T 92: Neutrinomasse IV

Zeit: Donnerstag 16:45–19:05 Raum: VMP5 SR 0079

Gruppenbericht T 92.1 Do 16:45 VMP5 SR 0079

Status of the KATRIN experiment — •Florian Fraenkle for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT), Institut für Kernphysik (IKP)

The KArlsruhe TRItium Neutrino (KATRIN) experiment is a large-scale experiment for the model independent determination of the mass of electron anti-neutrinos with a sensitivity of 200 meV/c^2 (90% C.L.). It investigates the kinematics of electrons from tritium β-decay close to the endpoint of the energy spectrum with a high-resolution electrostatic spectrometer ($\Delta E = 0.93$ at 18.6 keV).

The KATRIN measurement setup consists of a high luminosity windowless gaseous tritium source (WGTS), a magnetic electron transport system with differential and cryogenic pumping for tritium retention, and an electro-static spectrometer section (pre-spectrometer and main spectrometer) for energy analysis, followed by a segmented detector system for counting transmitted β-electrons.

In order to investigate the backgrounds and transmission characteristics of the main spectrometer, a dedicated series of commissioning measurements was performed in 2015. The talk will present the current status of the experiment and give an overview on the results of the recent commissioning measurements.

This work has been supported by the German BMBF (05A14VK2).

T 92.2 Do 17:05 VMP5 SR 0079

Performance of the KATRIN spectrometer and detector section — •Thomas Thümmler for the KATRIN-Collaboration — Karlsruher Institute of Technology (KIT), Institute of Nuclear Physics (IKP), Karlsruhe, Germany

Neutrino properties and especially the determination of the neutrino mass play an important role at the intersections of cosmology, particle physics and astroparticle physics. The KArlsruhe TRItium Neutrino experiment (KATRIN) investigates single beta decay electrons close to their kinematic endpoint in order to determine the neutrino mass by a model-independent method.

Applying an ultra-luminous molecular windowless gaseous tritium source and an integrating high-resolution spectrometer of MAC-E filter type, KATRIN allows beta spectroscopy close to the kinematic endpoint with unprecedented precision and will reach a sensitivity of about 200 meV/c^2 (90% C.L.) on the neutrino mass.

The spectrometer and detector section (SDS) of KATRIN has successfully passed three consecutive commissioning phases to confirm the spectroscopic specifications, the long-term operation and stability, as well as the background level. Currently the SDS is being prepared for final commissioning, integration with the source and transport system, and the transition to neutrino mass measurement mode.

This talk will summarize the performance of the spectrometer and detector section, followed by an overview of the final steps towards complete KATRIN commissioning. Supported and funded by the Helmholtz Association, BMBF grant 05A14VK2, and the US DOE.

T 92.3 Do 17:20 VMP5 SR 0079

Near-time modeling of the gas dynamics in the KATRIN tritium source using extensive sensor data — •Florian Heizmann for the KATRIN-Collaboration — KIT Campus Nord, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen

The KArlsruhe TRItium Neutrino (KATRIN) experiment - currently under construction at KIT - will determine the neutrino mass with an unprecedented sensitivity of 200 meV at 90 % C.L. by high-precision tritium β-decay spectroscopy. In order to reach this new level of neutrino mass sensitivity it is very important to understand the tritium source properties and the related systematic measurement uncertainties. Since the KATRIN tritium source features several 100 sensors to monitor its operational parameters, the implementation of the sensors into the source modeling is a major task. This talk focuses on the extension of the gasdynamics model to incorporate sensor data from pressure and temperature sensors in a near-time model. Furthermore, the challenge of determining the magnetic field inside the source beam-tube by stray field measurements is addressed.

This work is supported by BMBF under grant number 05A14VK2 and by the Helmholtz-Association.

T 92.4 Do 17:35 VMP5 SR 0079

The KATRIN Forward Beam Monitor Spectral Analysis — •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. This detector is being constructed at the University of Wuppertal and will be transported on-site to the KATRIN experiment in Karlsruhe within the first half of 2016. The working principle of the FBM, in particular the strategy for continuous monitoring of the column density of the tritium source, will be described. The expected β-electron spectra over varying source column densities has been simulated. The observation of such spectra by the FBM, and the statisical criteria for data quality control for the continuous monitoring the tritium source, will be shown.

T 92.5 Do 17:50 VMP5 SR 0079

Status of the KATRIN Focal-Plane Detector — •Agnes Seher for the KATRIN-Collaboration — Karlsruher Institute of Technology (KIT) — Institut für Kernphysik (IKP)

The KArlsruhe TRItium Neutrino (KATRIN) experiment aims to determine the mass of the electron anti-neutrino with a sensitivity of 200 meV/c^2 by measuring the kinematics of tritium β-electrons close to the enpoint of the energy spectrum. The energy analysis of the experiment is performed with a high-resolution electrostatic spectrometer of MAC-E filter type which acts as an integranting high pass filter. Transmitted electrons are counted with a segmented silicon detector system located at the downstream end of the experiment. The detector system consists of two super-conducting solenoids ($B_{max} = 6$T), a post-acceleration electrode, a detector wafer with silicon pixel-diodes, readout electronics as well as a calibration and monitoring devices. This talk will give an overview of the detector system and its current status as well as key performance parameters.

This work has been supported by the U.S. Department of Energy, the Helmholtz Association, and the German BMBF (05A14VK2).

T 92.6 Do 18:05 VMP5 SR 0079

The particle tracking package Kassiopeia — •Stefan Groh for the KATRIN-Collaboration — Karlsruhe Institute of Technology

The Kassiopeia particle tracking framework is an object-oriented software package utilizing modern C++ techniques, written originally to meet the needs of the Katrin collaboration. Kassiopeia's target consists of simulating particle trajectories governed by arbitrarily complex differential equations of motion, continuous physics processes that may in part be modeled as terms perturbing that equation of motion, stochastic processes that occur in flight such as bulk scattering and decay, and potentially stochastic surface processes occurring at interfaces, including transmission and reflection effects. This entire set of computations takes place against the backdrop of a fully-featured geometry package which serves a variety of roles, including initialization of electromagnetic field simulations, gas flow simulations, and the support of state-dependent algorithm-swapping and behavioral changes. Kassiopeia has been well validated and widely used within the Katrin collaboration, playing a primary role in many theses and refereed publications. This talk will give an overview of the latest version of the simulation package. Supported by the German BMBF (05A14VK2).

T 92.7 Do 18:20 VMP5 SR 0079

KATRIN Sensitivity on Right-Handed Currents with eV Scale Sterile Neutrinos — •Nicholas Steinbrink[1,2], Steen Hannestad[2], Kathrin Valerius[3], and Christian Weinheimer[1] — [1]WWU Münster, Institute for Nuclear Physics — [2]Aarhus University, Department of Physics and Astronomy, Denmark — [3]KIT Karlsruhe, Institute for Nuclear Physics

The KATRIN experiment aims to determine the absolute neutrino mass by measuring the endpoint of the Tritium beta spectrum. As a large-scale experiment with a sharp energy resolution, high source luminosity and low background it may also be capable of testing certain theories of neutrino interactions beyond the standard model.

As an example for such an interaction, right-handed currents are introduced in some theories which contain a hidden left-right-symmetry. They have basically the same properties as standard left-handed weak currents but are strongly suppressed. Interference between left- and right-handed currents leads to slightly modified kinematics, thus allowing to boost or weaken certain regions near the endpoint of the beta spectrum. The effect would be even more pronounced in case of the existence of a fourth sterile neutrino since it is proportional to the mass of the neutrino final state. In the talk, that is discussed for the case of a sterile neutrino with a mass of some eV. The qualitative effects on the shape of the spectrum are shown as well as results of sensitivity simulations are presented.

This work is partly funded by BMBF under contract no. 05A11PM2, by DFG RTG 2149 and by the IP@WWU program.

T 92.8 Do 18:35 VMP5 SR 0079

Simulation of Background by Rydberg states in the KATRIN Mainspectrometer — •Nikolaus Trost for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT), Institut für Kernphysik (IKP)

The KArlsruhe TRItium Neutrino (KATRIN) experiment is a large-scale experiment for the model independent determination of the mass of electron anti-neutrinos with a sensitivity of 200 meV/c^2. It investigates the kinematics of electrons from tritium β-decay close to the endpoint of the energy spectrum with a highresolution electrostatic spectrometer (ΔE = 0.93 at 18.6 keV). Due to the low signal rate near the endpoint a low background level is of very high importance. Rydbgerg atoms excited and desorbed from the spectrometer surface can penetrate in the sensitive fluxtube uninfluenced by fields and be ionised by thermal radiation. The talk will present detailed simulation and analysis of this particular background process. This work has been suported by the German BMBF (05A14VK2).

T 92.9 Do 18:50 VMP5 SR 0079

Optimization of metallic magnetic calorimeters with embedded ^{163}Ho — •Ch. Fischer[1], H. Dorrer[2], Ch. E. Düllmann[2], K. Eberhardt[2], Ch. Enss[1], A. Fleischmann[1], L. Gastaldo[1], C. Hassel[1], D. Hengstler[1], S. Hähnle[1], K. Johnston[3], S. Kempf[1], T. Kieck[2], M. Krantz[1], U. Köster[4], F. Schneider[2], A. Türler[5], M. Wegner[1], and K. Wendt[2] — [1]Kirchhoff-Institut für Physik, Heidelberg — [2]Johannes Gutenberg-Universität, Mainz — [3]Physics Department CERN, Geneva — [4]Institut Laue-Langevin, Grenoble — [5]Laboratory of Radiochemistry and Environmental Chemistry, Paul Scherrer Institut, Villigen

The Electron Capture in ^{163}Ho (ECHo) collaboration plans to reach sub-eV sensitivity on the electron neutrino mass by the analysis of high statistics of ^{163}Ho electron capture spectra. Large arrays of metallic magnetic calorimeters (MMCs) with enclosed ^{163}Ho read out using microwave SQUID multiplexing will be used for the measurement of the spectrum. With first prototypes of MMCs having the ^{163}Ho source ion-implanted in the absorbers, operated at 25 mK, an energy resolution ΔE_{FWHM} = 7.6 eV and a signal rise time τ = 130 ns have been achieved, paving the way to the first stage of the experiment (ECHo 1k). We present the optimization of MMCs and of the methods to embed the high purity ^{163}Ho source in detector absorbers. In particular we discuss how to define the optimal activity per pixel considering the limits coming from the allowed unresolved pileup fraction and from the additional contribution of detector heat capacity related to the magnetic moments of ^{163}Ho.