T 79: Suche nach Dunkler Materie 3 (Direkter Nachweis)

Zeit: Mittwoch 16:45–19:10 Raum: VSH 19

Gruppenbericht T 79.1 Mi 16:45 VSH 19

Searching for low-mass Dark Matter with EDELWEISS — •Valentin Kozlov — Karlsruher Institut für Technologie, Institut für Experimentelle Kernphysik, Gaedestr. 1, 76128 Karlsruhe

The EDELWEISS experiment uses Germanium low-temperature detectors with heat and ionization readout for direct dark matter search. These advanced high-purity detectors are operated at 18 mK in a low-radioactivity environment of the Modane underground laboratory (LSM, France). Eight detectors with best energy resolutions were selected for low-mass WIMP analysis from a total set of 20 detectors operated in a long-term campaign. Boosted Decision Tree and likelihood approaches were used to analyze acquired data and show up to two orders of magnitude improvement with respect to the previous EDELWEISS-II low-mass WIMP search for 7 GeV/c^2 WIMPs. The current R&D program concentrates on further improvements of ionization and heat baseline resolutions, and use of voltage-assisted heat amplification technique (so-called Neganov-Luke mode). Significant improvement in sensitivity can be realized with a moderate exposure of 350 kg.d at actual background conditions within the next 1-2 years. Beyond 2018 the already existing cooperation with SuperCDMS should lead to a common experimental infrastructure in SNOLAB. Recent results, current R&D activities, sensitivity projections and the project towards the SNOLAB cryogenic facility will be discussed.

Gruppenbericht T 79.2 Mi 17:05 VSH 19

Direct Dark Matter Search with CRESST III – Status & Perspectives — •Michael Willers for the CRESST-Collaboration — Physik-Department, Technische Universität München, D-85748 Garching, Germany

The CRESST experiment, located in the Gran Sasso underground laboratory (LNGS), Italy aims at the direct detection of dark matter (DM) particles. Scintillating $CaWO_4$ crystals operated as cryogenic detectors are used as target material for DM-nucleus scattering. The simultaneous measurement of the heat signal from the $CaWO_4$ crystal and the emitted scintillation light is used for particle identification. Due to it's low nuclear recoil energy threshold the experiment is probing the low-mass region of the parameter space for spin-independent DM-nucleus scattering below $\sim 5\,\mathrm{GeV/c^2}$ with high sensitivity. Recent results obtained using a 300 g detector with a nuclear recoil energy threshold of 307 eV provide the world best limit for DM particle masses below 1.7 GeV/c^2.

The goal of the CRESST III experiment is to significantly improve the sensitivity for low-mass DM particles by using optimised cryogenic detector modules, each consisting of a 24 g $CaWO_4$ target crystal and 20x20 mm^2 Silicon-on-Sapphire light detector. Phase 1 of the experiment operates 10 detector modules with a total target mass of 240 g and started taking data in August 2016. In this talk I will present the current status and future perspectives of the CRESST III experiment.

T 79.3 Mi 17:25 VSH 19

Production of high-purity $CaWO_4$ crystals for direct dark matter search with CRESST — •Andrea Münster for the CRESST-Collaboration — Physik-Department and Excellence Cluster Universe, Technische Universität München, D-85748 Garching

The direct dark matter search experiment CRESST (Cryogenic Rare Event Search with Superconducting Thermometers) uses scintillating $CaWO_4$ single crystals as targets to search for possible recoils of dark matter particles. Since several years these $CaWO_4$ crystals have been produced directly at the Technische Universität München (TUM) including the $CaWO_4$ powder production from the raw materials $CaCO_3$ and WO_3, the $CaWO_4$ crystal growth via the Czochralski method as well as the after-growth treatment of the crystals. In CRESST-II Phase 2 (2013-2015), 4 TUM-grown crystals were operated in the experiment for the first time, showing the best radiopurities of all crystals installed. Therefore, in CRESST-III Phase 1 (started in summer 2016) mainly TUM-grown crystals have been included. The goal for the upcoming CRESST-III Phase 2 is a further improvement of the radiopurity. A method to chemically purify the raw materials was developed at TUM and will be presented together with first promising results. This research was supported by the DFG cluster of excellence "Origin and Structure of the Universe", by the Helmholtz Alliance for Astroparticle Physics, by the Maier-Leibnitz-Laboratorium (Garching) and by the BMBF.

T 79.4 Mi 17:40 VSH 19

Characterization of the non-linearity of the light-yield at low energy deposition in $CaWO_4$ crystals — •Erik Lindner, Xavier Defay, Jean-Côme Lanfranchi, Alexander Langenkämper, Elizabeth Mondragón, Andrea Münster, Corbinian Oppenheimer, Tobias Ortmann, Walter Potzel, Stefan Schönert, Hong Hanh Trinh Thi, Andreas Ulrich, Stephan Wawoczny, Michael Willers, and Andreas Zöller — Technische Universität München, Physik Department Lehrstuhl E15 und Excellence Cluster Universe, James-Franck-Straße 1, D-85748 Garching

The CRESST experiment uses scintillating $CaWO_4$ single crystals as target material for direct dark matter seach. A particle interaction in the crystal simultaneously produces heat and light. The light-yield, defined as the ratio of energy in the light channel compared to the phonon channel, can be used as discrimination parameter for different event classes. The light-yield shows a crystal dependent non-linear behaviour at low energy depositions in the crystal. The $CaWO_4$ crystals of the current phase CRESST-III are mainly produced at the TUM. To investigate the energy dependence of the growth parameters, a coincident Compton scattering experiment is conducted. The experimental setup, the latest results, and future plans for the experiment will be presented. This research was supported by the DFG cluster of excellence "Origin and Structure of the Universe" and the Maier-Leibnitz-Laboratorium (Garching).

T 79.5 Mi 17:55 VSH 19

Quenching Factor Measurements using the CRESST/ EURECA Neutron-Scattering-Facility — •S. Wawoczny[1], X. Defay[1], J.-C. Lanfrachi[1], A. Langenkämper[1], E. Lindner[1], A. Münster[1], E. Mondragon[1], L. Oberauer[1], C. Oppenheimer[1], W. Potzel[1], S. Schönert[1], T. Ortmann[1], R. Strauss[2], M. Willers[1], and A. Zöller[1] — [1]Physik Department E15 and Excellence Cluster Universe, Technische Universität München, 85748 Garching — [2]Max-Planck-Institut für Physik, Föhringer Ring 6, 80805 München

The direct Dark Matter search experiment CRESST and the planned EURECA experiment use scintillating $CaWO_4$ crystals as target for Dark Matter interactions. The scitillation light is measured in a separate cryogenic detector and enables the identification of nuclear recoils based on their distinct light yield. Especially in the search for low mass Dark Matter it is therefore necessary to precisely know the Quenching Factors (QF), describing the reduction of the light yield of nuclear recoils relative to electron recoils, and their energy dependencies at low recoil energies ($< 100\,\mathrm{keV}$). The QFs of the target nuclei can be measured with high precision insitu at mK-temperatures with the CRESST Neutron-Scattering-Facility at the Maier-Leibnitz-Laboratory (MLL) by irradiating a dedicated cryogenic detector module with neutrons (11 MeV, from MLL accelerator). We present a new technique employed at the Neutron-Scattering-Facility as well as first promissing results. This work was supported by the DFG cluster of excellence "Origin and Structure of the Universe" and the MLL (Garching).

T 79.6 Mi 18:10 VSH 19

Purity control of the XENON1T gas inventory — Constanze Hasterok, Sebastian Lindemann, •Veronica Pizzella, and Hardy Simgen for the XENON-Collaboration — Max-Planck-Institut für Kernphysik (MPIK), Saupfercheckweg 1, 69117, Heidelberg, Germany

The XENON1T experiment uses xenon nuclei as scattering target for dark matter particles. It employs a total of 3.5 tonnes of liquid xenon, from which 2 tonnes are in a Time Projection Chamber (TPC). For the success of the experiment, it is necessary to use xenon with low concentration impurities. The dangerous ones are: radioactive impurities such as Kr-85 and Rn-222, since they increase the background; electronegative molecules such as oxygen and water, since they lower the electron life-time and disrupt the well functioning of the TPC; helium, since it can harm the photomultipliers (PMTs). In this presentation, the measurements of the xenon inventory prior to filling the XENON1T detector for the first time will be discussed using the technique of gas chromatography. A dedicated measurement of the helium concentration will be introduced, and the results before and after a gas phase distillation of the xenon inventory will be illustrated.

T 79.7 Mi 18:25 VSH 19

Krypton assay in xenon at the ppq level for Xenon1T — •Luisa Hötzsch, Steffen Form, Sebastian Lindemann, and Hardy Simgen for the XENON collaboration — Max-Planck-Institut für Kernphysik (MPIK), Heidelberg, Germany

The Xenon1T experiment aims for the detection of dark matter with a ton scale liquid xenon target for scattering events of Weakly Interacting Massive Particles (WIMPs), which represent one of the main candidates for particle dark matter. Due to the expected very low event rate of this process, ultra-low background conditions are required to reach the sensitivity necessary for WIMP detection. Among the most serious internal background contributions is the radioactive krypton isotope ^{85}Kr, a β-emitter which is intrinsically present in commercially available xenon at the ppm or ppb level. However, krypton traces are successfully reduced from liquid xenon by cryogenic distillation. For the purpose of monitoring krypton concentrations in xenon, the Xenon collaboration uses an off-line gas-chromatographic mass spectrometry setup (RGMS), sensitive to krypton in xenon concentrations at the ppq (parts per quadrillion) level.

In this talk, the RGMS setup and its current status will be presented, as well as krypton in xenon measurement results from recent Xenon1T samples.

T 79.8 Mi 18:40 VSH 19

Monte Carlo simulations of a neutron veto for the XENONnT dark matter experiment — •Diego Ramírez García for the XENON-Collaboration — Institut für Physik, Johannes Gutenberg-Universität Mainz

XENON1T is the first multi-ton dual-phase xenon time projection chamber (TPC) aiming for the direct detection of dark matter in the form of weakly interacting massive particles (WIMPs). With dark matter search already operative at the Laboratori Nazionali del Gran Sasso (LNGS), a spin-independent WIMP-nucleon cross section sensitivity of $1.6 \cdot 10^{-47}$ cm^2 for WIMP masses of 40 GeV will be reached in an exposure of two years. With the goal of improving sensitivity by another order of magnitude, the infrastructure of the experiment has been designed for XENON1T to be rapidly upgraded to XENONnT, a detector already under development with a 35% larger photosensor coverage than its predecessor and containing about twice the mass of xenon.

With an improved self-shielding due to a larger TPC, it will be more effective to define a fiducial volume in which the external backgrounds can be reduced to a negligible level. In order to optimize this volume for the dark matter search, the possibility of developing a liquid scintillator neutron veto is now under study and Monte Carlo-based simulations have been performed to evaluate the potential decrease of nuclear recoil background from the detector materials.

T 79.9 Mi 18:55 VSH 19

Search for Dark Matter at keV energies with the GERDA **experiment** — •Roman Hiller for the GERDA-Collaboration — Universität Zürich

The GERDA experiment consists of an array of enriched ^{76}Ge-detectors, surrounded by a liquid argon cryostat, which also acts as an active shielding. Located in the Laboratori Nazionali del Gran Sasso, an underground laboratory in Italy, it is shielded by 1400m of rock and after the careful selection of low background materials, it is one of the least radioactive places on earth. Its main goal is the detection of neutrinoless double beta decay, which would shed light on the nature and mass scale of the neutrino. However, its low background and high energy resolution make it a perfect environment to search also for other extremely rare processes. This study focuses on the capabilities of GERDA to detect narrow spectral lines at energies below 1 MeV to search for example for bosonic superweakly interacting massive particles, a dark matter candidate with keV scale mass.