HK 56: Hadron Structure and Spectroscopy I

Time: Wednesday 16:30–19:00 Location: H-ZO 20

Invited Group Report HK 56.1 We 16:30 H-ZO 20

Recent results from the WASA-at-COSY experiment — •Andrzej Kupsc for the WASA-at-COSY-Collaboration — Department of Physics and Astronomy, Uppsala University, Box 516, 75120 Uppsala, Sweden

WASA is a 4π multidetector system for studies of light meson production and decays in light ion collisions at the COSY storage ring. The facility allows the detection of both photons and charged particles and it is equipped with an internal hydrogen pellet target.

The primary objectives of the experimental program are studies of symmetry breaking patterns in η and η'-decays and in meson production reactions. Additional objectives include searches and further investigations of specific hadronic bound systems.

Since the startup of the routine operation in 2007 WASA-at-COSY has collected data for about 18 weeks. The experiments involve studies of η meson decays, isospin violation in the $dd \to \alpha\pi^0$ reaction, studies of the ABC effect and searches for bound states of η and light nuclei. For example, a recent six week run period in autumn 2008 was devoted to the studies of the η meson decays and a data sample of a few times 10^7 tagged events were collected.

I will give an overview of the main WASA-at-COSY activities and present some preliminary results.

Supported by BMBF, Wallenberg Foundation and Göran Gustafsson Foundation

HK 56.2 We 17:00 H-ZO 20

Cross section asymmetries of D- and K- Mesons produced in deep-inelastic scattering of polarized muons from polarized nucleons — Alexander Zvyagin and •Martin Faessler for the COMPASS-Collaboration — Fakultaet Physik, LMU, Am Coulombwall 1, D-85748 Garching

One of the main goals of the COMPASS experiment at CERN has been to measure the gluon polarization in a polarized nucleon. The production of open charm (D) mesons via the photon-gluon fusion in deep inelastic scattering of polarized muons on polarized nucleons is the ideal, direct probe for the gluon polarization. The D0 is detected via its decay to Kpi. The invariant K-pi mass spectrum shows other K-pi resonances in addition to the D0(1865), in particular 2 narrow peaks, which can be attributed to K2(1430) and K*(890). The measured cross section asymmetries for the 2 relative polarizations of muon and nucleon are shown for the D- and K-mesons and the background.

HK 56.3 We 17:15 H-ZO 20

ω Photoproduction off Protons and Neutrons with CBELSA-TAPS* — •Frida Hjelm for the CBELSA/TAPS-Collaboration — II Physikalisches Institut, Heinrich-Buff-Ring 16, 35392 Giessen

ω photoproduction off LH_2 and LD_2 targets has been studied with the tagged photon beam of the ELSA accelerator in Bonn. The combined setup of the Crystal Barrel and TAPS detector systems, which formed a 4π electromagnetic calorimeter, was used for detecting the ω meson via the $\omega \to \pi^0\ \gamma$ decay mode. The aim of this study is to determine the ω photoproduction cross section on the neutron, which has not been measured so far, and to compare it to the cross section on the free proton and on the bound proton in LD_2. The photoproduction cross section on the neutron is of particular importance with respect to model calculations of the ω-nucleus interaction. Preliminary results on both total and differential cross sections will be presented. In addition, the inclusive cross section for omega produced off LD_2 has been determined and is compared to the sum of the exclusive production channels.

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HK 56.4 We 17:30 H-ZO 20

Hadron production in muon-nucleon deep inelastic scattering at COMPASS — •Jean-Francois Rajotte — Fakultät Physik LMU München, Am Coulombwall 1 Garching 85748, Deutschland

The COMPASS experiment at CERN is running since 2002. Its main goals are to improve our knowledge of the nucleon spin structure, using a polarized muon beam and a polarized target, and to contribute to hadron spectroscopy, using hadron beams and searching for "exotic" hadrons with constituent gluons. To reach these goals, the collaboration has built an open spectrometer to detect, with high precision, the incoming muon of 160GeV/c, the outgoing muon and the produced hadrons. The large amount of high quality data accumulated gives access to the (un)polarized parton distributions of the nucleon, and the hadronisation process.

Results will be presented on the absolute (unpolarized) inclusive cross section for the deep-inelastic muon-nucleon interaction, on the single-photon exchange cross section extracted from it, and on the nucleon structure function F2. The latter will be compared with the results from the earlier NMC experiment.

The subtle difference (asymmetry) between semi-inclusive differential cross sections has been predicted for the production of hadrons in polarized muon-nucleon interactions as a function of transverse momentum of hadrons. In this context, it is important to first compare predictions with the gross features of the unpolarized cross section. The unpolarized semi-inclusive cross sections will be shown. They can be used as benchmark for the reliability of theoretical calculations.

HK 56.5 We 17:45 H-ZO 20

Neutral decays of the η meson at MAMI — •Marc Unverzagt for the A2-Collaboration — Institut für Kernphysik, Universität Mainz, Johann-Joachim-Becher-Weg 45, 55099 Mainz, Germany

Neutral decays of the η meson were studied within the A2-collaboration at the MAMI accelerator in Mainz. The main emphases were the branching ratio of the $\pi^0\gamma\gamma$ decay and the Dalitz plot parameter of the isospin violating $3\pi^0$ decay, which are tests for chiral perturbation theory. Furthermore, the η photoproduction threshold off protons was investigated to precisely determine the η meson mass.

η mesons were produced in the $\gamma p \to \eta p$ reaction, using the high intensity tagged photon facility of MAMI and a liquid hydrogen target. The η decay products and recoil protons were measured with the Crystal Ball and TAPS large acceptance detectors, covering 94 % of the full solid angle.

Physical issues of the neutral η decays, the experimental set-up and recent results will be discussed.

HK 56.6 We 18:00 H-ZO 20

Precision Measurement of the η-Mass at COSY-ANKE — •Paul Goslawski, Alfons Khoukaz, Malte Mielke, Michael Papenbrock, Tobias Rausmann, and Alexander Täschner — Institut für Kernphysik, Westfälische-Wilhelms-Universität Münster, Münster, Germany

Recent measurements on the η meson mass performed at different experimental facilities (i.e. COSY-GEM, MAMI, CLEO, KLOE, NA48) resulted in very precise data but differ partly by up to more than eight standard deviations, i.e. 0,5 MeV/c^2. In order to clarify this situation a new high precision measurement using the ANKE spectrometer at the COoler SYnchrotron - COSY - has been realised in March 2008. Using the two-body reaction dp $\to$ ^{3}Heη at low excess energies the η mass can be determined only from pure kinematics by the determination of the production threshold. To obtain a total uncertainty of $\Delta m_\eta < 50$ keV/c^2 on the η mass the beam momentum has to be determined with an accuracy of $\Delta p/p = 5 \cdot 10^{-5}$. This can be achieved by using an artificial spin resonance which can be induced by a horizontal rf magnetic field from a solenoid. With such a spin resonance a vector polarized deuteron beam can be depolarized depending on the revolution frequency and the beam momentum.

The method for determination of the η mass as well as preliminary results for the high precision beam momentum evaluation will be shown in this presentation.

Supported by the COSY-FFE program.

HK 56.7 We 18:15 H-ZO 20

The chiral partner of the nucleon in the mirror assignment with global symmetry — •Susanna Gallas[1,2], Francesco Giacosa[1], and Dirk Rischke[1,2] — [1]Institute for theoretical physics, Goethe University, Max-von-Laue-Str. 1, D-60438 Frankfurt am Main, Germany — [2]Frankfurt Institute for Advanced Studies, Goethe University, Ruth-Moufang-Str. 1, D-60438 Frankfurt am Main, Germany

We calculate the pion-nucleon scattering lengths $a_0^{(\pm)}$ and the mass parameter m_0, which describes the nucleon mass in the chirally restored phase for parity-doubled nucleons. This is done at tree-level in the framework of a linear sigma model with global chiral symmetry.

We obtain $m_0 = 300$-600 MeV when using the recent lattice results of T.Takahashi and T. Kunihiro. While $a_0^{(-)}$ is in fair agreement with experimental data, $a_0^{(+)}$ is too small because of the employed large mass of the sigma meson. This indicates the need of an additional scalar degree of freedom, such as a scalar tetraquark state with a mass of about 500 MeV. In this framework the very existence of a light tetraquark is responsible of the stability of nuclear matter.

HK 56.8 We 18:30 H-ZO 20

Spectroscopy of hadron resonances on the lattice — Gunnar Bali[1], Tommy Burch[1], Christian Ehmann[1], Christof Gattringer[2], Meinulf Göckeler[1], •Christian Hagen[1], Christian Lang[2], Markus Limmer[2], Daniel Mohler[2], and Andreas Schäfer[1] — [1]Institut für Theoretische Physik, Universität Regensburg, D-93040 Regensburg, Germany — [2]Institut für Physik, FB Theoretische Physik, Universität Graz, A-8010 Graz, Austria

The reproduction of the hadron mass spectrum from first principles is an important task for lattice QCD. While ground state spectroscopy, especially in the quenched approximation, is by now well understood, a clean extraction of excited hadron masses from a lattice QCD simulation still is a serious challenge. We discuss the relevant techniques for spectroscopy calculations on the lattice, in particular the variational technique which is needed for separating the different excited states from the ground state. Using this method we study three different sectors of the hadron spectrum. In the light quark sector we present hadron masses obtained from simulations with dynamical approximately chiral fermions, so-called Chirally Improved Fermions. For charmonium, we are able to extract masses for a number of excited states including ones with higher spin and exotic quantum numbers. The heavy-light hadron sector is investigated in the static-light approximation, i.e., the heavy quark is treated as infinitely heavy. Also here we are able to determine a large number of excitations.

HK 56.9 We 18:45 H-ZO 20

The heavy quark-antiquark potential from QCD and the quarkonium spectrum — •Alexander Laschka, Norbert Kaiser, and Wolfram Weise — Physik Department, Technische Universität München, D-85747 Garching, Germany

The quarkonium potential has been studied by lattice simulations as well as in perturbative QCD. It is an ideal object for exploring the interplay between perturbative and non-perturbative physics. However, the perturbative prediction is subject to ambiguities and tends to fail already at very small distances. We show how to derive a well-defined and stable short-distance potential that can be matched to results from lattice QCD simulations at intermediate distances. The static potential as well as quark mass dependent corrections are discussed and implications on the quarkonium spectrum are shown.

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