HK 26: Fundamental Symmetries

Zeit: Dienstag 16:30–18:30 Raum: S1/01 A02

Gruppenbericht HK 26.1 Di 16:30 S1/01 A02

The *a*SPECT experiment - an overview and latest results — •Alexander Wunderle for the aSPECT-Collaboration — Johannes Gutenberg-Universität Mainz

The *a*SPECT retardation spectrometer measures the $\beta - \nu$ angular correlation coefficient a in free neutron β-decay. This measurement can be used to determine the ratio $\frac{g_A}{g_V}$ of the weak coupling constants, as well as to search for physics beyond the Standard Model.

In spring/summer 2013 *a*SPECT had a successful beam time at the Institut Laue-Langevin. The goal of this beam time is to improve the current uncertainty of a from $\frac{\Delta a}{a} \sim 5\%$ to about 1%. The data analysis is in its final stage and will be finished soon. In order to achieve an uncertainty of 1%, the systematics of *a*SPECT have to be understood accordingly. This understanding is obtained from systematic tests and measurements of a with different parameter settings for the spectrometer during the beam time. Additionally, offline measurements have been performed to determine the effect on the systematics, e.g. work-function fluctuations of the electrodes, the magnetic field ratio of the spectrometer and detailed tests of the detector electronics. These measurements are used as input for sophisticated simulations of the spectrometer to understand and reduce the systematic uncertainties further.

In this talk we will present an overview of *a*SPECT and its measuring principle. The beam time 2013 will be presented in detail, including the current status of the data analysis and preliminary results for systematic effects and their uncertainties.

HK 26.2 Di 17:00 S1/01 A02

The neutron lifetime experiment τSPECT — •Marcus Beck[1,2], Klaus Eberhardt[1,2], Christopher Geppert[1], Jan Haack[1], Werner Heil[1], Jan Kahlenberg[1], Jan Karch[1], Sergey Karpuk[1], Fabian Kories[1], Kim Ross[1], Christian Siemensen[1], Yuri Sobolev[1], and Norbert Trautmann[1] — [1]Johannes Gutenberg-Universität Mainz — [2]Helmholtz-Institut Mainz

The decay of the free neutron into a proton, electron and antineutrino is the prototype of semi-leptonic weak decays and plays a key role in particle physics and astrophysics.

The most precise measurements of the neutron lifetime to date use ultra-cold neutrons (UCN) stored in material vessels. Their accuracy is limited by systematic errors, mainly caused by anomalous losses of UCN during storage at the vessel walls. With the magnetic storage of neutrons these systematic limitations can be avoided and an accuracy of 0.1-0.3 s for the lifetime of the neutron can be reached.

The neutron lifetime experiment τSPECT has been set up a the research reactor TRIGA Mainz. τSPECT uses a combination of magnetic multipole fields for radial storage and the superconducting aSPECT magnet for longitudinal storage of UCN. In this presentation, the status of τSPECT and the results of first commissioning measurements will be presented.

HK 26.3 Di 17:15 S1/01 A02

Measurement of the Beta Asymmetry in Neutron Beta Decay with PERKEO III — •Heiko Saul[1], Hartmut Abele[1], Dirk Dubbers[2], Bastian Märkisch[3], Holger Mest[2], Alexandr Pethukov[4], Christoph Roick[3], Torsten Soldner[4], Xiangzun Wang[1], and Dominik Werder[2] — [1]Atominstitut, TU Wien — [2]Physikalisches Institut, Universität Heidelberg — [3]Physik Department, TU München — [4]Institut Laue-Langevin, Grenoble

Neutron beta decay is the simplest semileptonic weak decay and described accurately by the standard model using the first CKM-matrix element, Vud, and the ratio of vector and axial vector couplings, λ, as parameters. Kinematic correlation coefficients, spectra and the neutron lifetime are accessible experimantally, providing an excellent toolkit for investigating the structure of weak interaction.

Measuring the beta asymmetry A is the most precise way of determining λ, which is an important standard model parameter and necessary for the determanitaion of Vud from neutron beta decay. Moreover a precise measurement of λ allows to derive limits on non-standard-model couplings by combining with measurements of other observables.

In this talk we present the neutron decay spectrometer Perkeo III and results of the currently most precise measurement of the beta asymmetry. This measurement was carried out at the PF1B cold neutron beam line at the Institut Laue-Langevin.

HK 26.4 Di 17:30 S1/01 A02

Measurement of the Proton Asymmetry with PERKEO III - First Results — •Lukas Raffelt[1,2], Christoph Roick[1], Michael Klopf[3], Heiko Saul[3,5], Wilfried Mach[3], Daniel Moser[3,4], Hartmut Abele[3], Gertrud Konrad[3,6], Bastian Märkisch[1], Ulrich Schmidt[2], and Torsten Soldner[4] — [1]Technische Universität München, Garching — [2]Physikalisches Institut, Heidelberg — [3]Atominstitut, Wien — [4]Institut Laue-Langevin, Grenoble, Frankreich — [5]FRM-II, Garching — [6]SMI, ÖAW, Wien

Precision measurements of angular correlation coefficients in neutron beta decay allow tests of the Standard Model and a determination of the ratio of coupling constants $\lambda = g_A/g_V$ of the weak interaction.

In our last beamtime in 2014/15 we measured the proton asymmetry C with the instrument PERKEO III at the ILL (Grenoble). This will provide a crosscheck of other measurements of several neutron decay correlation coefficients and might be sensitive to contributions of scalar and tensor interactions. Currently the only precision measurement of the proton asymmetry has been performed in 2008 with PERKEO II.

The new spectrometer with an improved detector concept and operation with a pulsed beam allows for an in depth analysis of systematic effects. Electrons and protons from the decay were measured in a combined detector. The protons are converted to secondary electrons using thin foils at high voltage.

This talk will present first results of the ongoing data analysis with focus on the systematic effects of the proton detection.

HK 26.5 Di 17:45 S1/01 A02

Status of the PERC experiment on neutron beta decay — •Bastian Märkisch for the PERC-Collaboration — Physik-Department, Technische Universität München

Neutron beta decay is an excellent system to study the charged weak interaction experimentally. The decay is precisely described by theory and unencumbered by nuclear structure effects. Observables are numerous correlation coefficients, spectra and the neutron lifetime. Most importantly, precision measurements in neutron beta decay are used to investigate the structure of the weak interaction and to derive the CKM matrix element Vud.

In this talk we will present the status of the new instrument PERC (Proton Electron Radiation Channel), which is currently under construction at the FRM II, Garching, by an international collaboration. PERC is designed to improve measurements of several correlation coefficients in neutron decay by an order of magnitude.

HK 26.6 Di 18:00 S1/01 A02

Characterisation of work function fluctuations for high-precision experiments — •Jan Kahlenberg[1], Martin Babutzka[2], Marcus Beck[1,3], Edward Bickmann[1], Werner Heil[1], Ernst W. Otten[1], Christian Schmidt[1], Kerstin Schoenung[2], and Alexander Wunderle[1] — [1]Johannes Gutenberg-Universität Mainz — [2]Karlsruher Institut für Technologie — [3]Helmholtz-Institut Mainz

For a wide range of high-precision experiments in physics, well-defined electric potentials for achieving high measurement accuracies are required. An accurate determination of the electric potential is crucial for the measurement of the neutrino mass (KATRIN) as well as the measurement of the $e^- - \bar{\nu}_e$ correlation coefficient a in free neutron decay (*a*SPECT). Work function fluctuations on the electrodes lead to uncertainties in the distribution of the electric potential.

For *a*SPECT, the electric potential has to be known at an accuracy of 10 mV. However, due to the patch effect of gold, work function fluctuations of several 100 meV can occur. Therefore, the work function distributions of the gold-plated electrodes have been measured using a Kelvin probe. Furthermore, the change of work function distributions over time as well as the influence of relative humidity on the work function measurement have been investigated.

HK 26.7 Di 18:15 S1/01 A02

Extraction of moments of net-particle event-by-event fluctuations in the CBM experiment — •Volodymyr Vovchenko[1,2,3] and Ivan Kisel[1,2] for the CBM-Collaboration — [1]Frankfurt Insti-

tute for Advanced Studies, Frankfurt am Main, Germany — [2]Goethe University, Frankfurt am Main, Germany — [3]Taras Shevchenko University, Kyiv, Ukraine

The future CBM experiment at FAIR will employ high intensity beams and large acceptance detectors in order to study the properties of the strongly interacting matter produced in heavy-ion collisions at high baryon densities. The search for the conjectured critical point of QCD is one the important tasks. It is predicted from statistical physics that higher moments of event-by-event fluctuations are very sensitive to the proximity of the critical point. This argument is explicitly demonstrated with the van der Waals equation of state. Thus, it was suggested that higher moments of fluctuations of conserved charges can be used as probes for the critical behavior.

The statistical convergence of cumulants of different order is explored. The extraction of scaled variance, skewness, and kurtosis of proton distribution from simulated UrQMD events is performed and the efficiency correction described by binomial distribution is accounted for. The validity of this correction is tested with different modelings of the CBM detector response: from binomial distribution with fluctuating event-by-event efficiency to a full-scale GEANT simulation. The obtained results indicate that a more elaborate efficiency correction is needed in order to accurately reconstruct moments of higher orders.