HK 9: Fundamentale Symmetrien

Zeit: Montag 16:30–19:00 Raum: HZ 3

Gruppenbericht HK 9.1 Mo 16:30 HZ 3

Electric Dipole Moments of Light Nuclei in Effective Field Theory — •Jan Bsaisou[1,2], Christoph Hanhart[1,2,3,4], Susanna Liebig[1,2], Ulf-G. Meissner[1,2,3,4,5,6], David Minossi[1,2], Andreas Nogga[1,2,3,4], Jordy de Vries[1,2,3,4], and Andreas Wirzba[1,2,3,4] — [1]Institut für Kernphysik, Forschungszentrum Jülich, D-52425 Jülich, Germany — [2]Jülich Center for Hadron Physics, Forschungszentrum Jülich, D-52425 Germany — [3]Institute for Advanced Simulation, Forschungszentrum Jülich, D-52425 Germany — [4]JARA - Forces And Matter Experiments, Forschungszentrum Jülich, D-52425 Germany — [5]Helmholtz-Institut für Strahlen und Kernphysik, Universität Bonn, D-53115 Bonn, Germany — [6]Bethe Center for Theoretical Physics, Universität Bonn, D-53115 Bonn, Germany

Electric dipole moments (EDMs) break parity (P) and time-reversal (T) symmetry and thus, by the CPT-theorem, CP-symmetry. Once measured, they will be unambiguous signs of new physics since CP-violation from the standard mechanism predicts EDMs that are experimentally inaccessible in the foreseeable future. We calculate within the framework of effective field theory the two-nucleon contributions to the EDMs of the deuteron, helion, and triton induced by P- and T-violating terms that arise from the QCD θ-term or dimension-6 sources of physics beyond the Standard Model (SM). We demonstrate what insights into physics beyond the SM can be gained from a suitable combination of measurements and, if needed, supplementary lattice QCD calculations.

Gruppenbericht HK 9.2 Mo 17:00 HZ 3

New limit on Lorentz and *CPT* violating neutron spin interactions using a free precession ^{3}He-^{129}Xe co-magnetometer — •Fabian Allmendinger[1], Ulrich Schmidt[1], Werner Heil[2], Sergei Karpuk[2], Anja Scharth[2], Yuri Sobolev[2], Kathlynne Tullney[2], and Stefan Zimmer[2] for the He-Xe-comagnetometer-Collaboration — [1]Physikalisches Institut, Ruprecht-Karls-Universität, 69120 Heidelberg, Germany — [2]Institut für Physik, Johannes Gutenberg-Universität, 55099 Mainz, Germany

We performed a search for a *CPT* and Lorentz invariance violating coupling of the ^{3}He and ^{129}Xe nuclear spins (each largely determined by a valence neutron) to background tensor fields which permeate the universe. Our experimental approach is to measure the free precession of nuclear spin polarized ^{3}He and ^{129}Xe atoms in a homogeneous magnetic guiding field of about 400 nT using LT$_C$ SQUIDs as low-noise magnetic flux detectors. As the laboratory reference frame rotates with respect to distant stars, we look for a sidereal modulation of the Larmor frequencies of the co-located spin samples. As a result we obtain an upper limit on the equatorial component of the background field interacting with the spin of the bound neutron $\tilde{b}^n_\perp < 6.7 \cdot 10^{-34}$ GeV (68% C.L.). Our result improves our previous limit (data measured in 2009) by a factor of 30 and the world's best limit by a factor of 5. In the talk we will give an overview of the principle of measurement and current results.

HK 9.3 Mo 17:30 HZ 3

Parity Violation in Hydrogen and Deuterium Spectroscopy: A new Approach — •Philipp Weiss — Institut für Kernphysik, Forschungszentrum Jülich, 52425 Jülich, Germany

The planned experiment provides an opportunity to measure the four weak coupling constants and the weak mixing angle with high precission by the use of an atomic physics method. Hereby, it is possible to prove the predictions given by the Standard Model.

In the Breit-Rabi diagram (binding energy as function of external magnetic field) for hydrogen and deuterium there are crossings between the β hyperfine substates of the $2S_{1/2}$ state and the e and f substates of the $2P_{1/2}$ states. Direct transitions at these crossings are forbidden by parity conservation. However, the Standard Model predicts a small admixture of the parity-violating weak force due to the nonvanishing probability density function of the $2S$ electron inside the nucleus.

With the knowledge about spinfilters used in a Lamb-shift polarimeter it is possible to provide a beam of hydrogen or deuterium atoms in one single metastable substate. In a modified spinfilter the interesting transitions can be induced and observed. This seems to be a feasible way to measure the effect of parity violation due to the weak force and to test the Standard Model.

HK 9.4 Mo 17:45 HZ 3

Test of Time-Reversal Invariance at COSY — Dieter Eversheim[1], •Yury Valdau[1,2], and Bernd Lorentz[2] — [1]Helmholz Institute für Strahlen- und Kernphysik, University Bonn, Germany — [2]Institute für Kernphysik, Forschungszentrum Jülich, Germany

At the Cooler Synchrotron COSY a null test of time-reversal invariance to an accuracy of 10^{-6} is planned as an internal target transmission experiment. The parity conserving time-reversal violating observable Ay,xz (P-even, T-odd) will be measured using a proton beam energy of 135 MeV. In this experiment, a total double polarized cross section will be measured observing a beam current change due to the interaction of a polarized proton beam with an internal tensor polarized deuterium target from the PAX atomic beam source. Thus, one of the most crucial systems for this experiment is a high precision beam current measurement system, which is in preparation now. The status of this activities, as well as status of the TRIC experiment will be presented in this contribution.

HK 9.5 Mo 18:00 HZ 3

Bestimmung des Spintunes am COSY Speichering — •Dennis Eversmann für die JEDI-Kollaboration — RWTH Aachen

Eine notwendige Bedingung für die Entstehung der Baryonenasymmetrie im Universum während der Baryongenese ist die CP Verletzung. Daher wird nach weiteren CP-Invarianz verletztenden Effekten gesucht, die sich in permanenten elektrischen Dipolmomenten (EDM) von Elementarteilchen bemerkbar machen könnten. Ziel der JEDI Kolaboration (Jülich Electric Dipole moment Investigations) ist es, die Stärke des elektrischen Dipolmoments von Proton, Deuteron und Helium-3 in einem Speichering zu vermessen. Am Cosy Speicherring werden dazu momentan Machbarkeitsstudien durchgeführt, die zum einen eine möglichst lange Erhaltung der Polarisation anvisieren und zum anderen untersuchen mit welcher Präzision der Spintune der Teilchen bestimmt werden kann. Der Spintune ν_s ist definiert als die Anzahl der Spinumdrehungen während eines Teilchenumlaufs durch den Speichering und ist in erster Ordnung durch den Lorentzfaktor γ und das anomale magnetische Moment G gegeben: $\nu_s = \gamma G$. Ein mögliches EDM würde diese Relation geringfügig modifizieren, womit eine präzise Spintunemessung eine Möglichkeit darstellt das EDM eines der oben genannten Teilchen zu bestimmen. Im Vortrag zur DPG wird gezeigt, dass eine relative Genauigkeit von 10^{-9} auf die Bestimmung des Spintunes am COSY Speichering für polarisierte Deuteronen in einer Messzeit von etwa 100 Sekunden erreicht wurde.

HK 9.6 Mo 18:15 HZ 3

Current status of *a*SPECT — •Alexander Wunderle for the aSPECT-Collaboration — Johannes Gutenberg-Universität, Mainz

The aSPECT retardation spectrometer measures the β-$\bar{\nu}_e$ angular correlation coefficient a in the β-decay of the free neutron. 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 aSPECT had a successful beamtime at the Institut Laue-Langevin in Grenoble (France). The goal of this run is to improve the current uncertainty of a from $\frac{\Delta a}{a} \approx 5$ % to about 1 %. To achieve this goal the systematics have to be understood accordingly. This is achieved on the one hand with different configurations during the beamtime (like different beam profiles or electrode settings), which is possible, as a statistical sensitivity of 1 % was reached within a few days. On the other hand the spectrometer and its systematics are precisely characterised with work function measurements of the electrodes and the experimental determination of the magnetic field ratio of the MAC-E filter. Furthermore, simulations of the field distribution and the particle transport in the spectrometer are used to quantify and reduce the systematic uncertainties of the measurements further.

In this talk we will present an overview of the systematics of aSPECT and their investigations.

HK 9.7 Mo 18:30 HZ 3

Precision NMR measurement of the magnetic field ratio of the *a*SPECT spectrometer — •Christian Schmidt for the aSPECT-Collaboration — Johannes Gutenberg-Universität, Mainz

The aSPECT retardation spectrometer measures the e-$\bar{\nu}_e$ angular correlation coefficient a in free neutron β decay by utilizing a MAC-E

filter. This measurement can be used to determine the ratio of $\frac{g_A}{g_V}$ of the weak coupling constants, as well as to search for physics beyond the Standard Model.

In spring/summer 2013 aSPECT had a successful beamtime at the Institut Laue-Langevin, Grenoble (France). The goal of this beamtime is to improve the current uncertainty of a from $\frac{\Delta a}{a} \approx 5$ % to about 1%. To achieve this goal the systematics of aSPECT have to be understood accordingly. One sensitive parameter to the systematic error of a is the knowledge of the magnetic field ratio, since this directly enters into the transmission function of our spectrometer. To determine the ratio with high precision two NMR probes were designed and implemented inside aSPECT.

In this talk we will present the design, the implementation inside aSPECT and the first results of the measurements.

HK 9.8 Mo 18:45 HZ 3

tau-SPECT: Neutron lifetime measurement at TRIGA Mainz
— Marcus Beck[1], Simo Dragisic[1], Klaus Eberhardt[2], Werner Heil[1], •Jan Peter Karch[1], Fabian Kories[1], Yury Sobolev[1,2], Dietmar Stepanow[1], and Norbert Trautmann[2] — [1]Institut für Physik, University of Mainz, Germany — [2]Institut für Kernchemie, University of Mainz, Germany

The decay of the free neutron into a proton, electron and antineutrino is the prototype of the semi-leptonic weak decay and plays a key role in particle physics and astrophysics. The accuracy in the experimental determination of the neutron lifetime could be steadily improved over the last 60 years. Nowadays, the achieved accuracy is limited by systematic errors, mainly caused by anomalous losses during storage of neutrons (ultracold neutrons) in material vessels. With the magnetic storage of neutrons one would like to avoid these systematic limitations and to reach an accuracy of 0.1-0.3 s in the lifetime of the neutron. In the talk, the magnetic spectrometer tau-SPECT is presented, which uses a combination of magnetic multipole fields for radial storage and the field configuration of the superconducting aSPECT magnet [1] for longitudinal storage of ultracold neutrons. This storage experiment benefits greatly from the new ultracold neutron source at the pulsable TRIGA reactor Mainz. [1] S. Baeßler et al., Eur. Phys. J. A 38, 1726 (2008)