HK 78: Fundamentale Symmetrien

Zeit: Donnerstag 16:45–19:00 Raum: HSZ-401

Gruppenbericht HK 78.1 Do 16:45 HSZ-401

A test of Lorentz invariance in β decay — Auke Sytema, Elwin Dijck, Stefan Müller, Gerco Onderwater, Coen Pijpker, •Hans Wilschut, Jacob Noordmans, and Rob Timmermans — Kernfysisch Versneller Instituut, Rijksuniversiteit Groningen, Nehterlands

In theories aiming to unify the Standard Model with gravity, Lorentz invariance may be broken. Although Lorentz symmetry appears to hold well, few experiments have been performed that consider its violation in the weak interaction. We have started a theoretical and experimental research program to this effect. In particular we consider a Lorentz-violating correction of the W-boson propagator, which manifests itself in a directional dependence of the β-decay rate and may be independent of boosts. We will discuss in the context of this extension of the Standard Model which observables are sensitive. Specifically, we consider allowed Fermi and Gamow-Teller transitions and explore the spin degrees of freedom in the latter.

Experimentally we exploit the Gamow-Teller transition of polarized ^{20}Na. The transition rate (i.e. lifetime) would depend on the spin orientation of ^{20}Na. The accuracy of the experiment relies on the fact that one measures an asymmetry when reversing the spin. The asymmetry should also follow the earth's rotation, depending on the polarization direction. The method of the measurement will be presented, together with the first results.

Gruppenbericht HK 78.2 Do 17:15 HSZ-401

Status of the WITCH experiment — •Martin Breitenfeldt for the WITCH-Collaboration — IKS, Leuven, Belgien

In the field of fundamental interactions two main branches of experimental techniques are pursued: The precision and the high-energy experiments. Both branches are complementary, in the first one probes the effect new particles have on certain observables. In the case of the WITCH experiment the weak interaction in nuclear beta decay is probed by observing the recoil energy distribution of the daughter nuclei. Measuring this distribution to very high precision could reveal the presence of exotic (non standard -model) components in the weak interaction. For this exotic component the mediator could a charged Higgs boson, which might be discovered on the high-energy frontier. In the WITCH setup Penning trap technology is combined with a MAC-E type retardation spectrometer to allow for the measurement of the recoil energy. After several upgrades in the last years the WITCH experiment finished its commissioning phase. By acquiring several sets of data last year not only could first physics information be extracted, but it was also possible to further characterize the WITCH system and solve the last issues. With the run in November 2012 we were aiming for a first complete data set for ^{35}Ar. In this talk preliminary results will be discussed together with the procedure to determine systematic uncertainties with the help of simulations.

HK 78.3 Do 17:45 HSZ-401

Analyse der Test-Strahlzeit des WITCH-Experiments mit ^{35}Ar-Ionen vom Herbst 2011. — •Peter Friedag für die WITCH-Kollaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster

Das WITCH-Experiment untersucht den Betazerfall von in einer Penning-Falle gespeicherten Ionen mit Hilfe eine Retardierungsspektrometers. Mittels Variation der angelegten Retardierungsspannung wird ein Rückstoßenergiespektrum gemessen. Aus diesem läßt sich die Beta-Neutrino-Winkelkorellation a bestimmen, über welche Rückschlüsse auf die Natur der zugrunde liegenden Wechselwirkungen möglich sind. Ziel des Experiments ist es, die Beta-Neutrino-Winkelkorellation mit einer Genauigkeit von $a < 0.5\%$ zu messen.

Eine Test-Strahlzeit mit dem Isotop ^{35}Ar im Herbst 2011 lieferte 6 Stunden Daten, welche genutzt wurden, um den Messzyklus zu optimieren, Systematiken zu charakterisieren und experimentelle Defizite aufzuzeigen. Des Weiteren wurde ein Vorgehen entwickelt um a aus den Daten zu bestimmen. Die Ergebnisse dieser Analyse bildeten eine wichtige Grundlage für die Vorbereitung einer längeren Messung mit dem gleichen Isotop welche im Herbst 2012 durchgeführt wurde. In diesem Vortrag wird das Analyse-Verfahren beschrieben und die Ergebnisse diskutiert.

Dieses Projekt wird vom BMBF unter der Nummer 06MS9151I unterstützt.

HK 78.4 Do 18:00 HSZ-401

The planned neutron lifetime experiment at the TRIGA reactor in Mainz — •Marcus Beck[1], Werner Heil[1], Jan Karch[1], Youri Sobolev[1,2], Tobias Reich[2], and Norbert Trautmann[2] — [1]Institut für Physik, Johannes Gutenberg Universität Mainz — [2]Institut für Kernchemie, Johannes Gutenberg Univesität Mainz

The lifetime of the neutron is of high interest for modern physics. It is an important particle property, plays a significant role in big bang nucleosynthesis and is used to determine the first element of the CKM-matrix. However, the results for the neutron lifetimes of the most precise experiments up to date differ significantly. In order to resolve these differences new experiments to measure the neutron lifetime are being set-up using magnetic storage to reduce the systematic uncertainties compared to material wall storage used in previous experiments. We will set up a neutron lifetime experiment, aSPECT-τ_n, at the new ultra-cold neutron source of the TRIGA reactor in Mainz. It will use existing parts of the aSPECT experiment and can thus proceed quickly. Especially, the UHV-system, the solenoids for the longitudinal storage, and the online decay proton detection are already available. Start-up funding is provided by the PRISMA cluster of excellence. In this talk we will present the principle of the experiment and first design studies.

HK 78.5 Do 18:15 HSZ-401

aSPECT, prepared for a new physics run — •Alexander Wunderle and Marcus Beck for the aSPECT-Collaboration — Institut für Physik, Johannes Gutenberg-Universität Mainz

The aSPECT retardation spectrometer measures the electron antineutrino angular correlation coefficient a in free neutron β-decay with high precision. 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. Currently a is known with a precision of $\frac{\Delta a}{a} \approx 4\%$ (PDG), whereas aSPECT aims for a precision of $\frac{\Delta a}{a} \approx 0.3\%$.

Since the last physics run of aSPECT at the Institut Laue-Langevin (ILL) in 2011 several significant improvements have been implemented. Namely the surfaces of our electrodes have been smoothed and therefore their field emission could be reduced. This and the renewal of several electrodes reduced runaway discharges in the spectrometer considerably. In the same step the uncertainty of the transmission-function due to workfunction fluctuations of the main electrode could be lowered considerably.

Since 2012 aSPECT has been operated at a separate test zone at the ILL, where we could investigate and determine the background level in our spectrometer in detail (see talk of Romain Maisonobe).

With all the improvements presented in this talk, we will determine a in 2013 with a yet unknown precision.

HK 78.6 Do 18:30 HSZ-401

Background studies for the spectrometer aSPECT — •Romain Maisonobe for the aSPECT-Collaboration — Institut Laue-Langevin, Grenoble, France

The retardation spectrometer aSPECT was built to determine the electron-antineutrino angular correlation coefficient a in neutron beta-decay with unprecedented accuracy $\Delta a/a \approx 0.3\%$, by measuring the proton recoil spectrum. The a coefficient can be used to derive the ratio $\lambda = g_A/g_V$ of the weak coupling constants g_A and g_V and to test the unitarity of the CKM matrix, or to derive limits for physics beyond the Standard Model. The attempted precision requires a good understanding of the background.

In 2012, the spectrometer was installed offline (without neutron beam) in order to perform high-voltage tests, to optimize operation parameters of the spectrometer (see talk of Alexander Wunderle), and to study the background behavior for different electrode voltage settings and vacuum conditions. A beta source (activated gold foil) was used to simulate rest-gas ionization by electrons from neutron decay. We present these background studies and the conclusions for the measurement of a.

A new beamtime with aSPECT is scheduled for spring 2013.

HK 78.7 Do 18:45 HSZ-401

A test of Lorentz-invariance in the β decay of ^{20}Na —

•Auke Sytema, Elwin Dijck, Stefan Müller, Gerco Onderwater, Coen Pijpker, and Hans Wilschut — Kernfysisch Versneller Instituut, Rijksuniversiteit Groningen, Netherlands

In Quantum-Gravity theories Lorentz symmetry may be broken. Although Lorentz invariance has been tested precisely in QED no symmetry breaking has been observed. However, such precise tests have not been done for the weak interaction. Anisotropy of the weak interaction can be tested in various ways. The present experiment aims to observe the lifetime of ^{20}Na as function of the direction of its polarization. The characteristic β asymmetry is used to measure the polarization while the $2^+ \rightarrow 0^+$ γ transition in the ^{20}Ne daughter nucleus is used to measure the decay rate. ^{20}Na is produced by shooting a beam of ^{20}Ne on a hydrogen target. The ^{20}Na is magnetically separated from the beam and stopped in a gas cell where it is polarized by laser light. The short halflife of ^{20}Na (0.448 s) allows it to decay before it diffuses outside the optically active region. By reversing the spin direction an asymmetry can be built which is sensitive to Lorentz-invariance violation but that is insensitive to most systematic errors associated with lifetime measurements. Details of the experimental procedure will be discussed and first results presented.