T 7: Direkte Suche nach Dunkler Materie I

Zeit: Montag 16:00–18:20 Raum: H09

Gruppenbericht T 7.1 Mo 16:00 H09

DARWIN: the ultimate dark matter detector — •Darryl Masson — Universität Freiburg

As dark matter detection experiments continue to push to ever-greater sensitivities, new experiments are devised to glimpse the elusive first signal. The DARWIN project, featuring a 40 tonne liquid xenon target, will attempt to measure WIMP-nucleon scattering cross sections down to $\sim 10^{-49}\,\mathrm{cm}^2$. Additionally, DARWIN should be able to probe the neutrino mass hierarchy via measurements of the half-life of ^{136}Xe $0\nu\beta\beta$-decay. Other potential science channels include measurements of galactic axions and axion-like particles coupling to electrons and some neutrino interaction channels, such as solar neutrinos via elastic scattering on electrons and galactic supernovae neutrinos via coherent neutrino-nucleus scattering. The current status of the DARWIN project will be presented along with sensitivity projections for a variety of science channels.

T 7.2 Mo 16:20 H09

Towards a hermetic TPC for the DARWIN experiment — •Julia Dierle — Hermann-Herder-Straße 3, 79104 Freiburg

With its ambitious sensitivity to rare WIMP-nucleus interaction, the DARWIN experiment has to significantly exceed the already very low target-intrinsic background rates achieved by the currently leading experiments. These are dominated by radon which is constantly emanated from all detector surfaces. The concept of a hermetic TPC could complement approaches like radon distillation, material selection and surface treatment and contribute towards the goal of a radon-induced background rate of $0.1\,\mu$Bq/kg. The hermetic TPC minimizes the surface being in direct contact with the active volume which must thus be enclosed in an (almost) liquid- and gas-tight shell. A small residual xenon flow from the purified target to the outside volume is expected. We report on the status and upcoming milestones towards construction and operation of such a hermetic TPC.

T 7.3 Mo 16:35 H09

Electromagnetic field and VUV light tracking simulations for the DARWIN field cage — •Sebastian Stern, Tobias Kleiner, Jonas Kellerer, Ferenc Glueck, and Guido Drexlin — Institut für Experimentelle Teilchenphysik, Karlsruher Institut für Technologie, Deutschland

The goal of the DARWIN experiment is to design and construct the ultimate dark matter detector, using a multi-ton target of liquid xenon for the direct detection of particle dark matter in a sensitive time projection chamber (TPC). Together with achieving very low radioactivity conditions and the required xenon purity, one of the most challenging aspects is the ability to have a very homogeneous drift field inside the TPC with ideally no radial electrical field. It is therefor of particular importance to gain a detailed understanding of the electrical field with high precision simulation algorithms.

In this work we present detailed calculations of the large-scale drift field of the DARWIN TPC with the aim to maximize the field homogeneity, using the KEMField and COMSOL codes. We also investigate the impact of surface charge on the PTFE-LXe interface and the local field of small Cu-pins, which are proposed as countermeasure against surface charges. We show that the impact of pins on the local drift field is well under control. In addition, we present simulations of the effect of the Cu-pins on the propagation of VUV light.

T 7.4 Mo 16:50 H09

Cu-pins as a novel tool to counteract PTFE surface charges in DARWIN — •Tobias Kleiner — KIT (IKP), Karlsruhe, Germany

The goal of the DARWIN experiment is to design and construct the ultimate dark matter detector, using a multi-ton target of liquid xenon for the direct detection of particle dark matter in a sensitive time projection chamber. Together with achieving very low radioactivity conditions and the required xenon purity, one of the most challenging aspects is the ability to have a very homogeneous drift field inside the TPC with ideally no radial electrical field. It is therefore crucial to investigate surface charge-up effects of the reflection enhancing PTFE wall observed in preceding experiments like LUX, as well as identifying a method to reduce its influence on the electric field. We experimentally investigate the novel ansatz to collect PTFE surface charges by Cu-pins. Surface charges are generated by an electron gun as well as by UV light with and without Cu-pins, and the resulting electric field is measured by a movable electrostatic voltmeter.

T 7.5 Mo 17:05 H09

Beyond Dark Matter with the XENONnT Experiment — •Arianna Rocchetti — Uni-Freiburg

The XENON project seeks to directly detect dark matter in the form of Weakly Interacting Massive Particles (WIMPs) and it is now entering a new exciting phase: XENONnT, which will feature almost triple the target mass of xenon as well as decreased backgrounds. This will give XENONnT not only an unprecedented sensitivity to the WIMP-nucleon interaction cross section but also it will open the possibility to probe several other rare physics processes. Among these, the search for the neutrino-less double beta decay of ^{136}Xe, which has a isotopic abundance of 8.49% in natural xenon. This decay channel has a Q-value of (2457.83 ± 0.37) keV, which is orders of magnitude greater than the expected dark matter signature, for which the detector is primarily optimized. We will present studies to improve the sensibility in the high energy region together with the modifications done in the data acquisition system in order to have a separate readout chain dedicated to these more energetic signals.

T 7.6 Mo 17:20 H09

The Gd-loaded water Cherenkov neutron veto of the XENONnT experiment — •Daniel Wenz for the XENON-Collaboration — Institut für Physik & Exzellenzcluster PRISMA, J. Gutenberg-Universität Mainz, 55099 Mainz, Germany

The XENON1T experiment searching for direct detection of Dark Matter at the Laboratori Nazionali del Gran Sasso in Italy has set in 2018 the world-leading limit on the spin-independent cross-section between nucleon and the Dark Matter candidate Weakly Interacting Massive Particle (WIMP), and is now undergoing an upgrade with a larger dual-phase xenon Time Projection Chamber, XENONnT. The new detector will employ more 8 tonnes of xenon, improving by one order of magnitude the sensitivity to the WIMP-nucleon spin-independent cross-section to $\sim 2 \times 10^{-48}$ cm^2. In addition, the current water Cherenkov Muon Veto system surrounding the XENONnT cryostat will be integrated with a new neutron veto system, based on the use of gadolinium-loaded water. In this talk we describe the implementation of the new neutron veto detector and the plans for its calibration, and we show its beneficial impact on the residual neutron background that could otherwise affect the XENONnT goal sensitivity.

T 7.7 Mo 17:35 H09

Characterization of the Heidelberg Xenon (HeXe) TPC — •Florian Jörg, Guillaume Eurin, Natascha Rupp, Dominick Cichon, and Teresa Marrodán-Undagoitia — Max-Planck-Institut für Kernphysik Heidelberg

Dual phase liquid xenon time projection chambers (TPCs) are among the most sensitive detector technologies used for rare event searches, such as for example direct dark matter detection. To ensure the optimal response of the detector, it is crucial to maintain the chemical purity of the xenon at a high level. New techniques aimed at the background reduction for these experiments, employ chemicals to improve the surface properties of different materials, which are used for the construction of such detectors. In order to guarantee the compatibility of these techniques with the high xenon purity demand of a dual phase TPC, it is mandatory to test these techniques under the operational conditions of such a detector. The Heidelberg Xenon (HeXe) dual phase liquid xenon TPC is dedicated to investigate the possible effects of different surface treatment techniques onto the liquid xenon purity. In this talk, the measuring system and its performance will be described. Results from a first characterization of the charge and light response of the system at different drift fields using a $^{83\mathrm{m}}$Kr source will be presented. Uncertainties in the drift field were evaluated with a three dimensional FEM simulation using COMSOL Multiphysics.

T 7.8 Mo 17:50 H09

Radon removal for the XENONnT dark matter experiment — •Michael Murra for the XENON-Collaboration — Institut für Kernphysik, Münster

The next-generation dark matter experiment XENONnT utilizes about 8.4 tonnes of liquid xenon for the direct search of Weakly Interacting Massive Particles (WIMPS). Intrinsic radioactive contaminants in the liquid xenon such as Kr-85 and Rn-222 will be the main source of background. Both noble gas species can be removed by cryogenic distillation, employing the differences in vapor pressure between krypton and radon with respect to xenon. While krypton can be reduced once before the start of the dark matter search with the existing krypton distillation column of XENON1T, radon is continously emanating from the detector components. Therefore, a new high-flux radon removal system is under developement for XENONnT. Besides the separation performance, the main challenge is an efficient thermodynamic design.

This talk will present the design along with first measurements with a prototype setup.

The project is funded by BMBF under contract 05A17PM2.

T 7.9 Mo 18:05 H09

Optical simulations of the XENONnT experiment — •Lutz Althüser for the XENON-Collaboration — Institut für Kernphysik, WWU Münster

The XENON Dark Matter Project uses a dual-phase xenon time projection chamber (TPC) for a direct search for weakly interacting massive particles (WIMPs). The next operation phase, XENONnT, is currently under construction at Laboratori Nazionali del Gran Sasso (LNGS).

Therefore, a new TPC was developed to maximize the active detector volume while keeping most of the infrastructure of XENON1T. This kind of detector is built to detect low intensity light signals, generated either directly by the recoil produced by the scattering processes of incoming particles (S1) or through proportional scintillation (S2). The light collection efficiency (LCE) of these signals depends on the position of interactions in the active volume and on optical properties of the detector materials. During operation and analysis of XENON1T, several aspects of the design revealed opportunities of further improvements, such as the geometrical arrangement of the PTFE components in the electroluminescence region.

A recap of the design choices for XENON1T and XENONnT regarding optical properties as well as preliminary optical simulations of XENONnT will be shown.

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