HK 25: Astroparticle Physics

Time: Thursday 16:30–18:45 Location: H4

Group Report HK 25.1 Thu 16:30 H4

Detecting CEvNS and searching for new physics with the CONUS experiment — •Janine Hempfling for the CONUS-Collaboration — Max-Planck-Institut für Kernphysik (MPIK), Heidelberg

The CONUS experiment aims to detect coherent elastic neutrino nucleus scattering (CEvNS) in the fully coherent regime at the nuclear power plant of Brokdorf, Germany. This talk will present the experimental setup of the CONUS experiment with its four very low energy threshold germanium detectors within an elaborate shield at 17 m distance from the 3.9 GW thermal power reactor core. A full spectral analysis of Run-1 and Run-2 data of the running experiment yields the current best limit on CEvNS with reactor antineutrinos. Additionally latest results for analyses of physics beyond the standard model will be discussed, including bounds on non-standard neutrino interactions (NSIs) and light scalar and vector mediators.

HK 25.2 Thu 17:00 H4

Pulse shape discrimination for the CONUS experiment — •Jakob Henrichs for the CONUS-Collaboration — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

The CONUS experiment, using four 1 kg-sized point-contact high-purity germanium detectors (HPGe) aims at the detection of coherent elastic neutrino nucleus scattering (CEνNS) in the fully coherent regime. It is located close to the reactor core of the nuclear power plant in Brokdorf, Germany. For the success of the experiment a very good background suppression is crucial. Therefore, a sophisticated shield as well as a muon anticoincidence veto system were installed, to reduce efficiently the overall background.

Further, the analysis of the pulse shape of each event offers a new opportunity for an additional background reduction. Depending on whether the incoming particle interacts in the fully depleted bulk region or in the transition layer of the detector, the resulting pulse shapes are different. The transition layer is an outer layer of the Ge diode, where the charge collection efficiency is below 100%. In this talk a technique to discriminate the different low energy interactions based on a rise time fit of their pulses will be presented. In addition, it will be demonstrated how this technique can also be applied to distinguish between multi-site and single-site events at higher energies.

Group Report HK 25.3 Thu 17:15 H4

Status and Prospects of the XENON Dark Matter Search Experiment — •Sebastian Lindemann — Physikalisches Institut, University of Freiburg, Germany

XENON1T was a dual-phase liquid xenon time projection chamber that operated deep underground at Italy's Gran Sasso National Laboratory from 2016 to 2018. Primarily designed to search for WIMP dark matter, XENON1T featured a ton-scale target mass, keV-scale energy threshold, and ultra low background rate that together led to several world-leading results on a variety of rare-event processes. XENON1T's successor, XENONnT, features a larger target mass and a further reduced background level. It is currently being commissioned and will be able to probe the parameter space of interest with improved sensitivity. This talk will summarize recent XENON1T results and detail the power of its successor XENONnT.

HK 25.4 Thu 17:45 H4

Measurement of the antinuclei nuclear inelastic cross sections with ALICE and implications for indirect Dark Matter searches — •Stephan Königstorfer for the ALICE-Collaboration — Technische Universität München

Light antinuclei in cosmic rays such as antideuteron or antihelium-3 are considered a unique probe for signals from exotic physics like WIMP Dark Matter annihilations. Indeed, these channels are characterised by a very low astrophysical background, which comes from antinuclei produced by high-energy cosmic ray interactions with ordinary matter.

In order to make quantitative predictions for antinuclei fluxes near earth, both the production and annihilation cross sections of antinuclei need to be accurately known down to low energies. In ultra relativistic pp, p-Pb and Pb-Pb collisions at the CERN LHC, matter and antimatter are abundantly produced in almost equal amounts, allowing us to study the production of antinuclei and measure their absorption in the detector material. The antinuclei absorption cross section is evaluated on the average ALICE material. Using this result, we can predict the transparency of our galaxy to antihelium-3 nuclei from both dark matter annihilations and high-energy cosmic ray collisions.

In this talk we present the first measurements of the antideuteron and anti-3He absorption cross section with ALICE and we discuss the implications of these results for indirect Dark Matter searches using cosmic antinuclei.

HK 25.5 Thu 18:00 H4

Neutrinoless double beta decay with XENON1T and XENONnT — •Tim Michael Heinz Wolf — Max Planck Institut für Kernphysik, Heidelberg

Liquid xenon (LXe) time-projection-chambers (TPCs), such as XENON1T or its successor XENONnT, are primarily used for low energy Dark Matter (DM) searches but also for other rare decay searches such as neutrinoless double beta (0vbb) decay. The large active mass of LXe (several tonnes) and its low background rate are beneficial for the sensitivity to detect Weakly Interacting Massive Particles (WIMPs) or rare decays such as 0vbb. The isotope Xe136 with a natural abundance of 8.9% is a known emitter of two-neutrino double beta decay and it is a potential emitter of the hypothetical process of 0vbb decay with a Q-value of 2457.8keV. The discovery of the 0vbb process would imply lepton number violation and would confirm the Majorana nature of neutrinos, a property that has never been seen before in nature for fundamental particles. I will review the ongoing efforts in XENON1T and XENONnT in this context.

HK 25.6 Thu 18:15 H4

Monte Carlo simulation of background components in low level Germanium spectrometry — •Nicola Ackermann[1], Hannes Bonet[1], Christian Buck[1], Janina Hakenmüller[1], Gerd Heusser[1], Matthias Laubenstein[2], Manfred Lindner[1], Werner Maneschg[1], Jochen Schreiner[1], and Herbert Strecker[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]Laboratori Nazionali del Gran Sasso, Via G. Acitelli 22, 67100 Assergi L'Aquila, Italy

This talk presents Monte Carlo simulations of the background spectra of the four gamma-ray Ge-spectrometers GeMPI 1 - 4 at the Gran Sasso Underground Laboratory (LNGS) using the Geant4 based framework MaGe. These detectors are very low background Ge-spectrometers located at a depth of 3800 m w.e. and they currently achieve one of the best sensitivities worldwide for primordial U and Th concentrations in materials at a level of μBq/kg. With these detectors material samples are tested to confirm that they meet the stringent requirements of rare event experiments.

The three main background components that are taken into consideration in the simulations are muons, neutrons and intrinsic contaminations in the detector and shielding materials. A detailed understanding of the composition of the background spectra allows for improvements in the sensitivity of next generation screening detectors.

HK 25.7 Thu 18:30 H4

Suppressing radon emanation by coating techniques — •Hardy Simgen, Florian Jörg, and Mona Piotter — Max-Planck-Institut für Kernphysik / Heidelberg

Radon-induced signals are a challenging source of background in most low-background experiments searching for rare events. The dominant radon source is emanation from detector materials, which contain traces of primordial uranium and thorium. While the problem is usually addressed by dedicated material screening and selection programs, novel radon mitigation techniques are required to fulfill the demanding needs of next-generation experiments.

In this talk we present our work on coating techniques to reduce radon emanation from metallic surfaces. A stable, tight and clean coating should reduce the radon emanation rate of materials significantly. Electro-deposition of copper turned out to be the most promising approach. We will discuss systematic studies of the parameters of our coating process and present achieved reduction factors for the emanation rate of the short-lived ^{220}Rn. Practically more relevant is the emanation of ^{222}Rn due to its much longer half-life. However, appropriate samples are hard to obtain. We present first results on the coating of a ^{222}Rn-emanating stainless steel sample which was custom-produced at the ISOLDE facility at CERN.