HK 11: Fundamental Symmetries I

Zeit: Montag 16:30–18:15 Raum: HZO 100

Gruppenbericht HK 11.1 Mo 16:30 HZO 100

Laser spectroscopy of highly charged bismuth ions: The hyperfine-puzzle of strong-field QED — •Johannes Ullmann — Institut für Kernphysik, Universität Münster

Laser spectroscopy of the ground state hyperfi ne splittings in hydrogen-like and lithium-like bismuth ions ($^{209}Bi^{82+}$ and $(^{209}Bi^{80+}$) tests the theory of bound-state quantum electrodynamics (QED) in the strong field of the nucleus. Precise theoretical predictions use a specifi c difference of both splitting energies to cancel the large uncertainty of nuclear contributions. The transition in Li-like Bismuth was observed for the first time in 2011, yet the accuracy of the result was limited by the calibration of the electron cooler voltage, determining the ion velocity. Here, we report on improved laser spectroscopic measurements of both hyperfine splittings. The accuracy was improved by about an order of magnitude compared to the first observation in 2011. The most important new feature was an in-situ high voltage measurement system with an accuracy at the 10-ppm level provided by German metrology institute Physikalisch-Technische Bundesanstalt. The experimentally determined specific difference deviates more than 7σ from theory. This so-called hyperfine puzzle might be explained either by unknown effects in the specific difference or by a incorrect value of the nuclear magnetic moment of ^{209}Bi. Recent and future investigations to resolve this puzzle are presented.

HK 11.2 Mo 17:00 HZO 100

Limits on the Fierz Interference Term in Neutron Beta Decay with PERKEO III — •Heiko Saul[1,2], Hartmut Abele[2], Dirk Dubbers[3], Bastian Märkisch[1], Alexandr Pethukov[4], Christoph Roick[1], Torsten Soldner[4], and Xiangzun Wang[2] — [1]Physik Department ENE, TU München — [2]Atominstitut, TU Wien — [3]Physikalisches Institut, Universität Heidelberg — [4]Institut Laue-Langevin, Grenoble

Neutron beta decay provides an excellent toolkit for the investigation of the structure of the weak interaction and potential deviations from the predictions of the standard model of particle physics.

Measuring the beta asymmetry provides the most precise way to determine the ratio of axialvector- and vector-coupling, λ, and is also sensitive to non-zero scalar and tensor couplings via the Fierz interference term, b.

The neutron decay spectrometer Perkeo III was used to measure several correlation coefficients in neutron beta decay and performed the most precise measurement of the beta asymmetry at the PF1B beam at the Institut Laue-Langevin, Grenoble. In this talk we present the result of an energy-dependent analysis of the experimental beta asymmetry which yields limits on the Fierz interference term.

HK 11.3 Mo 17:15 HZO 100

Current Status of the Proton Asymmetry Measurement with Perkeo III — •Christoph Roick[1], Michael Klopf[2], Lukas Raffelt[1,3], Heiko Saul[1,2], Wilfried Mach[1], Daniel Moser[5], Gertrud Konrad[5], Torsten Soldner[4], Hartmut Abele[2], Ulrich Schmidt[3], and Bastian Märkisch[1] — [1]Physik-Department der TU München — [2]TU Wien, Atominstitut — [3]Physikalisches Institut der Universität Heidelberg — [4]Institut Laue-Langevin, Grenoble, Frankreich — [5]Stefan-Meyer-Institut, Wien

We present the status of the data analysis of the recent measurement of the proton asymmetry in neutron beta decay with Perkeo III. This first direct measurement using a pulsed neutron beam and a proton retardation system will improve the first indirect measurement of the proton asymmetry, which has been performed with Perkeo II. Measuring the proton asymmetry allows searches for physics beyond axialvector and vector couplings of the Standard Model when combined with measurements of other correlation coefficients of neutron beta decay.

HK 11.4 Mo 17:30 HZO 100

Normalization of stopped muons for the COMET muon to electron conversion experiment — •Andreas Jansen, Kai Zuber, and Dominik Stöckinger — TU Dresden, Institut für Kern- und Teilchenphysik, Germany

The COMET experiment at J-PARC in Japan will search for charged-lepton flavor violation by measuring the rate of neutrinoless transition of muons to electrons in the surrounding of atomic nuclei. Because this process is highly suppressed in the Standard Model it represents an excellent candidate to search for new physics and to confirm or constrain many new theories.

Negative muons will be shot at a muon stopping target where they are stopped in the coulomb field of aluminum atoms. As muons are mostly captured in excited energy levels they promptly cascade down to the 1s ground state, emitting characteristic X-rays in the process. To obtain the total number of muons stopped these X-rays are beeing measured using a high-purity germanium detector.

The key role in the following calculation plays the full energy peak efficiency of the used detector. Because of a complex structure of the muon stopping target as well as the far away position of the detector 3.5 m downstream, it is not trivial to determine this quantity. The talk will present the methods which were developed to study the efficiency and determine its value for the upcoming COMET measurements.

HK 11.5 Mo 17:45 HZO 100

Probing charged lepton flavor violation with the Mu2e experiment — •Stefan E. Müller and Anna Ferrari for the Mu2e-Collaboration — Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

The Mu2e experiment, currently under construction at the Fermi National Accelerator Laboratory near Chicago, will search for the neutrinoless conversion of muons to electrons in the field of an aluminum nucleus. This charged lepton flavor-changing process is highly suppressed in the Standard Model and therefore undetectable. There exist however scenarios for physics beyond the Standard Model that predict small but observable rates.The Mu2e experiment aims at a sensitivity four orders of magnitude better than existing experiments. This is achieved by a rigorous control of all backgrounds that could mimic the monoenergetic signal electron.

The design and status of the Mu2e experiment will be presented. In addition, I will highlight the results from several test runs carried out at HZDR's ELBE facility to study the radiation hardness and performance of components for the Mu2e calorimeter and for the detector that monitors the rate of stopped muons in the aluminum target.

HK 11.6 Mo 18:00 HZO 100

Investigation of non-depolarizing neutron guide coatings for neutron beta decay studies with PERC — •Alexander Hollering[1], Thorsten Lauer[2], Bastian Märkisch[3], and Ulrich Schmidt[4] — [1]FRM-II TU München, 85748 Garching — [2]Movatec GmbH, 85386 Eching — [3]TU München, 85748 Garching — [4]Universität Heidelberg, 69120 Heidelberg

Neutron beta decay is a sensitive tool to search for non-V-A couplings beyond the Standard model in the charged weak interaction. The PERC instrument is currently under construction at the MLZ, Garching and aims to measure correlation parameters in neutron beta decay with an accuracy improved by one order of magnitude to a level of 10^{-4}. This requires control of the neutron polarization on the same level. Inside PERC instrument, an 8 m long neutron guide is used as decay volume in a magnetic field of 1.5 Tesla and is fed by a highly polarized cold neutron beam. Supermirror neutron guides are usually made of hundreds of layers from nickel and titanium on a glass substrate. Nickel is magnetized by the magnetic field which leads to depolarization of the neutron beam even for layers made of nickel alloy with vanadium added. In order to ensure a depolarization of the neutron beam on the level of 10^{-4} per bounce, completely non-magnetic coatings preferably made of diamagnetic materials are required. We present measurements of our supermirrors made from copper and titanium layers with excellent reflectivity. Also despite the high mobility of copper, which leads to interdiffusion, our supermirrors are highly resistant to baking-out needed to reach low residual gas pressure.