# HK 33: Fundamentale Symmetrien

Zeit: Mittwoch 16:30–19:00 Raum: P 1

**Gruppenbericht** HK 33.1 Mi 16:30 P 1

**Progress report on the nEDM project at the Paul Scherrer Institut, Switzerland** — •Martin Fertl for the nEDM-Collaboration — Paul Scherrer Institut, Villigen, Switzerland

The Standard Model (SM) of Particle Physics predicts a permanent electric dipole moment for the neutron (nEDM), breaking time reversal and parity symmetry. The electroweak prediction is several orders of magnitude below the current best experimental limit $d_\mathrm{n} < 2.9 \times 10^{-26}$ecm (90 % CL, ILL-RAL-Sussex). Many SM extensions predict a nEDM in the range of current experimental sensitivity. Improving the upper experimental limit restricts the allowed parameter space of these models. In a first step the nEDM collaboration has installed the upgraded ILL-RAL-Sussex instrument at the new ultra-cold neutron (UCN) source at the Paul Scherrer Institut (PSI), Switzerland. The collaboration aims at increasing the experimental sensitivity by a factor of five due to the expected higher UCN density and improved control of systematic effects. In parallel a new apparatus is developed for a next measurement phase aiming at another order of magnitude improvement. The experiment employs the Ramsey method of separated oscillatory fields to detect a shift of the Larmor precession frequency of UCN in a parallel and an anti-parallel configuration of very homogeneous magnetic and electric fields. In 2010/2011, the nEDM apparatus has been characterized in detail. The polarized UCN infrastructure was studied and significant progress in the homogeneity of the magnetic field was achieved. Preliminary results of dedicated measurements related to the major systematic false effects will be presented.

**Gruppenbericht** HK 33.2 Mi 17:00 P 1

**The new neutron EDM experiment at the FRM-II** — •Tobias Lins — Technische Universität München, Physikdepartment, James-Franck-Str. 1, 85748 Garching, Germany

Since the 1950's people have been searching for electric dipole moments (EDMs) of fundamental paticles. This is a very promising approach to find yet unknown manifestations of broken underlying symmetries in the early Universe. Although these experiments are among the most precise in physics, no EDM has been observed so far. In this talk a next generation approach with a sensitivity of < 5.10-28 ecm (3 sigma) for the neutron EDM based at the FRM-II neutron source will be presented. Ramsey's method of separated oscillatory fields is applied to trapped ultra-cold neutrons (UCNs) in vacuum. For the investigation of systematic effects a sophisticated strategy of various means to control ambient parameters on an unprecedented level of accuracy is currently being set up. The construction is planned to be finished by end of 2013, followed by the first measurements with UCNs in 2014. An overview of the overall strategy, main systems for magnetic field control and magnetometry, as well as the current status of the ongoing implementation on site will be shown.

HK 33.3 Mi 17:30 P 1

**Uncompensated magnetic field drifts in the nEMD experiment at Paul Scherrer Institute** — •Johannes Zenner for the nEDM-Collaboration — Johannes Guttenberg Universität, Mainz, Deutschland — Paul Scherrer Institut, Villigen, Schweiz

A non-zero value of the neutron electric dipole moment (nEDM) would violate both time (T) and parity (P) symmetry. The current experimental upper limit is $d_n < 2.9 \times 10^{-26}$ e cm, 90 % CL [ C. A. Baker et al., PRL 97, 131801 (2006) ]. The nEDM collaboration installed the experiment that has set the current limit at the new source for ultracold neutrons (UCN) at the Paul Scherrer Institute. Our goal is to increase the sensitivity by two orders of magnitude. That way one could confirm or exclude extensions of the standard model which introduce new sources of CP violation. To make use of the increased neutron intensity at the new UCN source a crucial task is to understand systematic effects at a corresponding level. A major systematic uncertainty is related to magnetic fields that could be created by the high voltage system of the experiment and are not fully compensated with the mercury co-magnetometer. This talk will cover our studies of this influence using an array of optical Cesium magnetometers.

HK 33.4 Mi 17:45 P 1

**Erste Messung eines $^{35}$Ar-Rückstoßspektrums und Bestimmung von $a$ mit dem WITCH-Experiment** — •Peter Friedag[1], Anna Bakenecker[1], Marcus Beck[1], Martin Breitenfeldt[2], Simon van Gorp[2], Tomica Porobic[2], Nathal Severijns[2], Christian Weinheimer[1] und Dalibor Zakoucky[3] für die WITCH-Kollaboration — [1]Institut für Kernphysik, Westfälische Wilhelms-Universität Münster — [2]Instituut voor Kern een Stralenfysika, Katholieke Universiteit Leuven — [3]Nuclear Physics Institute of ASCR, Rez near Prague

Mit dem WITCH-Experiment wird der Kern-Beta-Zerfall von Ionen in einer Penningfalle unter Verwendung eines Retardierungsspektrometers untersucht. Damit wird ein Rückstoßenergie-Spektrum gemessen, aus welchem sich die Beta-Neutrino-Winkelkorrelation $a$ extrahieren läßt. Das Ziel des WITCH-Experiments ist es, $a$ mit einer Genauigkeit von $\Delta a < 0,5\,\%$ zu bestimmen, was Rückschlüsse auf eine skalare Komponente in der schwachen Wechselwirkung erlaubt.

2011 fanden drei Strahlzeiten statt in denen erstmals $^{35}$Ar-Rückstoßspektren mit guter Statistik gemessen wurden. In diesem Beitrag werden die Messungen vorgestellt und die Analyse der Daten diskutiert. Diese Auswertungsmethode stützt sich wesentlich auf weitreichende Bahnverfolgungs- und Penningfallensimulationen, deren Ergebnisse mit den Messungen verglichen werden, um die Winkelkorrelation $a$ zu extrahieren und systematische Unsicherheiten zu bestimmen. Dieses Projekt wird vom BMBF unter der Nummer 06MS9151I unterstützt.

HK 33.5 Mi 18:00 P 1

**A novel approach to measure the electric dipole moment of 129Xenon** — •Florian Kuchler, Wolfhardt Feldmeier, Peter Fierlinger, and Bernd Taubenheim — Excellence Cluster "Universe", Technische Universität München, Boltzmannstr. 2, 85748 Garching

Permanent electric dipole moments (EDM) are promising systems to find new CP violation. The properties of the diamagnetic atom 129-Xe make it a particularly interesting candidate for an EDM search, as it enables new experimental strategies. Although the current experimental limit of $d_{Xe} < 4.0 \cdot 10^{-27}$ ecm is many orders of magnitude higher than the Standard Model (SM) prediction, theories beyond the SM usually require larger EDMs. Our experiment is based on microscopic hyper-polarized liquid xenon droplets, placed in a low-field NMR setup. Implementation of rotating electric fields enables a conceptually new EDM measurement technique, allowing thorough investigation of systematic effects. Still, a Ramsey-type spin precession experiment with static electric field can be realized at similar sensitivity within the same setup. Employing superconducting pick-up coils and highly sensitive LTc-SQUIDs, a large array of independent measurements can be performed simultaneously with different field configurations. With our novel approach we aim to be sensitive to an EDM of 129-Xe on the order of $10^{-30}$ ecm. The talk will give an update on the current status of the xenon EDM experiment.

HK 33.6 Mi 18:15 P 1

**Bound Beta-Decay: BOB** — •Josephine McAndrew — TU München

For many years exotic decay modes of the neutron have been investigated as possible doorways to the exploration of new physics. The bound beta-decay (BOB) of the neutron into a hydrogen atom and an anti-neutrino offers a very elegant method to study neutrino helicities. However, this rare decay has not yet been observed for the free neutron, owing to the challenge of measuring a decay involving only electrically neutral particles and with an estimated branching ratio of only a few $10^6$ of the three-body decay mode. During the past few years scientists from the TUM E18 Group have developed a novel experimental scheme which addresses all necessary problems associated with the observation of this two-body neutron decay in a very coherent way. The BOB experiment shall be installed at a tangential beam tube of a powerful research reactor such as the SR6 at the FRMII in Garching or H6-H7 beam tube at ILL. This talk will provide insights and ideas on how such an experiment is to be performed.

HK 33.7 Mi 18:30 P 1

**Investigation of the reaction $dd \to {}^3He n\pi^0$ with WASA-at-COSY** — •Paweł Podkopał for the WASA-at-COSY-Collaboration — Institut für Kernphysik and Jülich Center for Hadron Physics,

Forschungszentrum Jülich, Germany.

Investigations of charge symmetry breaking in $dd$ collisions is one of the most important topics of the physics programme for the WASA-at-COSY. One of the planned studies focuses on the charge symmetry forbidden reaction $dd \rightarrow {}^4He\pi^0$. Theoretical calculations based on existing data still lack precise information for determining low-level $\chi$PT parameters as well as for the description of $dd$ initial state interaction and $4N$ final state interaction. New data should comprise the measurement of $p$-wave pion production in the $dd \rightarrow {}^4He\pi^0$ and of the charge symmetry conserving $dd \rightarrow {}^3Hen\pi^0$ reaction. The latter measurement is especially necessary in order to study the relevance of initial and final state interaction. The reaction has been measured at a beam momentum of $p_d = 1.2$ GeV/c, using the WASA-at-COSY facility. For the first time data on the total cross section as well as differential distributions were obtained. The data are described with a phenomenological approach based on the combination of a quasi-free model and partial wave expansion model for the three-body reaction. Data analysis and results will be discussed.

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HK 33.8 Mi 18:45 P 1

**Improvements of the $a$SPECT retardation spectrometer** — •Alexander Wunderle for the aSPECT-Collaboration — Institut für Physik, Johannes Gutenberg-Universität Mainz

The $a$SPECT retardation spectrometer measures the electron antineutrino angular correlation coefficient $a$ in free neutron decay with high precision. This measurement can be used to determine the ratio of $\frac{gA}{gV}$ of the weak coupling constants, as well as to search for physics beyond the Standard Model.

Currently $a$ is determined with a precision of $\frac{\Delta a}{a} \approx 5$ %, whereas $a$SPECT aims for a precision of $\frac{\Delta a}{a} \approx 0.3$ %. To achieve this precision a new detector electronics has been developed and implemented, which avoids a previously observed saturation effect. Also, the main electrode has been redesigned and their surface treatment/coating has been improved. Compared to the previous electrode this leads to a smaller fluctuation of the work function, hence to a more precise determination of the potential. Furthermore, the collimation system for the neutron beam has been coated with a conductive layer to avoid a potential charging of the system.

These and further improvements will be presented and discussed in this talk.