squared (N^2). The COHERENT collaboration was formed to study CEvNS with a variety of targets to test the physics of CEvNS, including the N^2 cross section scaling. As part of COHERENT, a segmented ton-scale NaI[Tl] experiment is being prepared for deployment to the Spallation Neutron Source (SNS) to detect CEvNS-induced nuclear recoils. A dual-gain base has been developed to potentially allow a simultaneous measurement of CEvNS on sodium and iodine nuclei as well as charged-current electron neutrino interactions on iodine within the same detector. An overview of the detector will be presented, along with current status and future plans.

Noble-element detectors and dark matter / 63

Dark matter and neutrino search with the LZ experiment

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The LZ dark matter detector is currently under construction at the 4850 level of the Sanford Underground Research Facility (SURF) in Lead, SD. The experiment will contain 7 tonnes of pure xenon in a dual-phase Time Project Chamber (TPC) –a technology that has demonstrated very high sensitivities to hypothetical dark matter interactions. LZ is projected to reach unprecedented sensitivities for WIMP dark matter masses of GeV/c2 to TeV/c2 range. In addition, LZ will also be sensitive to Coherent Elastic Neutrino Nucleus Scattering (CEvNS) from solar neutrinos and supernovae neutrinos as the interactions produce similar nuclear recoil signatures to that of WIMPs. The presence of CEvNS signals in the experiment both provides a direct proof of the detector's sensitivity and poses an irreducible background in WIMP dark matter searches. I will present an overview of the LZ experiment and its potential in observing CEvNS from high energy neutrino sources.

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Differential measurement of coherent-elastic neutrino-nucleus scattering using isotopically enriched Ge detectors

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The Spallation Neutron Source (SNS) and the High Flux Isotope Reactor (HFIR) of ORNL are two very powerful neutrino sources. Coherent elastic neutrino-nucleus scattering (CEνNS) was first predicted in 1974 and recently observed by the COHERENT collaboration taking advantage of the extremely high-quality stopped-pion neutrino source available at the SNS. CEνNS is a process in which a neutrino scatters off an entire nucleus. The precise measurement of CEνNS has the potential to probe physics beyond the Standard Model and can also provide information about the nuclear form factors. We present a novel neutrino experiment that allows for precision measurements with a miniaturized detector size. It will demonstrate the N^2 dependence of the cross-section and significantly improve constraints on non-standard interactions of neutrinos with nuclei. The proposed project utilizes highly enriched $^{70-76}$Ge isotopes and has straightforward scalability to a large-scale experiment. The process of isotopically enriching germanium is a well-known technology used to fabricate ^{76}Ge search for neutrinoless double-beta decay. By making a simultaneous differential CEνNS measurement with Ge detectors of different Ge composition many systematic errors would cancel. We will present the experimental strategy for this proposal and an estimate of the sensitivity of the detection system to changes in the form factor.

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Characterization of Na[TI] Crystals for Ton-scale Detector Array

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The suite of detector targets as part of the COHERENT experimental program includes a ton-scale array of NaI[Tl] crystals designed to measure CEvNS interactions on sodium and iodine, and to study charged-current neutrino interactions on iodine. The 7.7 kg NaI[TI] crystals being used are repurposed detector modules and must be characterized for quality and suitability for this detector. One set of detectors is being characterized at the University of Washington. The second set of modules is being characterized at the Triangle Universities Nuclear Laboratory (TUNL) on Duke campus. The characterization procedure uses known gamma-ray sources and background lines for testing the crystal quality, analyzing gain response, determining energy resolution, and comparing the crystal response in different regions along its length. Qualifying crystals will be deployed to "Neutrino Alley"located at the Oak Ridge National Laboratory Spallation Neutron Source experimental site.

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Precision neutrino spectrum measurement and search for sterile neutrino with on-surface experiment PROSPECT

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Deployed at the High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory (ORNL), PROSPECT is a reactor-based short-baseline experiment designed to make high-precision anti-neutrino spectrum measurements from highly enriched U235 reactor and search for possible sterile neutrino oscil-

lation. The on-surface anti-neutrino detector consists of 4-ton 6Li loaded liquid scintillator optically separated into 14 by 11 segments enabling model-independent search for eV2-scale sterile neutrino oscillations. With minimal overburden, reactor anti-neutrinos are detected at 5 σ within 2 hours of operation. The detector has been taking data for almost a full year since March 2018 and upgrade plans are underway for better statistics for spectrum and oscillation analysis.

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Quantifying Liquid Argon Neutrino Detector Sensitivity to Supernova Burst Neutrinos

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We produced figures of merit that show how many neutrinos can be detected for supernovae as a function of distance and compactness. Compactness is the ratio of the mass contained within the radius of the progenitor at the time of core bounce as defined by O'Connor and Ott (2011). This was used to quantify the sensitivity of a 40-kiloton liquid argon detector to core-collapse supernovae. We calculated neutrino event rates for a range of compactnesses. Compiling the results of the neutrino fluxes with a probability distribution of supernovae with respect to compactness and a probability distribution of supernovae with respect to distance allows the generation of useful data visualizations. Specifically, it produces a histogram that shows the number of neutrinos likely to be detected as well as the probability of seeing core-collapse supernovae as a function of both compactness and distance. With these histograms, we are able to determine how many models can be observed given a neutrino event threshold for this type of detector. These methods can be repeated for other types of detectors in the future.

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Measuring Quenching Factors in Liquid Scintillator at keV Energies

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Quantifying the light response of detector materials to nuclear recoils is important for almost all dark matter and neutrino experiments. While theoretical models exist, they offer differing features at the energy region of interest to CEvNS and dark matter searches. I describe our measurement campaign to characterize the common liquid scintillator EJ-301 at the Triangle Universities Nuclear Laboratory's Tandem Van de Graff accelerator and its support for the modified Birks' model.

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Organization and future of M7s

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A D_2O detector for COHERENT

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The COHERENT collaboration recently made the first measurement of the Coherent Elastic Neutrino-Nucleus Scattering (CEvNS) process, more than 40 years after its theoretical prediction, by using neutrinos produced in the Spallation Neutron Source (SNS) at the Oak Ridge National Laboratory. This measurement opened up a window to further studies of interest to a diverse community of physicists. The 10% uncertainty on the SNS neutrino flux will soon be the dominant systematic for precision studies of CEvNS. We plan to address this issue by taking advantage of the well-understood charged current interaction of electron neutrinos on deuterium, using a heavy-water detector to measure the flux normalization. This poster will present an overview of the plans to deploy such detector in the near future.

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Light yield of an undoped CsI crystal at 77 K

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The NaI/CsI(Tl) crystals are widely used in experiments to search for dark matter and coherent elastic neutrino-nucleus scattering thanks to their high scintillation light yields (˜50 photons/keV) and relatively low costs. An even higher light yield of NaI/CsI crystals will lead to a lower energy threshold and better energy resolution. It was observed that the light yields of undoped NaI/CsI crystals increase rapidly when temperature goes down and reach the highest point around liquid nitrogen temperature. The light yield of an undoped ˜1 kg CsI crystal was studied at 77 K.

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NEXUS: Northwestern Experimental Underground Site

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NEXUS is an underground test facility equipped with dilution fridge and D-D neutron generator inside a cleanroom. Located 106 m underground at FermiLab, it provides 300 meter-water-equivalent overburden and 100 event/kg/day background level. The fridge is reconfigurable for different types of payloads. This facility opens the possibility of coherent neutrino scattering experiments with low temperature bolometers.

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Applying Feldman-Cousins Method to NSI in COHERENT

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The first measurement of coherent elastic neutrino-nucleus scattering performed by the COHERENT collaboration in 2017 using a CsI detector has been used to significantly reduce the space of allowed non-standard-neutrino-interaction couplings. In this work, we apply the Feldman-Cousins method to the COHERENT data to improve the obtained limit and discuss how the results can be refined further.