T 43: Neutrinophysik II

Zeit: Dienstag 16:30–18:40 Raum: Z6 - SR 2.012

Gruppenbericht T 43.1 Di 16:30 Z6 - SR 2.012
The Large Enriched Germanium Experiment for Neutrinoless double beta Decay - LEGEND — •Yoann Kermaidic — Max Planck Institute fur Kernphysik, Heidelberg

The search for neutrinoless double beta ($0\nu\beta\beta$) decay is a very sensitive tool for probing whether neutrinos are Dirac or Majorana particles. A potential discovery has far reaching consequences for particle physics and cosmology (leptogenesis). Current ^{76}Ge based experiments, Gerda and Majorana Demonstrator, benefit from a superior energy resolution and the lowest background at $Q_{\beta\beta}$ in the field if normalized by the resolution. This demonstrates the feasibility of Germanium for a next generation experiment. The Legend (Large Enriched Germanium Experiment for Neutrinoless $\beta\beta$ Decay) collaboration has been founded with the goal to build a ton scale experiment and boost the $0\nu\beta\beta$ decay half-life sensitivity by two orders of magnitude. The collaboration envisions a phased approach based on the Gerda and Majorana Demonstrator experience, starting with existing resources as appropriate to expedite physics results. This talk will present the general aspect of Legend and focus on the ongoing developments for the first 200 kg phase using the Gerda cryostat at LNGS underground laboratory in Italy.

T 43.2 Di 16:50 Z6 - SR 2.012
Towards the Development of Highly Integrated Low-mass Signal Readout Electronics for Germanium Detectors — •Frank Edzards — Max Planck Institute for Physics, Munich, Germany

The LEGEND experiment is a future large-scale experiment that will search for the neutrinoless double beta decay ($0\nu\beta\beta$) in the isotope ^{76}Ge using high purity germanium detectors. Its observation would decisively proof that neutrinos are their own antiparticles, reveal that the conservation of the lepton number is violated and provide information on the neutrino mass.

This talk focuses on the signal readout which is one of the most important components of a $0\nu\beta\beta$ experiment since it facilitates the conversion of charges produced within the detectors into appropriately shaped voltage signals. Current $0\nu\beta\beta$ experiments such as GERDA and Majorana Demonstrator use a *discrete signal readout solution* consisting of a JFET amplifier, an RC-circuit and a preamplifier. We are developing a highly integrated low-mass signal amplifier based on state-of-the-art *application specific integrated circuit* (ASIC) technology which allows for the combination of all relevant components in a single low-mass chip.

This work is supported by the Max Planck society and the DFG SFB 1258 ("Neutrinos and Dark Matter in Astro- and Particle Physics").

Gruppenbericht T 43.3 Di 17:05 Z6 - SR 2.012
Status and prospects of the COBRA experiment — •Stefan Zatschler for the COBRA-Collaboration — TU Dresden, Institut für Kern- und Teilchenphysik, Germany

The COBRA experiment is dedicated to the search for the hypothesized neutrinoless double beta-decay ($0\nu\beta\beta$-decay). The observation of this lepton number violating process would prove the Majorana nature of neutrinos and shed first light on physics beyond the established Standard Model. The COBRA collaboration is currently operating a demonstrator array of 4×4×4 monolithic crystals at the underground facility LNGS (Italy). The detectors are made of CdZnTe, which is a commercially available semiconductor at room temperature. In 2018 a new detector module will be implemented to establish the COBRA extended demonstrator (COBRA XDEM). For this a new prototype of CdZnTe detectors with advanced veto capabilities has been developed and approved. In the transition phase the existing COBRA demonstrator was optimized for low-threshold operation to investigate the fourfold forbidden non-unique β-decay of ^{113}Cd. The spectral shape of the electron momentum distribution of this highly forbidden decay is sensitive to the effective value of the axial vector coupling strength g_A in a nuclear medium. Such experimental input is urgently needed in the scientific discussion of quenching effects that might affect the half-life predictions for the $0\nu\beta\beta$-decay. This talk will present the status of COBRA XDEM, the current and improved detector technology as well as the status of the recent physics analysis.

COBRA is funded by the German Research Foundation DFG.

T 43.4 Di 17:25 Z6 - SR 2.012
Selection criteria for $2\nu2\beta$-decay measurements with the COBRA experiment — •Julia Küttler for the COBRA-Collaboration — TU Dresden, Institut für Kern- und Teilchenphysik, Germany

The COBRA collaboration searches for the neutrinoless double beta-decay ($0\nu2\beta$-decay). This process is forbidden in the Standard Model of particle physics due to the lepton-number violation. Currently a demonstrator setup using coplanar-grid CdZnTe detectors is operated at the underground facility LNGS in Italy. The setup consists of 64 detectors, each with a volume of $1\,\mathrm{cm}^3$, arranged in four layers of 4×4 detectors. The CdZnTe semiconductor crystals contain nine double-β isotopes with several possible decay modes. The main focus is on ^{116}Cd due to its high Q-value of 2813 keV. Besides the effort to search for the $0\nu2\beta$-decay the $2\nu2\beta$-spectrum of the normal double-decay should be measured to confirm half-life measurements of other groups. The most promising $2\nu2\beta$-decays are coming from ^{116}Cd and ^{130}Te which have not been measured yet by the COBRA experiment itself.

This talk will focus on different selection criteria with the aim to identify run periods and detectors with a high background index. Such a data partitioning will improve the background understanding since one data sample will be background enriched while the other results in a cleaner spectrum. Combining both information will be beneficial for the intended $2\nu2\beta$-decay analysis of ^{116}Cd with the COBRA demonstrator.

T 43.5 Di 17:40 Z6 - SR 2.012
Investigation of EC/β^+-decays with the COBRA experiment — •Juliane Volkmer for the COBRA-Collaboration — TU Dresden, Institut für Kern- und Teilchenphysik, Germany

This talk's topic will be the investigation of double beta-decay modes with the COBRA experiment and focus on EC/β^+-decays. In contrast to $\beta^-\beta^-$-decays, $\beta^+\beta^+$-decay modes have not been observed yet, mainly due to their relatively small Q-values coupled with an extremely long half-life. Also, if the emission of two positrons is energetically possible, three different decay modes have to be dealt with: $\beta^+\beta^+$, EC/β^+ and EC/EC. Having a lower half-life than $\beta^+\beta^+$-events and creating a more characteristic signature than EC/EC-events, EC/β^+-decays are the most promising of those to be detected. Measuring the half-life of 2νEC/β^+-events would help to probe models used to calculate nuclear matrix elements. By constraining the model parameters with such experimental input it is possible to improve the half-life predictions for the standard neutrinoless double beta-decay. 0νEC/β^+-events on the other hand are especially sensitive to the involvement of right-handed currents in the decay mechanism, thus, could help to gain a deeper understanding of the general physics involved. The COBRA demonstrator, consisting of $4 \times 4 \times 4$ crystals of the semiconductor CdZnTe, provides three different isotopes capable of EC/β^+-decays. Additionally, the experiment's granularity greatly improves the probability to recognize the events' characteristic decay structures. First investigations of the feasibility, the characteristic decay signature in the COBRA demonstrator and background discrimination will be presented.

T 43.6 Di 17:55 Z6 - SR 2.012
Status of the XDEM-Phase for the COBRA-Experiment — •Lucas Bodenstein-Dresler for the COBRA-Collaboration — TU Dortmund, Lehrstuhl für Experimentelle Physik IV, Otto-Hahn-Straße 4, 44227 Dortmund

The COBRA collaboration searches for neutrinoless double beta-decay. If this decay would be detected, it would proof that the neutrino is a Majorana particle.
The COBRA demonstrator is located at the Gran Sasso underground laboratory in Italy with a $4 \times 4 \times 4$ array of $1\,\mathrm{cm}^3$ CdZnTe detectors. In the beginning of 2018, the setup will be upgraded with an extended demonstrator (XDEM). XDEM comprises of a new layer of nine CdZnTe detectors with $(2 \times 2 \times 1{,}5)\,\mathrm{cm}^3$ installed on top of the current inner housing. The goal of XDEM is to show that large-volume CdZnTe detectors can be used in low-background applications.
This talk will present the preparation of XDEM and the current status

of the experiment. This includes the design of a new detector-holder and a new cable management. Furthermore, a guideway for the calibration sources has been realised. For the read-out electronics a new preamplifier box was built and tested.

T 43.7 Di 18:10 Z6 - SR 2.012

Detector Evaluation for the COBRA XDEM — •Robert Temminghoff for the COBRA-Collaboration — TU Dortmund, Lehrstuhl für Experimentelle Physik IV, Otto-Hahn-Straße 4, 44227 Dortmund

The COBRA experiment is designed with the goal to search for neutrinoless double beta-decay, a long sought-after process whose existence could hint at physics beyond the Standard Model. In the ongoing demonstrator phase of the experiment 64 CdZnTe detectors with a volume of $1\,\mathrm{cm}^3$ each are operated in the LNGS underground laboratory in Italy.

The setup is currently being extended with an additional array of nine CdZnTe detectors with a volume of $6\,\mathrm{cm}^3$ each (XDEM phase). These detectors will also feature an instrumented guard-ring electrode which is used to suppress surface related background contributions. Thereby the COBRA collaboration will improve the experiments background level and demonstrate the usage of large volume CdZnTe detectors for double beta-decay searches.

In this talk, results from the evaluation of the detectors used for the XDEM phase will be shown. In total ten detectors from two different manufacturers have been tested, of which the best nine will be installed at the LNGS. The evaluation includes a determination of the ideal working point as a function of the applied bulk- and grid-bias, measurements of the energy resolution and the efficiency as well as electrical tests.

T 43.8 Di 18:25 Z6 - SR 2.012

A measurement of the thermal neutron capture on gadolinium with the ANNRI spectrometer at J-PARC — Pretam Kumar Das[1], Rohit Dir[1], William Focillon[2], Michel Gonin[2], Kaito Hagiwara[1], Hideo Harada[3], Nobuyuki Iwamoto[3], Tsubasa Kayano[1], Atsushi Kimura[3], Yusuke Koshio[1], •Sebastian Lorenz[1,4], Takaaki Mori[1], Shoji Nakamura[3], Iwa Ou[1], Makoto Sakuda[1], Mandeep Singh Reen[1], Takashi Sudo[1], Michael Wurm[4], Tomoyuki Tanaka[1], Yoshiyuki Yamada[1], and Takatomi Yano[5] — [1]Okayama University, Japan — [2]École Polytechnique, France — [3]Japan Atomic Energy Agency — [4]Johannes Gutenberg-Universität Mainz, Germany — [5]Kobe University, Japan

Due to its high cross-section for thermal neutron capture and the succeeding emission of a γ cascade with a total energy of $\sim 8\,\mathrm{MeV}$, gadolinium (Gd) is used in low-energy neutrino searches to increase the tagging efficiency for neutron capture signals from inverse beta decay reactions. Prominent examples are Daya Bay, Double Chooz and RENO, which use Gd-doped liquid scintillator. Since now also Super-Kamiokande plans to dissolve Gd in its water target, a precise modeling of the γ ray cascade from the Gd(n,γ) reaction is important to study neutron tagging efficiencies in MC simulations. However, existing MC frameworks do not reproduce the capture reaction in detail when compared to experimental outcomes. Using the ANNRI germanium spectrometer at J-PARC, the thermal neutron capture on enriched ^{157}Gd has been measured and the data are used to build a corresponding model. This talk presents results of the ANNRI-Gd experiment.