HK 27: Fundamentale Symmetrien I

Zeit: Dienstag 16:30–19:00 Raum: HG V

Gruppenbericht HK 27.1 Di 16:30 HG V

Correlation measurements in neutron decay. The PERC project — •Torsten Soldner for the PERC-Collaboration — Physik-Department E18, TU München — Institut Laue Langevin, Grenoble

Neutron decay is well-understood in the Standard Model of particle physics. However, from measuring the neutron's lifetime and angular correlations in the decay, we can not only derive parameters of the Standard Model but also search for new physics. I will briefly review the latest experiments at the Institut Laue Langevin that measured successfully beta-, neutrino- and proton asymmetry and the electron-neutrino correlation with experimental precisions of a few times 10^{-3}, and discuss limitations of existing instruments. Then I will introduce the instrument project PERC, a clean, bright and versatile source of neutron decay products, designed to overcome these limitations. A strong longitudinal magnetic field collects charged decay products directly from inside a neutron guide. This combination provides the highest phase space density of decay products. A magnetic mirror serves to limit the phase space precisely, reducing related systematic errors. Sensitivity and applications of PERC will be discussed.

Gruppenbericht HK 27.2 Di 17:00 HG V

A new measurement of the neutron electric dipole moment — •Johannes Zenner for the Neutron EDM-Collaboration — Paul Scherrer Institut, Villigen, Switzerland — Johannes Gutenberg Universität, Mainz, Germany

A non-zero value of a neutron electric dipole moment (nEDM) would violate both time (T) and parity (P) symmetry. The present experimental upper limit is $d_n < 2.9{\cdot}10^{-26}$ e·cm.

A collaboration of 15 European institutes aims at a sensitivity of $5{\cdot}10^{-28}$ e·cm. This will allow probing much of the parameter space for super symmetric theories while it is still far away from the prediction of the electroweak standard model.

Currently an improved version of the former ILL-RAL-Sussex experiment is set up at the new powerful source for ultra cold neutrons (UCN) at the Paul Scherrer Institut, Switzerland. The improvements together with a higher UCN density will already yield a sensitivity of $5{\cdot}10^{-27}$ e·cm. At the same time a new experiment is designed by the collaboration to have superior control over systematic effects, in particular with respect to magnetic fields. One such effect, the influence of Johnson-Nyquist noise that arises in metallic electrodes, and possible solutions to that problem will be presented in more detail. The status of the experiment will be discussed along with the progress for the new apparatus.

HK 27.3 Di 17:30 HG V

The new ultracold neutrons source at PSI — •Reinhold Henneck — UCN collaboration, Paul Scherrer Institut, Switzerland

At PSI we are building a new, high-intensity source of ultracold neutrons (UCN) which will deliver UCN densities in excess of 1000 UCN/cm^3. Its essential elements are a pulsed 590 MeV proton beam with 2 mA intensity and 1% duty cycle, a lead spallation target, a large heavy water moderator and 30 l of solid deuterium at 5 K as a converter. The source is in its commissioning phase and is expected to deliver first UCN by April 2010 after the accelerator shutdown . As a first experiment we will perform a new measurement of the neutron electric dipole moment (n-EDM). The characteristics of the source, the corresponding R&D programm and the commissioning program will be reported.

HK 27.4 Di 17:45 HG V

First results of Beta-asymmetry measurement in neutron decay with the spectrometer Perkeo III — •Holger Mest[1], Bastian Märkisch[1,2], Torsten Soldner[2,3], Xiangzun Wang[4], Dominik Werder[1], Alexander Petukhov[2], Hartmut Abele[4], and Dirk Dubbers[1] — [1]Physikalisches Institut, Universität Heidelberg — [2]Institut Laue-Langevin, Grenoble — [3]Physik-Department E18, TU München — [4]Atominstitut, TU Wien

Neutron decay is well described by theory. Accurate measurements of correlations in this semileptonic decay allow high precision tests of the Standard Model and physics beyond, i.e. unitarity of quark mixing CKM matrix, right handed currents or scalar and tensor interactions. With the new spectrometer Perkeo III we measured the parity-violating Beta-asymmetry described by the correlation-coefficient A. We improved systematics as well as statistics. The measurement is virtually background-free due to the use of a pulsed cold neutron beam. The instrument was installed at the high flux neutron source at the ILL. Data taking has been finished in August 2009. We present the current status of the data analysis.

HK 27.5 Di 18:00 HG V

The Neutron Decay Spectrometer *a*SPECT: Update on data analysis and recent results — •Michael Borg[1], Fidel Ayala Guardia[1], Stefan Baessler[2], Ferenc Glück[3], Werner Heil[1], Igor Konorov[4], Raquel Muñoz Horta[1], Gertrud Konrad[1], Beatrix Ostrick[1], Martin Simson[4,5], Torsten Soldner[4,5], Hans-Friedrich Wirth[6], and Oliver Zimmer[4,5] — [1]Institut für Physik, Universität Mainz — [2]University of Virginia, Charlottesville, VA, USA — [3]IEKP, Universität Karlsruhe (TH) — [4]Physik-Department E18, TU München — [5]Institut Laue-Langevin, Grenoble, France — [6]Fakultät für Physik, LMU München

The purpose of the retardation spectrometer *a*SPECT is to determine the antineutrino electron angular correlation coefficient a with high precision in free neutron decay. By measuring the recoil spectrum of the proton precisely, tests of the validity of the Standard Model become possible. Of great interest are the search for scalar and tensor interactions and to test the unitarity of the CKM matrix.

From a beam time performed at the research reactor of the ILL in Grenoble/ France in April/ May 2008 we expect a relative precision of $\delta a/a < 5\%$, which is the present error of prior determinations of a. In this talk selected topics from the on-going data analysis will be presented, including a discussion of the main systematic effects, their corrections and impact on the extracted value of a.

HK 27.6 Di 18:15 HG V

Laser-driven optically-pumped Cs magnetometer array for a nEDM experiment — •Martin Fertl for the Neutron EDM-Collaboration — Paul Scherrer Institut, Villigen, Schweiz — ETH Zürich, Zürich, Schweiz

The Standard Model of Particle Physics predicts a static electric dipole moment for the neutron (nEDM) breaking time reversal and parity symmetry. This prediction is several orders of magnitude below the current best experimental limit $\mathrm{d_n} < 2.9 \cdot 10^{-26}$ ecm (90 % CL). We are currently setting up a new experiment at the new ultra-cold neutron (UCN) source at the Paul Scherrer Institut, Switzerland, with the ultimate goal to improve the sensitivity limit by almost two orders of magnitude. Besides passive and active compensation of external magnetic fields we will use an array of laser-driven optically-pumped atomic cesium magnetometers to control and monitor the stability and homogeneity of the magnetic field at the neutron precession chamber. A first array of eight cesium magnetometers was used to obtain the field distribution and stability over the neutron precession volume on a sub-pT level. The setup and first results will be presented.

HK 27.7 Di 18:30 HG V

Active compensation of the magnetic field surrounding a new nEDM apparatus — •Beatrice Franke for the Neutron EDM-Collaboration — Paul Scherrer Institut, Villigen, Schweiz — EXC Universe, Technische Universitaet Muenchen, Deutschland

A non-zero neutron electric dipole moment (nEDM) would violate time and parity reversal symmetry. Its detection would be a major discovery, but also improving the current upper limit of $2.9{\cdot}10^{-26}$ e·cm constrains theories beyond the Standard Model of Particle Physics, such as super symmetry.

An apparatus is being set up at the Paul Scherrer Institut in Switzerland in order to improve the current sensitivity by two orders of magnitude. This shall be achieved by increasing statistics with a new powerful ultracold neutron source, and by improving control on systematics. The main sources for systematic errors are fluctuations of magnetic field inside the experimental volume. These might be introduced from the environment and shall be actively compensated for by implementing a surrounding field compensation (SFC) coil system. In this talk the working principle of the SFC and its commissioning will be presented. First results on the investigation of the magnetic environment of the experiment and the effect of the SFC on it are included.

HK 27.8 Di 18:45 HG V

aSPECT - Measuring the proton spectrum in neutron decay
— •Martin Simson[1,2], Fidel Ayala Guardia[3], Stefan Baessler[4], Michael Borg[3], Ferenc Glück[5], Werner Heil[3], Igor Konorov[2], Gertrud Konrad[3], Raquel Muñoz Horta[3], Beatrix Ostrick[3], Torsten Soldner[1,2], Hans-Friedrich Wirth[6], and Oliver Zimmer[1,2] — [1]Institut Laue-Langevin, Grenoble, France — [2]Physik-Department E18, TU München — [3]Institut für Physik, Universität Mainz — [4]University of Virginia, Charlottesville, VA, USA — [5]IEKP, Universität Karlsruhe (TH) — [6]Fakultät für Physik, LMU München

With the aSPECT spectrometer we measure the proton recoil spectrum in the decay of the free neutron. Its shape depends on the angular correlation between the momenta of the antineutrino and electron for kinematic reasons. A precision measurement of this correlation coefficient a allows to test the unitarity of the CKM matrix and provides limits on the existence of scalar and tensor currents.

aSPECT is a retardation spectrometer, this means protons from neutron decay are guided by a strong magnetic field and the proton recoil spectrum is measured by counting all protons that overcome a electrostatic barrier. By varying the height of the barrier the shape of the proton spectrum can be reconstructed. After the barrier the protons are accelerated to $\sim 15\,\mathrm{keV}$ and detected by a silicon drift detector.

This talk will cover details of the spectrometer and detector, as well as techniques used in the ongoing data analysis.