T 52: Neutrino physics without accelerators V

Time: Wednesday 16:30–18:45 Location: H-HS XIII

T 52.1 Wed 16:30 H-HS XIII

Project 8: First application of CRES to tritium decay — •Martin Fertl — Johannes Gutenberg-Universität, Mainz

Neutrino flavor oscillation experiments prove that neutrinos do have non-zero masses. Extensions to the Standard Model of Particle Physics have been developed to explain the non-zero masses and can be directly tested by a measurement of the absolute neutrino mass scale. The mass of the electron antineutrino m_ν can be determined from the highest precision measurement of the β^--decay spectrum of tritium around its endpoint region. The current state of the art experiment KATRIN stretches all technological limits to probe the range of m_ν down to $200\,\mathrm{meV/c^2}$. The Project 8 collaboration envisions a completely new path to measure m_ν. The recently demonstrated technique of Cyclotron Radiation Emission Spectroscopy (CRES) allows for a frequency-based measurement of the decay electron energy. This new and staged approach to devise an experiment that combines CRES with an atomic tritium source to achieve a neutrino mass sensitivity of $40\,\mathrm{meV/c^2}$, below the minimum m_ν predicted for the inverted neutrino mass ordering scheme will be presented. Results from the first application of CRES to the continuous decay spectrum of tritium will be discussed. This work is supported by the Cluster of Excellence “Precision Physics, Fundamental Interactions, and Structure of Matter" (PRISMA+ EXC 2118/1) funded by the German Research Foundation (DFG) within the German Excellence Strategy (Project ID 39083149), the US DOE Office of Nuclear Physics, the US NSF and internal investments at all institututions.

T 52.2 Wed 16:45 H-HS XIII

Detection Efficiency in Project 8 — •Christine Claessens for the Project 8-Collaboration — JGU Mainz

The Project 8 collaboration aims to measure the absolute neutrino mass scale from the distortion of the tritium beta decay spectrum near the endpoint. To this end, the collaboration has successfully established Cyclotron Radiation Emission Spectroscopy (CRES), a frequency-based approach to detect electrons and determine their kinetic energy (Phys. Rev. Lett. 114, 162501). As we will extract the neutrino mass from the shape of the tritium spectrum, it is essential to quantify any dependence of the electron detection efficiency on frequency or energy. Incorporating this efficiency in our analysis is crucial for an accurate measurement of the endpoint and the extraction of the neutrino mass. In this contribution, I will demonstrate the influence of the detection efficiency and its integration in our analysis with the example of the first-ever tritium CRES spectrum.

T 52.3 Wed 17:00 H-HS XIII

A new muon fitter for the SNO+ experiment — •Johann Dittmer, Mikko Meyer, and Kai Zuber for the SNOplus-Collaboration — TU Dresden, Institut für Kern– und Teilchenphysik

The SNO+ experiment is a liquid scintillator based neutrino detector looking for the neutrinoless double beta decay of ^{130}Te. The experiment is the successor of the Nobel Prize winning SNO experiment and is located at the same location as SNO (at SNOLAB with 2 km rock overburden).

The goal of track reconstruction algorithms is to identify sub–volumes, where muon–induced nuclides (^{8}He, ^{9}Li, ^{11}C etc.) are produced, and – connected to that – to reduce the detector dead time. Both goals are important for the analysis of solar *pep*– and CNO–neutrinos. In addition, a precise knowledge of the muon track may also take part in other analyses.

In this talk, an algorithm to reconstruct the muon track is presented. First results of the quantitative analysis will be presented as well.

This work is supported by the DFG.

T 52.4 Wed 17:15 H-HS XIII

LEGEND: The future of neutrinoless double-beta decay search with germanium detectors — •Anna Julia Zsigmond for the LEGEND-Collaboration — Max-Planck-Institut für Physik

The observation of neutrinoless double beta ($0\nu\beta\beta$) decay would establish both the violation of lepton number conservation and the Majorana nature of the neutrino. It will also constrain the neutrino mass hierarchy and scale in the light-neutrino exchange mechanism. The current experiments using ^{76}Ge for $0\nu\beta\beta$ decay search, the Majorana Demonstrator and Gerda, lead the field in both the ultra-low background and the energy resolution achieved. Building on their success, the LEGEND experiment will conduct an improved search with the goal of reaching a half-life sensitivity beyond 10^{28} years. In order to achieve this goal, the enriched Ge detector mass has to be increased up to tonne-scale and the backgrounds further reduced. LEGEND will pursue a phased approach with the first phase expected to start in 2021 with about 200 kg of ^{76}Ge-enriched detectors operating at LNGS of INFN in Italy. The plans and physics reach of LEGEND together with the various ongoing R&D activities will be presented.

T 52.5 Wed 17:30 H-HS XIII

Sensitivity of the DARWIN observatory to the neutrinoless double beta decay of 136Xe — •Fabian Kuger for the DARWIN-Collaboration — Albert-Ludwigs-Universität Freiburg, Deutschland

The DARWIN observatory is a proposed next-generation experiment to search for particle dark matter and other rare processes. It will operate 40t of natural xenon in a time projection chamber, thus containing about 3.6t of ^{136}Xe. This renders DARWIN well suited to search for the neutrinoless double beta decay of ^{136}Xe, with a science reach compatible to dedicated double beta decay experiments. We show that DARWIN will reach a half-life sensitivity limit of $T^{0\nu}_{1/2} = 2.4 \times 10^{27}$ yr assuming a rather conservative radio-purity and performance scenario. The impact of more progressive assumptions on the sensitivity limit is discussed. We conclude that after 10 years of operation DARWIN will cover the Majorana mass range corresponding to the inverted hierarchy.

T 52.6 Wed 17:45 H-HS XIII

Signal and background event topologies in the $0\nu\beta\beta$ decay search in DARWIN — •Andrii Terliuk for the DARWIN-Collaboration — Physikalisches Institut, Universität Heidelberg, INF 226, 69120 Heidelberg — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg

The DARWIN observatory is a future Dark Matter detector with 40 tons of liquid xenon in a sensitive volume of a dual-phase TPC. Natural xenon contains approximately 8.9% of ^{136}Xe isotope, which is currently considered as one of the possible candidates to undergo a neutrino-less double beta decay. The large mass, excellent radiopurity and good energy resolution makes DARWIN an ideal device to search for such a rare decay. In DARWIN, separation of signal from background relies on identification of events with single and multiple scatterings in the detector. This contribution discusses event topologies created by signal and background, as well as an impact of different $0\nu\beta\beta$ decay models on the signal selection efficiency.

T 52.7 Wed 18:00 H-HS XIII

Status and Prospects of the COBRA Experiment — •Juliane Volkmer for the COBRA-Collaboration — TU Dresden, Institut für Kern- und Teilchenphysik, Germany

As many Beyond-Standard-Model theories predict the existence of the neutrinoless double beta decay ($0\nu\beta\beta$), this lepton-flavor-violating nuclear reaction is one of today's most examined processes in fundamental physics. Its observation could help to solve important questions as for the neutrino's mass or whether it is a Majorana particle, and thus shed light on physics beyond the Standard Model.

In 2011 the COBRA demonstrator was built with the objective of investigating the practicability of using CdZnTe semiconductor crystals for the decay's investigation. The CdZnTe crystals contain nine isotopes capable of different $0\nu\beta\beta$ decay modes, can be operated at room temperature and are commercially available. Additionally, the versatile detector material offers the possibility of investigating physics besides the $0\nu\beta\beta$ decay, like a potential quenching of g_A in nuclear processes – by measuring the spectrum shape of the strongly forbidden ^{113}Cd β decay – and exotic $\beta^+\beta^+$ decay modes.

Last year the demonstrator setup of $4\times4\times4$ 1 cm^3 CdZnTe crystals was upgraded based on the knowledge gained from the many years of operation. With nine additional larger detector crystals, higher exposure rates as well as strongly reduced background levels can be achieved.

This talk shall give an overview of the status, plans and most recent experimental results of the COBRA collaboration.

T 52.8 Wed 18:15 H-HS XIII

Search for double beta decay to excited states with COBRA XDEM — •Yingjie Chu for the COBRA-Collaboration — TU Dresden, Institut für Kern- und Teilchenphysik, Germany

The COBRA experiment uses CdZnTe semiconductor detectors to search for the neutrinoless double beta decay with the "source=detector" method. Several isotopes of Cadmium, Zinc, and Tellurium, which are known candidates for different double beta decay modes, are contained in the detector material. A new experimental phase has started by upgrading the experiment to the COBRA extended demonstrator (XDEM). The novel detector configuration technology is benefcial for the determination of multiple energy depositions within the same detector and the coincidences analysis between different detectors. This is a key concept to search for the phase space suppressed excited state transitions of double beta decay, which are accompanied by the emission of characteristic gamma lines. This talk will give an overview of the COBRA XDEM detector approach as well as first insights on how to identify the expected signal in the detector array based on Monte-Carlo simulations.

T 52.9 Wed 18:30 H-HS XIII

Characterization of surface events of a p-type point contact germanium detector — •Frank Edzards for the LEGEND-Collaboration — Max-Planck-Institut für Physik, Föhringer Ring 6, 80805 München

LEGEND is a future ton-scale experimental program to search for neutrinoless double beta decay ($0\nu\beta\beta$) in the isotope ^{76}Ge using high-purity germanium detectors. Its observation would establish lepton number violation and provide information on the neutrino mass.

In LEGEND-200, various detector types will be deployed in liquid argon (LAr). Among them are p-type point contact (PPC) germanium detectors that are currently operated in the Majorana Demonstrator experiment. Due to their large passivated surface, PPC detectors are particularly susceptible to surface effects. Therefore, their surface event response with respect to alpha and beta radiation in LAr has to be studied in detail. This talk focuses on the results of surface characterization measurements of a PPC detector carried out in a vacuum cryostat test facility. It is demonstrated that the passivated surface can accumulate charges resulting in a radial degradation of the event energy.

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