T 8: Neutrino physics 2

Time: Monday 16:00–18:00 Location: Geb. 30.22: Gaede-HS

T 8.1 Mon 16:00 Geb. 30.22: Gaede-HS

LEGEND: Background-free hunt for the neutrinoless double-beta decay — •Patrick Krause for the LEGEND-Collaboration — Department of Physics, TUM School of Natural Sciences, Technische Universität München, 85748 Garching b. München

The discovery that neutrinos are Majorana fermions would have profound implications for particle physics and cosmology. The Majorana character of neutrinos would make neutrinoless double-beta ($0\nu\beta\beta$) decay, a matter-creating process without the balancing emission of antimatter, possible. The LEGEND Collaboration pursues a phased, ^{76}Ge-based double-beta decay experimental program. The first phase, LEGEND-200, deploys up to 200 kg of germanium detectors enriched in ^{76}Ge. A background index of $2 \cdot 10^{-4}$ counts/(keV kg yr) will be achieved. With that background index, when integrated over the exposure, less than one background event in the region around the expected peak position of the $0\nu\beta\beta$ decay will be accumulated. It constitutes a quasi-background-free operation of LEGEND-200, enabling a potential discovery of the $0\nu\beta\beta$ decay at a half-life of at least 10^{27} years. The second phase, LEGEND-1000, will deploy 1000 kg of enriched germanium and reach a discovery potential above 10^{28} years. This talk will portray the LEGEND project and its goals. Furthermore, first results from the currently ongoing data-taking period of LEGEND-200 are presented.

This research is supported by the DFG through the Excellence Cluster ORIGINS EXC 2094-390783311, the SFB1258, and by the BMBF Verbundprojekt 05A2023.

T 8.2 Mon 16:15 Geb. 30.22: Gaede-HS

Muon Veto of LEGEND-200 — •Gina Grünauer for the LEGEND-Collaboration — Physikalisches Institut, Eberhard Karls Universität Tübingen

The **L**arge **E**nriched **G**ermanium **E**xperiment for **N**eutrinoless $\beta\beta$ **D**ecay (LEGEND) is an experimental program searching for the neutrinoless double beta ($0\nu\beta\beta$) decay of ^{76}Ge. To look for such rare events and reach the aimed half-life sensitivity of more than 10^{28} years, every opportunity to reduce the background has to be taken. A Water-Cherenkov-Veto is used for this purpose for the current experimental phase LEGEND-200. It uses photomultiplier tubes (PMTs) as detectors in a water-tank faced with a reflective foil to increase the light yield inside the Veto. This contribution presents the working principle and data analysis of the Muon Veto of LEGEND-200.

T 8.3 Mon 16:30 Geb. 30.22: Gaede-HS

Column Density Determination for the KATRIN Neutrino Mass Measurement — •Christoph Köhler for the KATRIN-Collaboration — Technische Universität München

The KATRIN experiment aims to model-independently probe the effective electron anti-neutrino mass with a sensitivity of 0.2 eV (90 % CL) by investigating the endpoint region of the tritium beta decay spectrum. To achieve this goal the gas quantity of the windowless gaseous tritium source, characterized by the column density, has to be known with great accuracy.

In this talk we present the principle of measuring the column density with an angular resolved photoelectron source. Further, a method to ensure continuous monitoring of the column density during measurement campaigns of KATRIN is described. The influence of the recent hardware upgrade of the photoelectron source is discussed in light of the column density determination accuracy.

This work is supported by the Technical University of Munich, the Helmholtz Association and by the Ministry for Education and Research BMBF (grant numbers 05A23PMA, 05A23PX2, 05A23VK2, and 05A23WO6). This project has received funding from the European Research Council (ERC) under the European Union Horizon 2020 research and innovation programme (grant agreement No. 852845).

T 8.4 Mon 16:45 Geb. 30.22: Gaede-HS

Evolution of the KATRIN energy scale measured with 83mKr. — •Justus Beisenkötter and Matthias Böttcher for the KATRIN-Collaboration — Universität Münster

To study the energy scale of KATRIN, which is influenced by beamline workfunctions and plasma effects in the gaseous tritium source, 83mKr conversion electron lines are used. Gaseous 83mKr is inserted into the tritium source, which allows us to measure energy shifts and broadenings of the conversion lines that also affect the beta spectrum. This talk gives an overview of the time evolution of the line position of the 83mKr L3-32 and N23-32 lines, which were measured throughout the KATRIN operation. We also present the evolution of the radial dependent coupling of rear wall bias voltage to the line positions and the optimal value for chosen rear wall bias, which are monitored using 83mKr conversion electrons. This work is supported by the Helmholtz Association and by the Ministry for Education and Research BMBF (grant numbers 05A23PMA, 05A23PX2, 05A23VK2, and 05A23WO6)

T 8.5 Mon 17:00 Geb. 30.22: Gaede-HS

Absolute $^{83\mathrm{m}}$Kr transition energy determination using the Gaseous Krypton Source of the KATRIN experiment — •Benedikt Bieringer and Matthias Böttcher for the KATRIN-Collaboration — Institute for Nuclear Physics, University of Münster

The KATRIN experiment aims to determine the neutrino mass with a sensitivity better than 0.3 eV/c^2 at 90 % CL. An important cross check to verify the analysis is the comparison of the Q-value derived from the measured endpoint of the tritium beta spectrum to values from literature. This is achieved by calibration of the energy scale with conversion electrons from a gaseous $^{83\mathrm{m}}$Kr source. However, reaching the desired accuracy requires an unprecedented knowledge of the energy of $^{83\mathrm{m}}$Kr gamma transitions.

This talk presents first results on improving the knowledge on the transition energies through a measurement of conversion electron lines for all three $^{83\mathrm{m}}$Kr gamma transitions using a high-luminosity Gaseous Krypton Source. The measurement follows the recent, first direct measurement of the highest $^{83\mathrm{m}}$Kr gamma transition, performed with the Condensed Krypton Source of the KATRIN experiment.

This work is supported by the Helmholtz Association and by the Ministry for Education and Research BMBF (grant numbers 05A23PMA, 05A23PX2, 05A23VK2 and 05A23WO6).

T 8.6 Mon 17:15 Geb. 30.22: Gaede-HS

Non contact measurement and stabilization of ultra-high temperatures in a hydrogen atom source — •Maximilian Hüneborn and Sebastian Böser for the Project 8-Collaboration — Johannes Gutenberg-Universitat Mainz, Mainz, Germany

The Project 8 experiment aims to achieve a 40 meV neutrino mass measurement through the use of atomic tritium, to eliminate rotational and vibrational modes found in molecules, combined with measuring tritium beta decay electrons using cyclotron radiation emission spectroscopy. As a possible starting point, at the Mainz atomic test stand we are currently developing a thermal hydrogen cracker. One major aspect is the on-demand precise temperature control of the filament. This presentation compares the use of a thermocouple and a pyrometer for this purpose. Challenges, including source degradation at temperatures above 2000 K, led to the implementation of a PID loop for accurate temperature maintenance. This advancement not only addresses the issue of source degradation but also enhances the capabilities of the setup, enabling other measurements within the Mainz atomic setup to benefit from the newly acquired stability, precision, and reproducibility.

T 8.7 Mon 17:30 Geb. 30.22: Gaede-HS

Precise Temperature Characterization of Project 8's Atomic Hydrogen Source — •Brunilda Mucogllava and Martin Fertl for the Project 8-Collaboration — Johannes Gutenberg Universität Mainz

In order to achieve a neutrino mass sensitivity of 40 meV, the Project 8 experiment aims to use the Cyclotron Radiation Emission Spectroscopy technique to analyze the atomic tritium beta decay spectrum. Due to the radioactive nature of tritium, initial measurements have been carried out using a Hydrogen Atom Beam Source (HABS) at the Mainz atomic test stand. Molecular hydrogen is introduced into the HABS setup, flowing through a 1 mm diameter tungsten capillary which is radiatively heated to ~2300 K by a tungsten filament. This causes the molecules to thermally dissociate in a temperature-dependent way. Accurate capillary temperature measurements with low uncertainty at these high temperatures are required to characterize the source accurately and understand the dissociation efficiency from molecular to atomic hydrogen. This talk will present infrared spectroscopy measurement results of the capillary, addressing challenges arising from uncertain emissivity values, ultra-high vacuum conditions, and device-dependent absolute calibration.

T 8.8 Mon 17:45 Geb. 30.22: Gaede-HS

Calorimetric measurement of the ^{159}Dy electron capture spectrum — •Peter Wiedemann[1], Arnulf Barth[1], Christian Enss[1], Andreas Fleischmann[1], Karl Johnston[2], Ulli Köster[3], and Loredana Gastaldo[1] — [1]Kirchhoff Institute for Physics, Heidelberg, Germany — [2]ISOLDE, CERN, Geneva, Switzerland — [3]Institut Laue-Langevin, Grenoble, France

The neutrino mass can be determined by analyzing the endpoint of electron capture (EC) spectra. Decay processes with a low Q-value provide high statistics near the endpoint and are therefore especially suitable. While ^{159}Dy decays with a Q-value of about 365 keV to the ground state of ^{159}Tb, a decay branch that populates the excited $5/2^-$ state of ^{159}Tb, has a low Q-value of 1.18(19) keV. Therefore it was suggested for the determination of the electron neutrino mass.

Our goal is to measure the ^{159}Dy EC spectrum for the first time and aim for an energy resolution of about 10 eV. We will use metallic magnetic calorimeters (MMC) with ^{159}Dy ion-implanted at ISOLDE (CERN) into two electroplated layers of gold absorber. Analyzing this spectrum will allow for a better understanding of the decay of ^{159}Dy. Even if the decay to the excited nuclear state cannot be discriminated, from the precise measurement of the total EC spectrum, we can infer the contribution of the decay to the excited state. We present the MMC-detectors used for this experiment, with a focus on the properties of the absorber that contains ^{159}Dy. Finally, we report on the status of the experiment.