T 52: Suche nach dunkler Materie III

Zeit: Mittwoch 16:30–19:05 Raum: Philo-HS5

Gruppenbericht T 52.1 Mi 16:30 Philo-HS5

Searching for low-mass dark matter particles with the SuperCDMS experiment — •Belina von Krosigk — University of British Columbia, Vancouver, Canada

A compelling set of diverse astrophysical observations points to the existence of dark matter. The most popular particle dark matter candidates are Weakly Interacting Massive Particles (WIMPs). SuperCDMS, the advanced successor of the Cryogenic Dark Matter Search, is designed to directly observe galactic WIMPs via keV-scale nuclear recoils in semiconductor detectors operated at temperatures around 50 milliKelvin. The nuclear recoils are detected in the form of lattice vibrations (phonons). Additionally, electron-hole pairs produced in the biased crystals drift to the electrodes, creating further phonons. The CDMS low ionization threshold experiment (CDMSlite) modified the operation of existing SuperCDMS detectors to take advantage of this effect. A bias of 70 V applied across these detectors allows very small ionization signals to appear as larger phonon signals, which significantly reduces the energy threshold of the detectors. The most recent results will be presented, which probe a new parameter space for the spin-independent WIMP-nucleon cross section at WIMP masses as low as 1.6 to 4 GeV/c2.

T 52.2 Mi 16:50 Philo-HS5

DARWIN – The Ultimate WIMP Detector — •Fabian Kuger — Albert-Ludwigs Universität, Freiburg, Germany

The DARWIN (DARk matter WIMP search with liquid xenoN) experiment, a 40 t target mass liquid Xenon time projection chamber, will be the next-to-next generation direct search dark matter detector. It will reach a sensitivity to WIMP nuclear recoil cross-sections at the level of the "ultimate" irreducible coherent scattering background induced by solar and atmospheric neutrinos, probing the entire experimentally accessible parameter space for WIMP masses above a few GeV/c^2. Besides its excellent sensitivity to WIMP dark matter, DARWIN will explore a plethora of science channels in astroparticle and nuclear physics, e.g., the neutrinoless double beta decay of ^{136}Xe.

The DARWIN Collaboration currently performs R & D and design studies to investigate potential improvements to the detector baseline design. This talk will provide an overview on the science program of DARWIN and introduce its baseline design. The technical challenges owed to the detector size and its requirements in terms of detector backgrounds will be addressed. Some of the technological alternatives currently under study are showcased briefly.

T 52.3 Mi 17:05 Philo-HS5

Analysis of the Optical Characteristics of the DARWIN Prototype via Ray Tracing - First Results — •Marius Goetz, Guido Drexlin, Jonas Kellerer, and Daniel Hilk — Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

DARWIN (**DAR**k matter **WI**mp search with liquid xeno**N**) aims to probe spin-independent WIMP-nucleon cross-sections down to $\mathcal{O}(10^{-49}\,\mathrm{cm}^2)$, using a multi-ton dual phase noble gas detector. WIMP interactions produce both an ionization and photon signal in liquid xenon (LXe). The electrons are extracted from the LXe by a drift field to the gaseous xenon, where secondary photons are created. Secondary and primary photons are measured with photosensors.

An optimized photon detection efficiency in LXe is crucial to separate signal from background. To this end, optical properties like reflectivity, absorption, detection efficiency and photomultiplier design of a prototype, to be built at KIT, and the final detector have to be investigated in detail. The impact of novel concepts such as inner electrodes also has to be investigated.

Comprehensive light collection models of the prototype at KIT are developed and implemented both into Geant4 and Comsol Multiphysics to study the implications of different detector designs on the light yield. First results of this analysis are summarized in this talk.

T 52.4 Mi 17:20 Philo-HS5

Electronic recoil background in the XENON1T experiment — •Miguel Angel Vargas — Institut für Kernphysik, WWU Münster, Germany

The XENON1T experiment aims at finding direct evidence for dark matter through the scattering of Weakly Interacting Massive Particles (WIMPs) with target nuclei in an ultra-low background dual-phase xenon Time Projection Chamber (TPC) based detector that employs about 2 tons sensitive volume of liquid xenon.

In order to reach its projected sensitivity a robust estimation of the background rate in the detector is a key ingredient. Therefore, the background sources are divided in two main classes for their analysis: electronic recoils (ER) off the atomic electrons and nuclear recoils (NR) off the Xe nuclei.

This talk focuses on the ER backgrounds sources: from radioactivity in the detector materials, sources intrinsic to the LXe (beta decay of Kr-85, of Rn-222 and its daughters, and Xe-136 double-beta decay) and from solar neutrinos scattering off electrons. Their understanding is used to predict the potential statistical leakage of ER events into the NR region, which could mimic a WIMP signal.

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T 52.5 Mi 17:35 Philo-HS5

The radioactive backgrounds of XENONnT — •Arianna rocchetti — XENON Collaboration

The XENON project aims at the direct detection of WIMP dark matter through the elastic scattering off xenon nuclei. It consists of a time projection chamber (TPC) filled with liquid xenon both as target and detection medium. The next step of the XENON program, the multiton scale XENONnT, is currently being developed by the collaboration. Its target mass of 6.0 t will improved the sensitivity to the WIMP nucleon interaction cross section to 1.6 * 10^48 cm^2 in a 20 t * y exposure. To estimatate the XENONnT sensitivity, the detailed knowledge about all possible background events is crucial. In this talk we present the detailed Monte Carlo simulations addressing the electronic and nuclear recoil backgrounds. Among the background sources are the decays of radioactive isotopes contained in the detector materials, which can lead to electronic and nuclear recoil signals. By means of Monte Carlo simulations we can reconstruct the spatial distribution of the interactions and fiducialize the target volume. We will present the results of these studies.

T 52.6 Mi 17:50 Philo-HS5

The Neutron Veto System for the XENONnT Dark Matter experiment — •Melanie Scheibelhut — Johannes Gutenberg-Universität Mainz, on behalf of the XENON Collaboration

The currently operating XENON1T experiment at the Laboratori Nazionali del Gran Sasso (LNGS) is the first ton-scale dual-phase xenon time projection chamber (TPC) aiming for the direct detection of dark matter in the form of Weakly Interacting Massive Particles (WIMPs). It has achieved world-leading sensitivity with its first science exposure of 34.2 live days, and has meanwhile taken a full year of dark matter search and calibration data. While XENON1T is exploring the WIMP spin-independent cross-section in the few 10^{-47} cm^2 regime, the collaboration is already preparing the upgraded experiment XENONnT with about 8 tons of LXe, aimed at a further order of magnitude in sensitivity improvement. In order to maximize the fiducial volume free of nuclear recoils, we are working towards a neutron veto system based on Gd-loaded liquid scintillator. We report on Monte Carlo simulations and first validation measurements.

T 52.7 Mi 18:05 Philo-HS5

Particle Identification via Liquid Argon-Xenon Scintillation — •Andreas Himpsl[1], Walter Potzel[1], Stefan Schönert[1], Marcel Toulemonde[2], Andreas Ulrich[1], and Jochen Wieser[3] — [1]Technische Universität München, Physik Department E15, James-Franck-Str., 85748 Garching, Germany — [2]CIMAP-GANIL, Bd. Henri Becquerel BP5133 14070 Caen cedex 5, France — [3]Excitech GmbH, Branterei 33, 26419 Schortens, Germany

Two well separated scintillation light emission peaks are observed in liquid argon with a 10ppm xenon admixture: The VUV emission of the xenon excimer at 174nm, and a NIR emission with a center wavelength of 1173nm, attributed to a transition between a Wannier Mott exciton and the first excited level in xenon (A. Neumeier EPL109, 12001, 2015). The goal of this study was to test potential particle identification by measuring the NIR-to-VUV intensity ratio. Various ions from the Munich Tandem accelerator exciting the liquid with energies between 0.3 and 20 MeV/u were used for that purpose. It was found that the NIR/VUV intensity ratio depends on the projectile species and its energy. Furthermore, for detector physics, energy deposition per unit volume is important, not only linear energy transfer (LET). Superheating and boiling conditions have to be considered in the center of some of the heavy ion tracks. To explain the results the transition from LET to energy deposition per atom will be discussed.

This work was supported by the DFG Excellenzcluster Origin and Structure of the Universe and the Maier-Leibnitz-Laboratorium (Garching).

T 52.8 Mi 18:20 Philo-HS5

XEBRA - A test platform for liquid xenon detectors — •Patrick Meinhardt — Physiklalisches Institut, Freiburg, Deutschland

Dual-phase time projection chambers (TPCs) filled with liquid xenon (LXe) are a widely-used technique for the direct search for dark matter in the form of weakly interacting massive particles (WIMPs). The future DARWIN experiment will use a multi-ton LXe TPC to improve the WIMP-nucleon scattering sensitivity to the neutrino floor, defined by irreducible neutrino-nucleus interactions. In order to realize DARWIN, new detection concepts need to be developed and the background of the instrument needs to be reduced compared to the state-of-the-art. XEBRA (XEnon Based Research Apparatus) is a cryogenic test platform to investigate detection technologies and methods of background reductions relevant for the DARWIN experiment. This talk will give an overview about the XEBRA setup in Freiburg, its capabilities and ongoing R&D within the ERC-funded project ULTIMATE.

T 52.9 Mi 18:35 Philo-HS5

Improving the radiopurity of $CaWO_4$ crystals for the CRESST experiment — •A. Kinast[1], A. Erb[1,2], T. Faestermann[1], G. Korschinek[1], A. Langenkämper[1], E. Lindner[1], A. Münster[1], E. Mondragon[1], T. Ortmann[1], S. Pavetich[3], W. Potzel[1], S. Schönert[1], H. H. Trinh Thi[1], S. Wawoczny[1], A. Wallner[3], and M. Willers[1] — [1]Physik-Department, Technische Universität München, D-85748 Garching — [2]Walther-Meißner-Institut für Tieftemperaturforschung, D-85748 Garching — [3]Department of Nuclear Physics, Australian National University, Canberra, Australia

The direct dark matter search experiment CRESST uses scintillating $CaWO_4$ single crystals as targets for possible recoils of dark matter particles. For several years these $CaWO_4$ crystals are produced directly at TUM including the $CaWO_4$ powder production from the raw materials $CaCO_3$ and WO_3 as well as the crystal growth via the Czochralski method. To further increase the sensitivity of the CRESST experiment, an improvement of the crystal radiopurity is crucial. To achieve this goal, a new method for the chemical purification of the raw materials has been developed at TUM. In order to investigate the radiopurity-level achieved by this method, highly-sensitive screening methods are required. In this work Accelerator Mass Spectrometry (AMS) has been tested for $CaWO_4$ radiopurity screening and first results will be presented. This research was supported by the DFG cluster of excellence “Origin and Structure of the Universe”, by the BMBF Verbundprojekt 05A2017 CRESST-XENON and by the SFB1258.

T 52.10 Mi 18:50 Philo-HS5

Characterization of Sputtered Tungsten Thin Films for the CRESST Experiment using Transition Measurements and X-Ray Diffraction — •Tobias Ortmann, Angelina Kinast, Erik Lindner, Elizabeth Mondragón, Andrea Münster, Walter Potzel, Stefan Schönert, Andreas Ulrich, Stephan Wawoczny, and Michael Willers — Physikdepartment E15 and Excellence Cluster Universe, Technische Universität München, D-85748 Garching

The CRESST experiment (Cryogenic Rare Event Search with Superconducting Thermometers) searches for nuclear recoils events induced by elastic scattering of dark matter particles off the target nuclei within $CaWO_4$ target crystals. The detectors are operated at a temperature of $\mathcal{O}(10\,\mathrm{mK})$ and consist of the target crystal and a separate cryogenic light detector. Both heat (phonon) and light signals are read out via a tungsten TES (Transition Edge Sensor) utilizing the superconducting phase transition of tungsten to measure the energy deposited in the respective absorbers. RF-magnetron sputtering is promising method to produce the tungsten thin films for the TES. It provides a high production rate, highly tunable transition temperatures and it produces mechanically stable films. The thin film production via this method is investigated in terms of film quality reproducibility using transition measurements and x-ray diffractometry and the results of this investigation are presented. This research was supported by the DFG cluster of excellence “Origin and Structure of the Universe", by the BMBF Verbundprojekt 05A2017 - CRESST-XENON and by the SFB1258.