T 12: Neutrinophysik 2 (Doppelbetazerfall)

Zeit: Montag 16:45–19:05 Raum: VSH 118

Gruppenbericht T 12.1 Mo 16:45 VSH 118

Status of the CUORE $0\nu\beta\beta$ decay search — •Benjamin Schmidt for the CUORE-Collaboration — Institute for Nuclear and Particle Astrophysics, Lawrence Berkeley National Laboratory, Berkeley, CA, USA

Observation of neutrinoless double beta decay ($0\nu\beta\beta$) would establish lepton number violation, would indicate that neutrinos are Majorana particles, and could provide information on the absolute neutrino mass scale. CUORE, the Cryogenic Underground Observatory for Rare Events, uses a cryogenic array of 988 TeO_2 bolometers to target the $0\nu\beta\beta$ decay candidate isotope ^{130}Te. It is the first tonne-scale cryogenic bolometer experiment featuring a total detector mass of about 740 kg of natural tellurium. Recently the detector installation at the Laboratori Nazionali del Gran Sasso (LNGS) has been completed and data taking is scheduled to begin in early 2017. We will discuss the status of the CUORE experiment and present the most recent results from CUORE-0, a single-tower array of 52 crystals, operated at LNGS between 2013-2015.

T 12.2 Mo 17:05 VSH 118

The nEXO experiment — •Judith Schneider, Jürgen Hössl, Patrick Hufschmidt, Ako Jamil, Lukas Maderer, Michael Wagenpfeil, Tobias Ziegler, Gisela Anton, and Thilo Michel — Erlangen Centre for Astroparticle Physics, 91058 Erlangen, Germany

The question whether the neutrino is its own antiparticle or not is still not answered. The most feasible way to investigate this is the search for the neutrinoless double beta decay. The nEXO experiment, which is currently under development, will search for this decay. Its baseline concept is a single-phase liquid xenon (LXe) time projection chamber (TPC) filled with about 5 tons of LXe enriched to about 80% Xe-136 as double beta decay nuclide as well as detection material. In order to achieve an excellent energy resolution, a position-resolving, low-noise charge readout as well as very efficient light detection is mandatory. For the purpose of very low background levels, radiopure Silicon Photomultipliers (SiPMs) have to be used to detect the scintillation light of LXe. In this talk, the baseline-concept of the experiment will be presented.

T 12.3 Mo 17:20 VSH 118

Characterization of a VUV-sensitive Silicon Photomultiplier for the nEXO experiment — •Tobias Ziegler, Patrick Hufschmidt, Ako Jamil, Judith Schneider, Michael Wagenpfeil, Gisela Anton, and Thilo Michel — ECAP, Friedrich-Alexander-Universität Erlangen-Nürnberg

The future nEXO experiment 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. Besides suffering from correlated avalanches, such as crosstalk and afterpulsing, most commercially available SiPMs are not sensitive to UV light. The core criteria, for having an energy resolution of about $1\,\%\,(\sigma)$ at the Q-value of the $0\nu\beta\beta$ decay of ^{136}Xe at 2457.8 keV, are a photon detection efficiency (PDE) of at least 15 % at 175 nm and a correlated avalanche probability of less than 20 %. We present measurements with a new device dedicated to detect VUV light. These SiPMs were investigated at $-100\,°C$ both in the absence of light as well as using Xe scintillation light with respect to the requirements by the nEXO experiment.

T 12.4 Mo 17:35 VSH 118

Development of Large Area Silicon Photomultipliers in Noble Liquids for the nEXO Experiment — •Ako Jamil[1,2], Alexis Schubert[2], Gaosong Li[2], Igor Ostrovskiy[2], Giorgio Gratta[2], Gisela Anton[1], and Thilo Michel[1] — [1]Friedrich-Alexander-Universität Erlangen Nürnberg — [2]Stanford University

The nEXO experiment will reach a half-life sensitivity of 5×10^{27} yrs for the neutrino-less double beta decay of ^{136}Xe. nEXO will use Silicon Photomultipliers (SiPM) for the detection of the 175nm scintillation light of xenon. Simulations have shown that to reach the desired energy resolution of 1% (σ), a total of $4m^2$ of photo detectors are required, which would have to detect at least 5% of the scintillation light. Recent measurements show promising results from various SiPM vendors, where the detectors exceed the necessary 15% photon detection efficiency and meet our correlated avalanche rate requirement. The nEXO collaboration is also investigating solutions for reading out m^2 of SiPMs, which has not been done before. A prototype, with a photo detector area of about $40cm^2$, has been developed and tested in a liquid xenon TPC. In this talk we will report the development of solutions for light detection in nEXO, highlighting the technologies that are pioneered by the collaboration, especially VUV sensitive SiPMs and large area integration as well as readout in liquid xenon.

T 12.5 Mo 17:50 VSH 118

Investigations on electron drift in the EXO-200 TPC — •Gerrit Wrede, Sebastian Schmidt, Gisela Anton, Jürgen Hössl, and Thilo Michel — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander Universität Erlangen-Nürnberg, Erwin-Rommel-Str. 1, 91058 Erlangen

The EXO-200 experiment searches for the neutrinoless double beata decay of Xe-136 with a cylindrical LXe TPC.

The double-sided, single-phase TPC provides the position (X,Y,Z) of events and the deposited energy in LXe by simultaneously detecting the scintillation light and the amount of released charge.

For charge collection, electrons drift in the electric field towards the end plates on each side of detector, where they induce currents in a first plane of wires and are collected by a second plane of wires. In order to improve the accuracy of the position reconstruction an analysis of drift field inhomogeneities at the side wall of the cylindrical TPC was carried out.

In this contribution we present the results of our investigations on the non-uniformities of the electric field close to the field-shaping rings and our work on the charge drift simulation to account for these non-uniformities to eventually increase the fiducial volume in the data analysis.

T 12.6 Mo 18:05 VSH 118

Pulse Shape Discrimination for the Gerda Experiment — •Victoria Wagner for the GERDA-Collaboration — Max-Planck Institut für Kernphysik, Heidelberg

The Gerda experiment searches for neutrinoless double beta decay of ^{76}Ge using high purity germanium (HPGe) detectors operated in liquid argon (LAr). The aim is to explore half-lives of the order of 10^{26} yr. Therefore, Gerda relies on improved active background reduction techniques such as pulse shape discrimination (PSD) in which the time structure of the germanium signals is analyzed to discriminate signal- from background-like events. Two types of HPGe detectors are operated: semi-coaxial detectors previously used in the Heidelberg-Moscow and IGEX experiments and new BEGe detectors. For semi-coaxial detectors a method based on an artificial neural network is used. Due to their special geometry, BEGe detectors feature an enhanced PSD. The analysis is based on a single parameter, the ratio of the maximum amplitude of the current pulse over the energy, A/E. 76 % of the background events in the region of interest are rejected while keeping a signal efficiency of 87 %. In Gerda Phase I, a background index of the order of $10^{-2}\,\frac{\text{cts}}{\text{keV}\cdot\text{kg}\cdot\text{yr}}$ has been achieved. The Phase II upgrade features an active veto based on the read-out of argon scintillation light (LAr veto) for further background discrimination. Together, PSD and LAr veto achieve a BI of the order of $10^{-3}\,\frac{\text{cts}}{\text{keV}\cdot\text{kg}\cdot\text{yr}}$. With this unprecedented BI, less than one background event is expected until an exposure of 100 kg·yr. The talk reviews the applied PSD methods and their impact on the experimental sensitivity.

T 12.7 Mo 18:20 VSH 118

In-situ measurement of the light attenuation in liquid argon in the Gerda cryostat — •Birgit Schneider for the GERDA-Collaboration — TU Dresden, Institut für Kern- und Teilchenphysik, Germany

Gerda is an experiment searching for the neutrinoless double beta decay in ^{76}Ge. It operates the enriched germanium detectors bare in liquid argon (LAr), which serves both as a coolant and a shield for external radiation. Phase II of Gerda aims for an exposure of $100\ \text{kg}\cdot\text{yr}$ with a background index (BI) of 10^{-3} cts/(kg · yr · keV). One of the major improvements compared to Phase I is the instrumentation of the LAr to readout its scintillation light to further reduce the BI. Recently, first results of Phase II were published which have shown that the aimed BI could be reached. Hence, GERDA is operating quasi background-free and has the lowest background ever achieved with Ge-based $0\nu\beta\beta$-experiments. The attenuation of the scintillation light in LAr limits the effective active volume of the LAr veto and is therefore a key parameter to characterize the instrumentation.

In order to measure the light attenuation in LAr, a setup was designed that could be deployed directly into the cryostat. This setup contains a movable beta source and a PMT to detect the scintillation light at different distances.

The talk will present the acquired data as well as a detailed description of the performed analysis, the results and a comparison with a dedicated simulation.

This project is partially funded by BMBF.

T 12.8 Mo 18:35 VSH 118

Background characterization in GERDA Phase II — •ANN-KATHRIN SCHÜTZ for the GERDA-Collaboration — Eberhard Karls Universität Tübingen, Germany

The GERDA collaboration aims to determine the half-life of the neutrinoless double beta decay ($0\nu\beta\beta$) of ^{76}Ge. In Phase II additional 20 kg of isotopically enriched germanium detectors are operated. To further increase the sensitivity for the half-life of neutrinoless double beta decay the identification and suppression of the background is of great importance. The application of active background-suppression techniques, such as a liquid argon scintillation light read-out and pulse shape discrimination of germanium detector signals allowed to reduce the background index to the intended level of 10^{-3} cts/(keV·kg·yr). The background components at $Q_{\beta\beta}$ have been identified to be mainly due to β- and γ-induced events from close sources originating from the U-series, the Th-series, K and α emitting isotopes from the ^{226}Ra decay chain. (Anti-)coincidences between germanium detectors and with the liquid argon veto enlarges the tools of identification compared to Phase I. A background study based on results of material screening or the observation of characteristic structures in the energy spectrum was performed and will be presented in this talk.

T 12.9 Mo 18:50 VSH 118

Characterization of a new Ge detector type for future $0\nu\beta\beta$ **search experiments** — •YOANN KERMAIDIC for the GERDA-Collaboration — Max Planck Institue für Kernphysik

The search for a neutrinoless double decay ($0\nu\beta\beta$) is a very sensitive tool for probing whether neutrino are Dirac or Majorana particles. A potential discovery has far reaching consequences for particle physics and cosmology (leptogenesis).

^{76}Ge based experiments, like GERDA, are leading in the field because of the superior energy resolution and the lowest background. A new collaboration has been founded with the goal to boost the half-life sensitivities by two orders of magnitude.

In this talk, I will show recent works on a new ^{76}Ge detector type, called Small-Anode Germanium Well (SAGe) detector, manufactured by Canberra. Its working principle is similar to Broad Energy Germanium detectors used in GERDA but its unique geometry allows highly efficient particle interaction discrimination by pulse shape analysis with a detector mass that can be as high as 2.7 kg. Simulations are here compared to data. I will finally discuss the design and goals of the new ^{76}Ge experiment.