HK 44: Fundamentale Symmetrien

Time: Wednesday 16:30–19:15 Location: HS2

Group Report HK 44.1 Wed 16:30 HS2

Status report on the nEDM project at the Paul Scherrer Institut, Switzerland — •Beatrice Franke for the Neutron EDM-Collaboration — Paul Scherrer Institut, Villigen, Switzerland — Exzellenzcluster Universe, Muenchen, Germany

A non-zero neutron electric dipole moment (nEDM) would violate time reversal and parity symmetry. Its detection would be a major discovery, but already improving the present upper limit of $2.9{\cdot}10^{-26}\,e{\cdot}$cm will further constrain theories beyond the Standard Model of particle physics, such as supersymmetry.
The goal of the nEDM collaboration is to improve the current sensitivity by almost two orders of magnitude. This shall be achieved in two phases: Firstly by using an upgraded version of the former ILL-RAL-Sussex apparatus (oILL) at the new powerful ultracold neutron source at PSI. This source is expected to deliver neutron densities increased by a factor ≈100 compared to the former location at ILL. Secondly a new spectrometer is being designed and developed in order to improve statistical sensitivity and enhance control over systematic effects. After moving the oILL spectrometer to Paul Scherrer Institut in 2009, numerous test measurements have been performed. The apparatus has been characterized in great detail and many new features have been installed. It is now ready for first measurements with ultracold neutrons. This talk will present the current achievements with focus on the alterations and improvements that have been implemented.

HK 44.2 Wed 17:00 HS2

Recent improvements of the Hg cohabiting magnetometer for the nEDM experiment at PSI — •Martin Fertl for the Neutron EDM-Collaboration — Paul Scherrer Institut, Villigen, Schweiz

The Standard Model (SM) 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 $d_n < 2.9 \cdot 10^{-26}$ecm (90 % CL). An experiment at the new ultra-cold neutron (UCN) source at the Paul Scherrer Institut (PSI), Switzerland, aims at a factor five improved sensitivity. Ultimately, the collaboration pursues the goal to improve the sensitivity by another order of magnitude. The experiment employs Ramsey's method of separated oscillatory fields to detect a Larmor frequency shift for the UCN in a parallel and an anti-parallel configuration of a magnetic and an electric field. The transmission modulation of a circularly polarized light beam is used to detect the spin precession of a spin polarized ensemble of ^{199}Hg atoms in the same volume as the UCN and thus to measure the applied magnetic field (≈ 1μT). Currently we reach a precision of 50fT over 100s. I will present recently achieved improvements of this co-magnetometer and ideas how to further improve this magnetometer by using a laser as light source.

HK 44.3 Wed 17:15 HS2

Entwicklung eines Prototypen der magnetischen Abschirmung für das n2EDM Experiment — •Stefan Stuiber[1], Igor Altarev[1], Peter Fierlinger[2], Erwin Gutsmiedl[1] und Stephan Paul[1] — [1]Technische Universität München, Physik-Department E18 — [2]Technische Universität München, Exzellenzcluster Universe

Im Standardmodell der Teilchenphysik wird ein elektrisches Dipolmoment für das Neutron (nEDM) in der Größenordnung von 10^{-32} ecm vorhergesagt. Dieser Wert liegt deutlich unter dem aktuellen experimentellen Wert von $d_n < 2.9\ 10^{-26}$ ecm. Erweiterungen des Standardmodells, z.B. SUSY, liefern jedoch Werte im Bereich von 10^{-28} ecm. In diesen Bereich vorzudringen ist Ziel des n2EDM Experiments. Dafür ist unter anderem eine sehr genaue Kontrolle der magnetischen Umgebung der Messung nötig, da sowohl zeitliche als auch räumliche Schwankungen des Magnetfeldes systematische Fehler erzeugen. Um die benötigte Stabilität des Magnetfeldes zu gewährleisten, werden eine neue magnetische Abschirmkammer aus fünf Lagen Mu-Metall und ein Spulensystem zur Erzeugung des Haltefeldes entwickelt. Anhand eines skalierten Prototyps wird das Design und Schirmverhalten dieser Kammer getestet. Hier werden FEM Simulationen präsentiert, in denen das Schild und das Spulensystem des Prototyps untersucht werden, mit dem Ziel ein 1 μT starkes Magnetfeld mit einer Homogenität von $\frac{dB}{B_0} < 10^{-4}$ im Messvolumen zu erzeugen.

HK 44.4 Wed 17:30 HS2

The Neutron Decay Spectrometer *a*SPECT: Results of systematic studies — •Michael Borg[1], Marcus Beck[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[5], Torsten Soldner[5], Hans-Friedrich Wirth[6], and Oliver Zimmer[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 aSPECT 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, a determination of the ratio $\frac{g_A}{g_V}$ of the weak coupling constants becomes possible as well as tests of the validity of the Standard Model. Of great interest are the search for scalar and tensor interactions and to test the unitarity of the CKM matrix. The present error of prior determinations of the coefficient a is $\frac{\delta a}{a}$ ≈5%.

In a beam time performed at the research reactor of the ILL in Grenoble/ France in April/ May 2008 we achieved a statistical precision of $\left(\frac{\delta a}{a}\right)_{stat.}$ <1.4%. The dominating systematical uncertainties have been identified and studied and will be presented in this talk.

HK 44.5 Wed 17:45 HS2

Verbesserungen für die nächste Strahlzeit mit aSPECT — •Marcus Beck[1], Fidel Ayala Guardia[1], Stefan Baessler[2], Ferenc Glück[3], Werner Heil[1], Gertrud Konrad[1], Martin Simson[4], Torsten Soldner[4], Hans-Friedrich Wirth[4], Oliver Zimmer[4] und Michael Borg[1] — [1]Institut für Physik, Universität Mainz — [2]University of Virginia, Charlottesville, VA, USA — [3]IEKP, KIT, Karlsruhe — [4]Institut Laue-Langevin, Grenoble, Frankreich

Mit dem aSPECT Experiment wird die beta-neutrino Winkelkorrelation beim Zerfall des freien Neutrons gemessen. Das Ziel ist die Untersuchung des Standardmodelles, speziell die unabhängige Bestimmung von gA/gV und die Suche nach exotischen Wechselwirkungen. In früheren Strahlzeiten wurden die dominaten systematischen Unsicherheiten identifiziert und untersucht. Für Sommer 2011 ist eine Strahlzeit geplant, in der der Winkelkorrelationskoeffizient mit einer Genauigkeit von wenigen Prozent bestimmt werden soll. Hierzu werden gerade signifikante Verbesserungen des Experimentes vorgenommen. U.a. wird ein neuer Vorverstärker zum Einsatz kommen, der das bestehende Totzeitproblem vermeidet. Es wird auch Verbesserungen geben, die es erlauben verschiedene systematische Effekte quantitativ zu verstehen. Hierzu zählt beispielsweise die genaue Bestimmung des Einflusses the Neutronenstrahlprofils. In diesem Vortrag werden die experimentellen Verbesserungen für die nächste Strahlzeit vorgestellt.

Group Report HK 44.6 Wed 18:00 HS2

Search for Spin-dependent Short-range Interaction Using a ^{3}He/^{129}Xe-Co-magnetometer — •Kathlynne Tullney[1], Claudia Gemmel[1], Werner Heil[1], Kai Lenz[1], Sergej Karpuk[1], Yuri Sobolev[1], Martin Burghoff[2], Silvia Knappe-Grüneberg[2], Wolfgang Kilian[2], Wolfgang Müller[2], Allard Schnabel[2], Frank Seifert[2], Lutz Trahms[2], and Ulrich Schmidt[3] — [1]Universität Mainz — [2]PTB Berlin — [3]Universität Heidelberg

We report on an experiment to search for a new spin-dependent short-range interaction which could be caused by light pseudoscalar bosons such as the axion that was originally proposed as a solution to the strong CP problem. Of interest here is the search for axion mediated short range interaction between a fermion and the spin of another fermion. To search for this effect co-located, nuclear spin polarized ^{3}He and ^{129}Xe atoms are used. The new approach we made is to measure the free nuclear spin precession frequencies in a homogeneous magnetic guiding field of about 400 nT using LT_C SQUID detectors. The whole setup is housed in a magnetically shielded room at the Physikalisch Technische Bundesanstalt (PTB) in Berlin.
In this talk we present new results from the September 2010 run which gives new upper limits on the scalar-pseudoscalar coupling of axion-like particles in the axion-mass window from 10^{-2} eV to 10^{-6} eV.

Group Report HK 44.7 Wed 18:30 HS2

WITCH - a declaration of independence — •Martin Breitenfeldt for the WITCH-Collaboration — IKS, KU Leuven, Belgium

The WITCH set-up (Weak Interaction Trap for CHarged particles) installed at ISOLDE/CERN combines a double Penning trap system to store radioactive ions and a retardation spectrometer to probe the energy distributions of the daughter recoil ions [1]. This energy spectrum provides information of the beta-neutrino angular correlation coefficient a. A precise determination of a gives information about an admixture of exotic components of the weak interaction.
In the last years the WITCH set-up was upgraded and further optimized to allow measurements with the mirror nucleus ^{35}Ar. A first such measurement was already performed and allowed the investigation of systematic and unwanted effects in the system. These were compared with simulations for finding their origin and to implement countermeasures in the WITCH system.
Furthermore a tremendous effort was taken to allow an independent operation from neighboring experiments. This includes the installation of a 20 m^2 magnetic shielding. [1] M. Beck et al., Nucl. Instrum. and Meth. A 503 (2003) 569.

HK 44.8 Wed 19:00 HS2

Lorentz invariance on trial in weak decays of rubidium — Elwin Dijck, •Stefan E. Müller, Jacob Noordmans, Gerco Onderwater, Rob Timmermans, and Hans Wilschut — Kernfysisch Versneller Instituut, University of Groningen, The Netherlands

The invariance of the laws of physics under Lorentz transformations is one of the most fundamental principles underlying our current understanding of nature. In theories trying to unify the Standard Model with quantum gravity, this invariance may be broken, and dedicated high-precision experiments at low energy could be used to reveal such suppressed signals from the Planck scale.

In the framework of the TRIμP (**T**rapped **R**adioactive **I**sotopes: **m**icro-laboratories for fundamental **P**hysics) program at the KVI, we will test Lorentz invariance by searching for a dependence of the decay rate of spin-polarized ^{80}Rb nuclei on the daily, sidereal or deliberate re-orientation of the spin. Observation of such a dependence would imply a breakdown of Lorentz invariance.

The method of the measurement will be presented, together with first results from preparatory experiments using the AGOR cyclotron at the KVI.