T 36: Neutrinoloser Doppelbeta-Zerfall II

Zeit: Montag 16:45–19:05 Raum: VMP9 SR 07

Gruppenbericht T 36.1 Mo 16:45 VMP9 SR 07

Status of GERDA Phase II — •Victoria Wagner for the GERDA-Collaboration — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

The GERDA experiment is designed to search for neutrinoless double beta ($0\nu\beta\beta$) decay of ^{76}Ge. In Phase I of the experiment a background index (BI) of 10^{-2} cts/(keV·kg·yr) was reached. No signal has been found and a lower limit on the half-life of $2.1{\cdot}10^{25}$ yr (at 90% C.L.) is extracted. The aim of Phase II is to double the Ge mass and further reduce the BI by an order of magnitude to explore half-lives of about 10^{26} yr. Thirty new Broad Energy Germanium (BEGe) detectors have been produced. These detectors are distinct for their improved energy resolution and enhanced pulse shape discrimination of signal from background events. Further background reduction will be reached by an active veto to read out argon scintillation light. The Phase II commissioning showed that two of the major background components, external γ-rays from ^{214}Bi and ^{208}Tl decays, can be suppressed up to two orders of magnitude. This talk will present the current status of the GERDA Phase II upgrade.

T 36.2 Mo 17:05 VMP9 SR 07

A new approach to Neganov-Trofimov-Luke cryogenic light detectors for Astroparticle Physics — •Elizabeth Mondragón[1], X. Defay[1], J-C. Lanfranchi[1], A. Langenkämper[1], A. Münster[1], E. Olivieri[2], W. Potzel[1], S. Schönert[1], H. Steiger[1], S. Wawoczny[1], M. Willers[1], and A. Zöller[1] — [1]Physik-Department and Excellence Cluster Universe, Technische Universität München, D-85747 Garching — [2]Centre de Sciences Nucléaires et Sciences de la Matière (CSNSM), IN2P3 Orsay, France

There is a common need in Astroparticle experiments such as direct Dark Matter detection, neutrinoless double beta decay and coherent neutrino nucleus scattering experiments for detectors with a very low energy threshold. By employing the **Neganov-Trofimov-Luke Effect (NTLE)** the thermal signal of particle interactions in a semiconductor absorber, operated at cryogenic temperatures, can be amplified by drifting electrons and holes under an electric field inside the semiconductor. We present here the first results of a novel type of a NTLE light detector with a planar electric field configuration designed to improve the charge collection within the semiconductor. This research was supported by the DFG cluster of excellence "Origin and Structure of the Universe ", by the Helmholtz Alliance for Astroparticle Physikcs, by the Maier-Leibnitz-Laboratorium (Garching) and by the BMBF.

T 36.3 Mo 17:20 VMP9 SR 07

The next Enriched Xenon Observatory - A Search for Neutrinoless Double Beta Decay — •Reimund Bayerlein, Patrick Hufschmidt, Ako Jamil, Judith Schneider, Michael Wagenpfeil, Gerrit Wrede, Tobias Ziegler, Jürgen Hössl, Gisela Anton, and Thilo Michel — ECAP, Friedrich-Alexander-Universität Erlangen-Nürnberg

The question whether the neutrino could be its own antiparticle is still not answered. The most practical way to test this is the search for the neutrinoless double beta decay. The half-life of this decay is related to the value of a linear combination of the masses of the neutrino mass eigenstates and therefore provides information about the absolute mass scale of neutrinos. The nEXO experiment - the successor of EXO200 - is currently under research and development. The baseline concept comprises a single-phase liquid xenon (LXe) time projection chamber (TPC) filled with about 5 tons of liquid xenon enriched to about 80% Xe-136 as the double beta decay nuclide.

In order to fully cover the range of the effective Majorana neutrino mass in the inverted hierarchy scheme, excellent energy resolution is required. Therefore, a position-resolving, low-noise charge readout and very efficient light collection and detection are mandatory. For the purpose of very low background levels radiopure Silicon Photomultipliers (SiPMs) have to be used to detect the scintillation light of LXe. Due to the large half-life a huge detector mass and long term measurement are needed. In this talk the baseline-concept of the experimental setup will be presented.

T 36.4 Mo 17:35 VMP9 SR 07

Silicon Photomultipliers for the detection of VUV scintillation light in LXe for the nEXO experiment — •Tobias Ziegler, Ako Jamil, Reimund Bayerlein, Jürgen Hössl, Patrick Hufschmidt, Judith Schneider, Michael Wagenpfeil, Gerrit Wrede, Gisela Anton, and Thilo Michel — Erlangen Centre for Astroparticle Physics, Erlangen 91058, Deutschland

The future nEXO (next Enriched Xenon Observatory) experiment with a single phase TPC design will use about 4 m^2 of SiPMs for the detection of the VUV (vacuum ultraviolet) scintillation light ($\lambda = 175$ nm) from LXe to search for the neutrinoless double beta ($0\nu\beta\beta$) decay of ^{136}Xe. Commercially available SiPMs are not sensitive to ultraviolet light, because of an antireflective coating on top of the sensitive area. In addition, they suffer from relatively high dark count rate at room temperature and correlated avalanches, such as crosstalk and afterpulsing. The core criteria, for having an energy resolution of about 1% (σ) at the Q-value of the $0\nu\beta\beta$ decay of ^{136}Xe (2457.8 keV), are a photon detection efficiency (PDE) of at least 15% at 175 nm and a correlated avalanche probability (CAP) of less than 20% at -100 °C. We considered different approaches for optimizing both PDE and CAP. These improved SiPMs from several vendors were tested in different test setups at temperatures of about -100 °C with respect to the criteria required in the nEXO experiment.

T 36.5 Mo 17:50 VMP9 SR 07

Setup for SiPM characterization in liquid xenon for the nEXO experiment — •Patrick Hufschmidt, Reimund Bayerlein, Ako Jamil, Judith Schneider, Michael Wagenpfeil, Gerrit Wredel, Tobias Ziegler, Gisela Anton, Juergen Hoessl, and Thilo Michel — ECAP, Friedrich-Alexander-Universitaet Erlangen Nuernberg

The nEXO (next enriched xenon observatory) is a future experiment to search for the neutrinoless double beta decay of Xe-136 with a single-phase time-projection-chamber filled with liquid xenon. Besides position resolved detection of the released charge with low noise electronics, efficient collection and detection of the xenon scintillation light with its short wavelength of 175 nm is important to obtain good energy resolution. Due to the demands on radiopurity of the materials employed in the detector, Silicon Photomultipliers (SiPM) shall be used to detect the scintillation light. Dedicated SiPMs, compatible with the requirements of the experiment, have to be developed. In order to characterize SiPMs - for example with respect to photon detection efficiency at 175 nm, cross-talk probability, dark-rate, after-pulse probability - we have set up a SiPM test stand in which SiPMs can be operated in liquid or in gaseous xenon. Cooling is performed with a cold finger immersed in liquid nitrogen. Scintillation photons are produced by the interaction of alpha particles from a radioactive source. In addition to the SiPMs, a VUV-sensitive photomultipier tube is present in the xenon cell so that coincidence measurements can be performed. In this contribution we present the status of our test setup.

T 36.6 Mo 18:05 VMP9 SR 07

Search for neutrinoless double beta decay beyond GERDA — •Bernhard Schwingenheuer — MPI Kernphysik, Heidelberg

The search for neutrinoless double beta decay might be the only window to observe lepton number violation and to determine the nature of neutrinos. Is is therefore considered to be of highest relevance. The isotope Ge-76 has historically been most important for this search and the ongoing experiment GERDA has the lowest background of all experiments in the field. The proposed experimental program beyond GERDA (and Majorana) is presented.

T 36.7 Mo 18:20 VMP9 SR 07

Untersuchung von TPB-Beschichtungen auf optischen Fasern zur Auslese des Szintillationlichts von flüssigem Argon in GERDA — •Julian Kratz für die GERDA-Kollaboration — Physik-Department and Excellence Cluster Universe, Technische Universität München, James-Franck-Straße 1, 85748 Garching,

Das GERDA-Experiment sucht nach dem neutrinolosen Doppel-β-Zerfall von ^{76}Ge. Germanium-Detektoren werden dabei direkt in einem Kryostaten, gefüllt mit 64 m^3 flüssigem Argon (LAr), betrieben. Untergrundereignisse können über das Szintillationslicht im LAr unterdrückt werden. Eine Kombination von optischen Fasern und Silizium-Photomultipliern (SiPM) wird als Teil des LAr-Veto eingesetzt. Die

Fasern werden mit TPB (Tetraphenyl butadiene) beschichtet, ein Wellenlängenschieber, der durch seine Eigenschaften die Fasern für das Szintillationslicht von Argon (127 nm) empfindlich macht. In einer Vakuumkammer wird das TPB verdampft und die Fasern damit beschichtet. Verschiedene Verdamfungszeiten und Temperaturen erzeugen unterschiedliche Schichtdicken, so können die Eigenschaften von TPB untersucht werden. Durch die optimale Schichtdicke wird die Lichtausbeute maximiert und die Unterdrückung des Untergrunds verbessert. Dieser Vortrag zeigt die Entwicklung von TPB-beschichteten Fasern mit unterschiedlichen Schichtdicken und deren Verhalten im Szintillationslicht von flüssigem Argon für die Anwendung in GERDA.
Diese Arbeit wurde durch das BMBF unterstüzt.

T 36.8 Mo 18:35 VMP9 SR 07

Development of phonon and photon detectors for rare events searches using scintillating crystals — •Felix Ahrens[1], Christian Enss[1], Andreas Fleischmann[1], Loredana Gastaldo[1], Clemens Hassel[1], Sebastian Hendricks[1], Sebastian Kempf[1], Yong-Hamb Kim[2], Martin Loidl[3], Xavier-François Navick[3], and Matias Rodrigues[3] — [1]Kirchhoff-Institut für Physik, Universität Heidelberg, Deutschland — [2]Korea Research Institute of Standards and Science, Daejeon, Rep. of Korea — [3]Commissariat à l'énergie atomique, Saclay, France

The use of scintillating crystals in cryogenic experiments searching for neutrinoless double beta decay and for direct interaction of dark matter particles allows for an efficient background reduction due to particle discrimination. We develop phonon and photon detectors based on metallic magnetic calorimeters (MMCs) to perform simultaneous measurements of heat and light generated by the interaction of a particle in a scintillating crystal. As designed we expect for the phonon sensor an energy resolution of $\Delta E_{\mathrm{FWHM}} < 100\,\mathrm{eV}$ and a signal rise time $\tau < 200\,\mu\mathrm{s}$ whereas for the photon detector we expect $\Delta E_{\mathrm{FWHM}} < 5\,\mathrm{eV}$ and $\tau < 50\,\mu\mathrm{s}$. We discuss the design and the fabrication of these detectors and present recent results.

T 36.9 Mo 18:50 VMP9 SR 07

Suppression of the background coming from ^{42}Ar in the GERDA experiment — •Alexey Lubashevskiy for the GERDA-Collaboration — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, D-69117 Heidelberg

The GERDA experiment aims at the $0\nu\beta\beta$ search in ^{76}Ge. The search is performed with high purity germanium detectors operated in liquid argon. One of the most dangerous backgrounds in GERDA is the background from ^{42}K which is a daughter isotope of cosmogenically produced ^{42}Ar, presented in natural argon. ^{42}K ions collect on the surface of the detector and increase its background level. Several ways to suppress such background has been investigated. The tests were performed at LArGe low-background test facility, which gives a possibility to operate bare detectors in about 1m^3 of LAr. It is equipped with a scintillation veto, so particles which deposit part of their energy in LAr can be detected by PMTs. The experimental setup is located at LNGS underground laboratory close to GERDA experiment location. Different experimental techniques were tested together with pulse shape discrimination (PSD) method in order to suppress ^{42}K background. The chosen solution for GERDA Phase II is so called "nylon mini-shroud" (NMS). It is made from nylon foil and covered with wavelength shifter from both sides. NMS allows to suppress collection of ^{42}K ions towards to the surface significantly. It was demonstrated in LArGe that together with PSD and scintillation veto the ^{42}K background can be suppressed in more than 1000 times. The results obtained during commissioning runs in GERDA Phase II will be also presented.