T 74: Neutrino Physics without Accelerators 5

Time: Wednesday 16:15–18:20 Location: T-H33

Group Report T 74.1 Wed 16:15 T-H33

CEνNS and new neutrino physics searches with the CONUS experiment — •Edgar Sanchez Garcia for the CONUS-Collaboration — Max-Planck-Institut für Kernphysik (MPIK), Heidelberg

The CONUS experiment (COherent elastic NeUtrino nucleus Scattering) aims to detect coherent elastic neutrino-nucleus scattering (CEνNS) of reactor antineutrinos on germanium nuclei in the fully coherent regime. The CONUS experiment - operational since April 2018 - is located at a distance of 17m from the 3.9 GWth core of the Brokdorf nuclear power plant (Germany). The possible CEvNS signature is measured by four 1 kg point-contact high-purity germanium (HPGe) detectors, which provide a sub keV energy threshold with background rates in the order of 10 events per kg, day and keV. The analysis of the first CONUS data set allows to establish the current best limit on CEνNS from a nuclear reactor with a germanium target. Moreover, competitive limits on neutrino physics beyond the standard model can be set such as on non-standard neutrino interactions or on the neutrino electromagnetic properties. These results will be presented in this talk together with the CONUS long-term operation.

T 74.2 Wed 16:35 T-H33

Novel constraints on neutrino physics beyond the standard model from the Conus experiment — •Thomas Rink for the CONUS-Collaboration — Max-Planck-Institut für Kernphysik (MPIK)

The detection of coherent elastic neutrino-nucleus scattering (CEνNS) opens up new opportunities for neutrino physics within and beyond the standard model. As a leading reactor experiment, Conus aims for an observation in the fully coherent regime with antineutrinos emitted from the powerful 3.9 GW_{th} reactor of the nuclear power plant in Brokdorf (Germany). In particular, the application of ultra-low threshold, high-purity germanium detectors within a compact shield design in close vicinity to a nuclear reactor core describes the next milestone towards high-statistics neutrino physics. The acquired and future Conus data sets allow investigations of yet undetected neutrino channels and electromagnetic properties. Moreover, measurements of the Weinberg angle with neutrinos at the MeV-scale and analyses of the high energy part of a reactor's antineutrino emission spectrum become possible with CEνNS. This talk deals with constraints on beyond the standard model neutrino phenomenology that are obtained from data collected between April 2018 and June 2019. Bounds on non-standard neutrino-quark interactions of vector and tensor type from CEνNS are presented. Further, the parameter space of simplified scalar and vector mediators that is probed by CEνNS and elastic neutrino-electron scattering is discussed. Finally, limits on an effective neutrino magnetic moments and an effective neutrino millicharge are given.

T 74.3 Wed 16:50 T-H33

Pulse Shape Discrimination for the CONUS experiment — •Josef Stauber for the CONUS-Collaboration — Max-Planck-Institut für Kernphysik (MPIK), Heidelberg, Germany

The CONUS experiment, located at the nuclear power plant in Brokdorf, Germany, aims at the detection of coherent elastic neutrino nucleus scattering (CEνNS) in the fully coherent regime. Four 1kg-sized point-contact germanium detectors are used for this purpose. The suppression of the background and a very low energy threshold are crucial for the successful detection of CEνNS. The pulse shape discrimination PSD offers a tool to reduce the background by analysing the shapes of the individual events. The data acquisition module (DAQ) can alter the pulse shape (electric feedback) and add electrical noise to the signal. In this talk the concept of the PSD will be presented with special focus on the DAQ feedback and the impact of electrical noise in the low energy regime.

T 74.4 Wed 17:05 T-H33

Shield and detector optimization for the CONUS experiment — •Janina Hakenmüller for the CONUS-Collaboration — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69115 Heidelberg, Germany

The CONUS experiment is looking for coherent elastic neutrino nucleus scattering (CEνNS) with four low energy threshold point contact high-purity Ge spectrometers. The CONUS Collaboration is exploring options for a new reactor site outside Germany to continue and extend its scientific program. In the talk, the possibilities of improvement regarding the shield and detector design will be explored. The strong neutrino flux required for a detection is provided by a nuclear power plant, where only a small overburden to shield against cosmic rays is available. The current CONUS shield employs 25 cm of lead to shield against environmental gamma rays. Cosmic ray muons create secondaries inside the lead especially neutrons, that can induce CEνNS like recoils in the detector. Even though the background is suppressed by an active muon veto, it still contributes significantly to the measured background. With the help of MC simulations improvements and alternatives of the shield design are examined. Additionally, also the impact of a larger crystal size on the background as well as potentially enhancements of detector-specific background will be discussed.

T 74.5 Wed 17:20 T-H33

Simulation of Pulse Shapes for Low Background Germanium Spectrometers in CONUS — •Janine Hempfling for the CONUS-Collaboration — Max-Planck Institut für Kernphysik (MPIK), Heidelberg

The CONUS experiment aims to detect coherent elastic neutrino nucleus scattering (CEνNS). For this goal four 1 kg point-contact high-purity germanium detectors are operated near the 3.9 GW_{th} core of the Brokdorf nuclear power plant. A very good background suppression is crucial for the success of the experiment, achieved by an elaborate shield. A new opportunity for additional background reduction is offered by pulse shape analysis of the detector signals. To verify this analysis a pulse shape simulation (PSS) for the CONUS experiment is developed based on the software package SigGen. Additionally, investigations of the correlation between the signal shape and the interaction position as well as the fraction of single-site events and multi-site events are possible with the PSS. This talk presents the requirements needed to set up a PSS, starting from the input signal generation with the GEANT4 framework MaGe to the modeling of the response of the electronics up to the final output pulses. Furthermore, a comparison between the obtained simulation results and the measured signals will be discussed.

T 74.6 Wed 17:35 T-H33

The CRAB Experiment: a New Calibration Technique for CEvNS Detectors in the 100 eV Regime — •Victoria Wagner for the CRAB-Collaboration — Physik-Department, Technische Universität München, D-85748 Garching, Deutschland

Searches for light dark matter (DM) and studies of coherent elastic neutrino-nucleus scattering (CEvNS) imply the detection of nuclear recoils in the 100 eV range. However, an absolute energy calibration in this regime is yet missing. The CRAB project proposes a method based on nuclear recoils induced by the emission of an MeV-gamma following thermal neutron capture. Detailed feasibility studies show that this method yields distinct nuclear recoil calibration peaks at 112 eV and 160 eV for tungsten. In the first phase, the CRAB project foresees to perform a nuclear recoil calibration of cryogenic $CaWO_4$ detectors read-out by TES. The low power TRIGA reactor in Vienna provides a clean beam of thermal neutrons well suited for such a measurement. In the second phase, additional tagging of the photons produced in the de-excitation process will allow to extend the calibration method to even lower energies and to a wider range of detector materials, such as Ge. Combined with an electron recoil calibration, CRAB will allow to measure energy quenching in the sub-keV regime. With its novel idea, CRAB provides a direct and accurate calibration of nuclear recoils in the ROI of light DM and future CEvNS experiments, which is essential for studying new physics.

This work is supported by the DFG through the Excellence Cluster ORIGINS and the SFB1258.

T 74.7 Wed 17:50 T-H33

Development oft the cryogenic detector for observing coherent elastic neutrino nucleus scattering with NUCLEUS 10g — •Nicole Schermer[1], Andreas Erhart[1], Dieter Hauff[1,2,3], Margarita Kaznacheeva[1], Tobias Ortmann[1], Luca Pattavina[1], Johannes Rothe[1], Raimund Strauss[1], Victoria Wagner[1], and

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The study of coherent elastic neutrino nucleus scattering (CEνNS) offers the opportunity to explore fundamental neutrino properties and to search for physics beyond the Standard Model. The NUCLEUS experiment aims to precisely measure the CEνNS cross-section of reactor-antineutrinos produced by the Chooz nuclear power plant in France at low energies with gram-scale cryogenic detectors with ultra-low energy thresholds of O(10eV). The first science phase, NUCLEUS 10g, will deploy two detector modules, each containing nine cryogenic target detectors embedded in an inner veto. I will present the development of the first versions of the NUCLEUS 10g detector components as well as further strategies towards the full cryogenic detector, which will consist of the two detector modules, a LED calibration system and a cryogenic outer veto. The research was supported by the DFG through the Excellence Cluster ORIGINS and the SFB1258, and the ERC Starting Grant 2018 ”NU-CLEUS”.

T 74.8 Wed 18:05 T-H33

Exploring Coherent Elastic Neutrino-Nucleus Scattering at a nuclear reactor with the NUCLEUS experiment — •Johannes Rothe for the NUCLEUS-Collaboration — Physik-Department, Technische Universität München, D-85748 Garching, Germany

The NUCLEUS collaboration is working towards the first detection of reactor antineutrinos via Coherent Elastic Neutrino-Nucleus Scattering (CEvNS) using cryogenic detectors operating at 15mK temperature. This observation will open a new window to study fundamental neutrino properties at low energy with a high-flux source.

The first physics phase will employ a 10g target made of Al_2O_3 and $CaWO_4$ crystals read out with superconducting transition edge sensors, surrounded by cryogenic infrastructure, passive shielding and active anti-coincidence veto systems. Assembly and commissioning of all components of the experimental setup is planned at TUM in 2022. Afterwards, the experiment will be moved to the Chooz Nuclear Power Plant in France. I will present updates on the design and simulation of the setup, experimental work towards the 10g target detector and the physics goals of NUCLEUS-10g. This research was supported by the DFG through the Excellence Cluster ORIGINS and the SFB1258, and the ERC Starting Grant 2018 "NU-CLEUS".