HK 61: Fundamental Symmetries

Time: Wednesday 16:30–18:45 Location: H-ZO 70

Group Report HK 61.1 We 16:30 H-ZO 70

TRIμP facility for the study of fundamental interaction and symmetries — P.D. Shidling, G.S. Giri, K. Jungmann, W.L. Kruithof, M. Sohani, D.J. van der Hoek, O.O. Versolato, L. Willmann, and •H.W. Wilschut — KVI, University of Groningen, The Netherlands

Rare and short lived radioactive isotopes provide unique possibility for the study of fundamental interaction and symmetries. At TRIμP different radioactive isotopes are produced in inverse kinematics mode. Dual magnetic separator is used for separating fast radioactive isotopes of interest from the primary beam. For example, ^{21}Na are produced with a yield of 10^4/s/pnA(of primary beam) in the ^{20}Ne (^{2}H, n)^{21}Na reaction. Produced fast radioactive isotopes are converted into low energy ion beams in thermal ionizer. This allows one to collect efficiently and transport the ions into magneto-Optical Trap (MOT) and ions are neutralized in MOT chamber. We will measure β-ν energy and angular correlation measurement in β decay for ^{21}Na. From this measurement, deviation from the weak interaction (V-A type) can be studied. One of the other measurements which are of our particular interest is search of permanent electric dipole moment, and to improve the value for parity non conservation in Ra. Different radium isotopes have been produced in inverse kinematics. ^{213}Ra has been produced with a typical yield of 10^3 /s/pnA (Pb beam) in ^{206}Pb (^{12}C, 5n) ^{213}Ra reaction. A procedure to trap Ra effectively has been successfully developed by the first time trapping of Ba. Details on the facility and new technological approaches for several units of the TRIμP facility will be presented.

HK 61.2 We 17:00 H-ZO 70

Wigner and Serber symmetries for Nucleon-Nucleon Interactions and the large N_c limit. — •Alvaro Calle Cordon and Enrique Ruiz Arriola — Universidad de Granada, Granada, Spain

Wigner symmetry in nuclear physics provides a unique example of a non-perturbative long distance symmetry, a symmetry strongly broken at short distances. We analyse the consequences of such a concept within the framework of One Boson Exchange Potentials in NN scattering and keeping the leading N_c contributions. Phenomenologically successful relations between singlet $^1S_0$ and triplet $^3S_1$ scattering phase shifts are provided in the entire elastic region. We establish symmetry breaking relations among non-central phase shifts which are successfully fulfilled by even-L partial waves and strongly violated by odd-L partial waves, in full agreement with large N_c requirements. The Serber force has relative orbital parity symmetry and requires the vanishing NN interactions in partial waves with odd angular momentum. We illustrate how is well fulfilled for spin triplet states and violated for even singlet states. We show that interpreted as a long distance symmetry this feature can be made plausible from a large N_c perspective. A prerequisite for this is the identity of the scalar and vector meson resonance masses. While these masses arise as poles on the Second Riemann in $\pi\pi$ scattering, we find that within the large N_c expansion the corresponding Yukawa masses correspond instead to their location as Breit-Wigner resonances.

HK 61.3 We 17:15 H-ZO 70

Bau und Test eines ^3He-Magnetometer — •Kai Lenz — Institut für Physik, Mainz, Deutschland

Die mögliche Existenz eines Elektrischen Dipol Moments (EDM) des Neutrons wäre ein direkter Beweis für eine flavourerhaltende CP-Verletzung. Ziel der $n2EDM$ Kollaboration ist es, die Messempfindlichkeit um das sechzigfache gegenüber der bisherigen Obergrenze von $\delta d_n \leq 3 \cdot 10^{-26} e \cdot cm$ [1] zu steigern. Von zentraler Bedeutung ist die Kontrolle kleinster Magnetfeldfluktuationen ($\delta B \approx 1 fT$) während eines Ramsey-Zyklus von ca. $200s$. Bisher verwendete Magnetometer haben nur eine Sensitivität von $\delta B \approx 200 fT$ [2]. Bei dem vorgeschlagenen ^3He-Magnetometer handelt es sich um einen flachen zylindrischen Glasbehälter in den polarisiertes ^3He bei einem Druck von ca. 1 mbar eingefüllt wird. Das Signal der zu Präzession angeregten Spins kann mit einem hochempfindlichen SQUID-System gemessen werden. Über die Bestimmung der Frequenz des Präzessionssignals kann man auf das angelegte Magnetfeld zurück schließen Messungen mit dem Prototyp an der PTB in Berlin zeigten, dass sich Spin-Präzessionzeiten von $2000s$ realisieren lassen bei einem Signal-zu-Rausch Verhältniss von $\geq 1000:1$. Im Vortrag werden die Testmessungen vorgestellt und die erreichten Empfindlichkeiten diskutiert.

[1] P.G. Harris, C.A. Baker, K. Green, et al., Phys. Rev. Lett. 82(1999), 904
[2] K. Green, P.G. Harris, P. Iaydjiev , et al., Nucl. Instr. and Meth. A 404(1998), 381

HK 61.4 We 17:30 H-ZO 70

Measurement of the cross section $e^+e^- \to \pi^+\pi^-\pi^0\pi^0$ via Radiative Return at BaBar — •Andreas Hafner, Miriam Fritsch, and Achim Denig — Universität Mainz

We present a measurement of the cross section of the exclusive hadronic reaction $e^+e^- \to \pi^+\pi^-\pi^0\pi^0$ with the Babar detector at PEP-II, an e+e- collider running at the fixed CMS energy of 10.6 GeV. Events with photon emission in the initial state (ISR) are used, lowering the effective CMS energy of the hadronic system and allowing for a measurement of the entire energy range < 4.5 GeV (so-called Radiative Return). The preliminary precision of the measurement has a systematic uncertainty of ca. 8% and will be further reduced in near future. The measurement is also interesting from the hadron spectroscopy point-of-view, we see a dominance of the $\omega\pi^0$ and $a1(1260)\pi$ intermediate states and we can extract for the first time the branching ratio of the $J/\Psi \to \pi^+\pi^-\pi^0\pi^0$ decay. Cross section measurements of this kind are needed as input for a precise theoretical prediction of the anomalous magnetic moment of the muon. A comparison of the theory prediction with the direct measurement of the muon anomaly allows a unique precision test of the Standard Model of particle physics.

HK 61.5 We 17:45 H-ZO 70

Investigations of the Charge Symmetry conserving break-up reaction dd $\to$ ^{3}Henπ^0 with WASA-at-COSY — •Pawel Podkopal for the WASA-at-COSY-Collaboration — Nuclear Physics Division, Jagiellonian University, Cracow

One of the primary objectives of the experimental program with the WASA at COSY detector is the determination of p-wave contribution to the Charge Symmetry breaking amplitude in the reaction dd $\to \alpha\pi^\circ$ at 1.2 GeV/c beam momentum. As a first step the Charge Symmetry conserving break-up reaction dd $\to$ ^{3}Henπ^0 was measured to provide missing parameters for the theoretical analysis in the framework of Chiral Pertubation Theory. For example, the reaction can be used to gain information on the deuteron-deuteron initial state interaction for s- and p-wave pion production as necessary input for the theoretical description of the CSB reaction. Moreover, total as well as differential cross sections will serve as a testing ground for the calculation of the Charge Symmetry conserving channel.

The status of the analysis of data collected at the end of 2007 will be presented.

* Supported by FZ Jülich, EU FP6, BMBF, and Wallenberg Foundation.

HK 61.6 We 18:00 H-ZO 70

The Charge Symmetry Breaking in $dd \to \alpha\pi^\circ$ reaction with WASA-at-COSY — •Tytus Smolinski for the WASA-at-COSY-Collaboration — Institut für Kernphysik and Jülich Center for Hadron Physics, Forschungszentrum Jülich, Jülich

The $dd \to \alpha\pi^\circ$ reaction violates isospin and - in particular also charge-symmetry (CS).On the quark level, these symmetries are broken due to the quark mass differences and electromagnetic interaction. Therefore, an experimental determination of the value of the total cross section for the $dd \to \alpha\pi^\circ$ process, which constitutes a direct measure of the charge symmetry breaking (CSB), provides an opportunity for studies of the quark masses.

Based on existing data close to threshold a consistent description of CSB effects in the framework of Chiral Pertubation Theory is currently being developed. As a first result this analysis will provide a prediction of the p-wave contribution at higher energies. In order to verify this prediction a dedicated experimental program is underway using the WASA-at-COSY facility. In June/July 2008 a first experimental run was successfully completed. In the talk a status of the on-going data analysis will be presented.

* Supported by FZ Jülich, EU FP6, BMBF, and Wallenberg

Foundation.

HK 61.7 We 18:15 H-ZO 70

A new measurement of the electric dipole moment of 129-Xe — Peter Fierlinger[1], •Florian Kuchler[1], Klaus Kirch[2], Ralph DeVoe[3], Marlon Horras[2], and Gerd Petzold[2] — [1]TU München / Excellence-Cluster 'Universe', Garching, Germany — [2]Paul Scherrer Institut, Schweiz — [3]Stanford University, USA

Since the 1950's people search for electric dipole moments (EDM) of fundamental systems, an unambiguous manifestation of parity (P) and time reversal (T) symmetry violation. Although the Standard Model (SM) predicts very small values for EDMs, extentions of the SM (eg. Supersymmetry) require large EDMs, which are within the reach of next generation experiments. Besides the neutron as the most prominent example of an EDM search, diamagnetic atoms like 199-Hg set strong limits d_Hg $<$ 2.1E-28 ecm. We present a novel approach to measure the EDM of the diamagnetic atom 129-Xe by a novel method, based on liquid hyper-polarized 129-Xe droplets condensed in a microfabricated structure. Due to the large density of the liquid, the size of the experiment can be minimized. This enables a conceptually new stratey to measure an EDM by applying rotating electric fields in the spin-precession plane. This method, where the EDM and the Larmor-precession are independent effects, can be used in addition to the 'conventional' Ramsey technique. Due to the small size also stability and gradients of the magnetic field can be controlled on an unprecedented level, using low-temperature SQUID magnetometry. Systematic effects, in particular motional effects, are controlled by performing an array of experiments in parallel on the same chip with different conditions.

HK 61.8 We 18:30 H-ZO 70

Feasibility studies for the measurement of $\eta' \to \pi^+\pi^-\pi^0$ decays in pp interactions — •Marcin J. Zielinski for the WASA-at-COSY-Collaboration — Institut für Kernphysik and Jülich Center for Hadron Physics, 52425 Jülich, Germany — Institut of Physics, Jagiellonian University, 30-059 Cracow, Poland

One of the objectives of the physics programme with the recently commissioned WASA-at- COSY facility is the study of fundamental symmetries via the measurement of η and η' meson decays. Of particular interest are isospin-violating hadronic decays into 3π systems. These are driven by a term of the QCD Lagrangian that depends on the $u-d$ quark mass difference. At COSY-Jülich the η and η' mesons can be produced with sizable cross sections in pp interactions. However, in such hadronic reactions the signal from the decays may be obscured by prompt meson production. In this presentation we will estimate the upper limit of the background from prompt pion production to the $\eta' \to 3\pi^0$ and $\eta' \to \pi^+\pi^-\pi^0$ decays. Using pp data from the COSY-11 experiment we have deduced differential cross sections for multi-meson production with an invariant mass in the vicinity of the η' meson. We obtain parameterisations of the total η' production cross section as well as of the prompt $\pi^+\pi^-\pi^0$ production. We discuss in detail the feasibility of the planned WASA-at-COSY measurements on η' decays into $\pi^+\pi^-\pi^0$.