T 55: Neutrinophysik VII

Zeit: Mittwoch 16:30–19:00 Raum: Z6 - HS 0.001

T 55.1 Mi 16:30 Z6 - HS 0.001

Investigating the transmission function of KATRIN using gaseous ^{83m}Krypton — •Lutz Schimpf for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT), ETP, Postfach 3640, 76021 Karlsruhe

The **Ka**rlsruhe **Tri**tium **N**eutrino experiment (KATRIN) aims to measure $m(\nu_e)$ with a sensitivity of 200 meV at 90 % confidence level. To determine the neutrino mass an integrated spectrum of the electron energy close to the endpoint is measured and a fit to the data containing the neutrino mass as a free parameter is performed. The measured beta spectrum is affected by various systematics, with the transmission function properties of the MAC-E filter spectrometer playing a major role. Although the transmission function of a MAC-E filter can be analytically calculated its shape is broadened and distorted by two main systematics. One is the short-term high voltage stability of the retardation potential in the main spectrometer, which is in the millivolts range. The other main systematic is the emission of synchrotron radiation while the electrons are magnetically guided from their origin in the tritium source towards the spectrometer and detector section. The usage of ^{83m}Krypton as source gas allows to study the above described transmission function properties, since the discrete energy spectrum of krypton provides monoenergetic electrons with line widths in the range of 1 eV and below. Both the influences on the transmission function as well as its influence on the measured linewidth of the krypton spectrum will be presented. This work has been supported by BMBF (05A17VK2), KSETA and the Helmholtz Association (VH-NG-1055).

T 55.2 Mi 16:45 Z6 - HS 0.001

Commissioning measurements of the CKrS with KATRIN — •Alexander Fulst for the KATRIN-Collaboration — Institut für Kernphysik, WWU Münster

The **KA**rlsruhe **TRI**tium **N**eutrino Experiment (KATRIN) is a model-independent measurement of the neutrino mass from the kinematics of tritium β-decay, aiming for a sensitivity of 0.2 eV/c^2 (90% C.L.). It uses an electrostatic spectrometer working in MAC-E-filter mode to analyze energies of beta-electrons generated in a windowless gaseous tritium source (WGTS). The experiment uses several sources for absolute energy calibration, monitoring and precise determination of the transmission function of the spectrometer. One of them is the ***Condensed Krypton Source*** (*CKrS*) developed in Münster which utilizes nearly monoenergetic conversion electrons from an adsorbed ^{83m}Kr layer on a graphite (HOPG) substrate. The substrate with the frozen ^{83m}Kr layer can be moved mechanically over the complete flux tube area at its position in the KATRIN beamline and therefore allows for per-pixel calibration of the KATRIN focal plane detector (FPD). The cleanliness of the substrate and the quality of the frozen radioactive films are crucial for the stability and reproducibility of the conversion electron spectrum and both are monitored by means of laser ellipsometry.

The source was recently installed at the KATRIN Cryogenic Pumping Section (CPS) and was successfully used in the KATRIN commissioning measurements in the summer 2017. Measurements regarding characterization of the source and spectroscopy with the CKrS are presented. This work is supported under BMBF contract 05A17PM3.

T 55.3 Mi 17:00 Z6 - HS 0.001

Pixel-resolved transmission and alignment analysis in KATRIN using ^{83m}Krypton — •Wonqook Choi for the KATRIN-Collaboration — Institut für Experimentelle Teilchenphysik, Karlsruher Institut für Technologie (KIT), Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen

The goal of the **KA**rlsruhe **TRI**tium **N**eutrino (KATRIN) experiment is the determination of the electron neutrino mass with a sensitivity of $m_\nu = 0.2\,\mathrm{eV/c^2}$ (90% C.L.) by measuring an integrated energy spectrum of electrons from tritium β-decay. The experiment uses a MAC-E filter where electrons that have sufficient kinetic energy pass an electrostatic barrier and arrive at the focal plane detector (FPD) where they are counted. An essential characteristic of the experiment concerns the transmission properties of the spectrometer, which are affected by inhomogeneities in the electrostatic and magnetic fields. These can be modeled by simulations which require precise knowledge of the FPD and beamline alignment. A major milestone during the preparation of KATRIN for tritium measurements was the krypton data-taking campaign in summer 2017. During this period we investigated electrons from gaseous and condensed ^{83m}Kr sources. Since ^{83m}Kr features several sharp conversion lines, it is ideally suited for comissioning measurements. The talk reports analysis results of ^{83m}Kr conversion electron measurements and demonstrates the investigation of transmission and alignment properties of the KATRIN beamline. This project is supported by BMBF (05A17VK2), the Helmholtz Young Investigators Group (YIG) VH-NG-1055 and the Helmholtz Association.

T 55.4 Mi 17:15 Z6 - HS 0.001

Forward Beam Monitor data from the KATRIN krypton measurement phase — •Stephanie Hickford for the KATRIN-Collaboration — Bergische Universität Wuppertal

The KATRIN collaboration aims to measure the neutrino mass with a sensitivity of 200 meV. This will be done by observing the β-electron spectrum from the decay of tritium. The tritium source properties need to be stable, and known to a high precision, in order to accurately measure the neutrino mass. For this reason the source will undergo extensive measurements from several monitoring systems. The *Forward Beam Monitor* (FBM) is one such monitoring system.

A KATRIN krypton measurement phase took place during July 2017. The gaseous ^{83m}Kr part of this measurement phase involved the entire KATRIN beamline, including the source section and the FBM. Initial krypton spectra were measured using the FBM pin diode detectors, the magnetic fluxtube was mapped, and early temperature impacts on the system operation were observed. These results, and related progress since the krypton measurement phase, are presented in this talk.

T 55.5 Mi 17:30 Z6 - HS 0.001

Analysis of the first Krypton-83m KATRIN Data — •Lisa Schlüter for the KATRIN-Collaboration — Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), Föhringer Ring 6, 80805 München

The KArlsruhe TRItium Neutrino (KATRIN) experiment is designed to determine the effective mass of the electron-antineutrino with an sensitivity of 200 meV/c^2 (90% C.L.) in a direct and model-independent way. The neutrino mass can be inferred from the shape of the endpoint region of the tritium β-decay spectrum, which is measured using a MAC-E filter and a Windowless Gaseous Tritium Source (WGTS). For calibration purposes and the investigation of systematic effects, in July 2017 the WGTS was operated in the Krypton mode, in which well characterized gaseous ^{83m}Kr is filled in the WGTS. ^{83m}Kr emits electrons via inner conversion in the few tens of keV range and with a natural line width in the eV range. This talk presents an analysis of the KATRIN Krypton run, including systematic effects based on the covariance matrix approach, using the Samak simulation analysis package.

T 55.6 Mi 17:45 Z6 - HS 0.001

High voltage monitoring and calibration at the KATRIN experiment — •Caroline Rodenbeck and KATRIN Collaboration for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT), ETP, Postfach 3640, 76021 Karlsruhe; Institut für Kernphysik, Westfälische Wilhelms-Universität Münster

The **Ka**rlsruhe **Tri**tium **N**eutrino experiment (KATRIN) aims to measure the rest mass of the electron-antineutrinos with a sensitivity of 0.2 eV/c^2 (90% C.L.). For this the tritium beta spectrum is measured in the endpoint region with an integrating spectrometer using the MAC-E-filter principle. To reach this high sensitivity the voltage which is used to create the electrostatic energy barrier for the beta electrons, needs to be precisely set and known. The KATRIN high voltage system meets these requirements with high precision power supplies and high precision monitoring using purpose-built high voltage dividers.

For reliable high voltage monitoring, calibrations need to be performed on a regular basis. The reliability of the high voltage monitoring system has been thoroughly tested and verified in the last years e.g. during commissioning measurements with conversion electrons of Krypton-83m. This talk will present the performance of the high voltage system over the last years and especially with regard to the requirements needed for the neutrino mass measurements.

This work was supported by BMBF (05A17VK2) and the HGF.

T 55.7 Mi 18:00 Z6 - HS 0.001

Background measurements at KATRIN — •Anna Pollithy for the KATRIN-Collaboration — Technische Universität München (TUM), Fakultät für Physik, 85748 Garching

The **Ka**rlsruhe **Tri**tium **N**eutrino (KATRIN) experiment is designed to determine the effective electron anti-neutrino mass with a sensitivity of m_ν=0.2 eV/c^2 (90 % C.L.) in a model-independent way by investigating the energy spectrum of tritium beta decay electrons near the endpoint. For the full neutrino mass sensitivity, a background level of 10^{-2} cps is required. One way to characterize the residual background in KATRIN is by determining its energy spectrum. This background information enables to verify the current "Rydberg" background hypothesis which predicts low energy electrons originating from highly excited atoms as a potential background source. In this contribution, two dedicated measurement methods to investigate the "Rydberg" background as well as first results will be presented. This work is supported by the SFB1258 and the Max Planck Society.

T 55.8 Mi 18:15 Z6 - HS 0.001

Plasma Investigations for the KATRIN experiment — •Jonas Kellerer for the KATRIN-Collaboration — Karlsruhe Institut of Technology (KIT), ETP, Postfach 3640, 76021 Karlsruhe

The Karlsruhe Tritium Neutrino (KATRIN) experiment aims to determine the effective neutrino mass with a sensitivity of $m_\nu = 0.2$ eV/c^2 (90% C.L.) in a direct approach using the β-decay of molecular tritium and a MAC-E filter spectrometer. The neutrino mass is extracted from a fit of modelled beta decay spectra to the measured electron spectrum. Hence, a complete investigation of the processes influencing the electron energy is necessary. The potential energy of the emitted electrons is set by the electrostatic potential at the position of β-decay in the windowless gaseous tritium source (WGTS). The potential distribution in the WGTS is determined by a cold low-density plasma that forms inside the strong magnetic field of the WGTS through β-decay and secondary ionizations. A comprehensive fluid plasma model has been developed to investigate the properties of the plasma. The model includes creation, annihilation and motion of electrons and ions in a steady flow of neutral gas and confined by a longitudinal magnetic field. Diverse creation and annihilation rates were studied and implications on the systematics of the neutrino mass measurement were deduced. Supported by BMBF (05A17VK2), KSETA and the Helmholtz Association.

T 55.9 Mi 18:30 Z6 - HS 0.001

Characterization of the KATRIN Pre-Spectrometer for operational mode — •Johannes Heizmann for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT), ETP, Postfach 3640, 76021 Karlsruhe

The **Ka**rlsruhe **Tri**tium **N**eutrino (KATRIN) experiment has the ambitious goal to determine the effective neutrino mass with a sensitivity of $m_\nu = 0.2\,\mathrm{eV}/c^2$ at 90% C.L. using electrons originating from tritium β-decay. These electrons are guided magnetically from the source section along the beam line of the transport and pumping section to the spectrometer and detector section (SDS). The SDS, consisting of the pre- and main spectrometer, and a silicon detector, is responsible for filtering and analyzing the energy of the β-electrons utilizing the MAC-E filter principle. Positive ions created by the large flux of β-electrons along the KATRIN beamline can enter the main spectrometer where they produce background via the ionization of residual gas molecules. In order to minimize this background, the pre-spectrometer will electrostatically filter electrons with energies lower than 18.3 keV and remove positive ions from the flux tube. At the same time it will guide β-electrons adiabatically to the main spectrometer. Moreover, the pre-spectrometer can be configured to detect tritium decays.

This talk will present results of recent pre-spectrometer background measurements in preparation of the upcoming tritium operation of KATRIN. Furthermore results of simulations to define the optimum electro-magnetic configuration of the pre-spectrometer for regular operation will be presented.

T 55.10 Mi 18:45 Z6 - HS 0.001

Bestimmung und Modellierung der Transmissionseigenschaften des KATRIN-Hauptspektrometers — •Jan David Behrens für die KATRIN-Kollaboration — Institut für Experimentelle Teilchenphysik, Karlsruher Institut für Technologie (KIT), Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen

Das **KA**rlsruhe **TRI**tium **N**eutrino-Experiment soll die Masse des Elektron-Antineutrinos mit einer Sensitivität von 0.2 eV/c^2 (90% C.L.) bestimmen. Die Vermessung der Form des Tritium-β-Spektrums im Endpunktbereich ermöglicht eine modellunabhängige Bestimmung der absoluten Neutrinomassenskala.

Das Experiment verwendet eine gasförmige Tritiumquelle, von der die Zerfallselektronen magnetisch zum Detektor geführt werden. Die Energieanalyse der Elektronen erfolgt in einem elektrostatischen Spektrometer, das nach dem Prinzip des MAC-E-Filters arbeitet. Eine präzise Beschreibung des gemessenen integralen Energiespektrums erfordert genaue Kenntnis der elektromagnetischen Felder im Spektrometer. Hierzu werden verschiedene Methoden kombiniert: detaillierte Feldberechnungen mit Hilfe des Software-Frameworks KASPER, direkte Bestimmung der Transmissionseigenschaften durch Kalibrationsquellen sowie kontinuierliche Überwachung durch magnetische Feldsensoren.

Der Vortrag beschreibt die Bestimmung der Transmissionseigenschaften und die Modellierung der elektromagnetischen Felder am Hauptspektrometer. Dieses Projekt wird gefördert durch das BMBF (Projekt 05A17VK2), die Helmholtz-Hochschul-Nachwuchsgruppe (YIG) VH-NG-1055 und die Helmholtz-Gemeinschaft.