HK 22: Hadron Structure and Spectroscopy V

Time: Wednesday 14:00–16:00 Location: J-HS A

Group Report HK 22.1 Wed 14:00 J-HS A

Truncated partial-wave analyses and complete experiments in pseudoscalar meson photoproduction — •Yannick Wunderlich — HISKP, Universität Bonn

The unravelling of the nucleon excitation spectrum poses a long lasting challenge on the way towards a precise understanding of bound-state formation in QCD. Experiments on the photoproduction of mesons have been performed, in order to find resonances which have escaped observations before. The photoproduction of a single pseudoscalar meson allows for the extraction of 16 polarization observables.

One can search for so-called "complete experiments", i.e. for minimal subsets of the 16 observables which still allow for an unambiguous determination of the underlying set of 4 spin-amplitudes. At least for studies of numerically precise pseudo-data, 8 carefully selected observables can form a complete experiment. The numerical extraction of the 4 spin-amplitudes is termed a complete experiment analysis (CEA).

In a truncated partial-wave analysis (TPWA), i.e. the extraction of a finite number of photoproduction multipoles from angular distributions of the data, fewer than 8 observables can be already sufficient. However, the apparent reduction of complete sets in the TPWA breaks down once one attempts to determine high multipoles from data with realistic error-bars. In this case, further constraints are needed.

The presentation will outline a new bipartite fit-method for the TPWA, which includes constraints from the results of a previously performed CEA. Preliminary results for an analysis of eta photoproduction ($\gamma p \longrightarrow \eta p$) will be shown.

HK 22.2 Wed 14:30 J-HS A

η' beam asymmetry at threshold using the BGO-OD experiment — •Stefan Alef for the BGO-OD-Collaboration — Physikalisches Institut Universität Bonn

The unexpected nodal structure of the beam asymmetry recently reported by the GRAAL collaboration in η' photoproduction very close to threshold could be explained by a previously unobserved very narrow resonance. Therefore, the measurement is important to be independently confirmed.
This possibility is offered by the BGO-OD experiment. It is well suited for the detection of forward going charged particles which in the threshold region of interest allows the identification of the reaction $\gamma p \to \eta' p$ solely based on the proton going in forward direction. This yields unprecedented statistics if in the missing mass analysis of the η' meson the background can be sufficiently well controlled. A linearly polarized photon beam produced via coherent bremsstrahlung off a diamond radiator makes it possible to measure the η' beam asymmetry.
In this talk I will present preliminary results on the determination of the η' beam asymmetry close to threshold.
Supported by DFG (PN 50165297).

HK 22.3 Wed 14:45 J-HS A

Search for a narrow nucleon resonance at 1685 MeV — •Mariana Nanova, Volker Metag, and Kai-Thomas Brinkmann for the CBELSA/TAPS-Collaboration — II. Physikalisches Institut, Justus-Liebig-Universität Giessen

The excitation spectrum of the nucleon is still not sufficiently understood despite various long-lasting experimental and theoretical efforts. Recently the interest in the existence of pentaquark states has been renewed since such states have been observed in the charm sector. Particular attention has been paid to the recently claimed narrow structure observed at 1685 MeV in the $N\pi\eta$ channel [1], because this narrow structure could be identifed as the second member of the exotic anti-decuplet predicted in [2]. We have studied the two-meson photoproduction with the CB/TAPS detector system at the ELSA accelerator in Bonn in the reaction γp$\to$ $p\pi^0\eta$. High statistics have been obtained by irradiating a liquid hydrogen target with photon beams in the incident energy range from 0.9 to 3.0 GeV. A kinematic fit has been used in the reconstruction and identification of the exit channels. In the search for the narrow structure at 1685 MeV acceptance corrected M(pη) invariant mass spectra will be presented and discussed.
[1] V. Kuznetsov *et al.*, *JETP Letters* **106** (2017) 693
[2] D. Diakonov, V. Petrov and M. Polyakov, *Z. Phys. A* **359** (1997) 305.

HK 22.4 Wed 15:00 J-HS A

Studies of π^0 and η Reconstruction Efficiencies for the PANDA Day-1 Setup — •Jana Rieger[1,2], Tetyana Galatyuk[1,2], Klaus Götzen[1], Ralf Kliemt[1,3], Frank Nerling[1,4], and Klaus Peters[1,4] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt — [2]Technische Universität Darmstadt — [3]Helmholtzinstitut Mainz — [4]Goethe-Universität Frankfurt

The PANDA experiment represents the central part of the hadron physics program at the FAIR facility that is under construction at GSI in Darmstadt. In the early stages of the experiment, during the commissioning phase, a proton beam instead of an antiproton beam will be provided by the accelerator and a reduced PANDA setup, the so-called Day-1 setup, will be available. The reconstruction efficiency for π^0 and η of the Day-1 setup has been studied. Cross section measurements of $pp \to pp\pi^0/\eta$ which are important to estimate nucleon-nucleon cross sections in nuclear reactions, can already be performed during the commissioning phase. Simulation studies show the feasibility of the reconstruction of the relevant final states at high statistics using the PANDA detector.

HK 22.5 Wed 15:15 J-HS A

The hadronic contribution to the running of the electromagnetic coupling — •Miguel Teseo San José Pérez[1,2,3], Marco Cè[1,2], Antoine Gérardin[4], Harvey Meyer[1,2,3], Kohtaroh Miura[1,2,5], Konstantin Ottnad[2,3], Andreas Risch[2,3], Jonas Wilhelm[2,3], and Hartmut Wittig[1,2,3] — [1]Helmholtz-Institut Mainz, Johannes Gutenberg-Universität Mainz, Germany — [2]PRISMA+ Cluster of Excellence, Johannes Gutenberg-Universität Mainz, Germany — [3]Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Germany — [4]John von Neumann-Institut für Computing (NIC), DESY Zeuthen, Germany — [5]Kobayashi-Maskawa Institute for the Origin of Particles and the Universe, Nagoya University, Japan

The electromagnetic coupling that intervenes in the interactions between charged particles varies with the energy due to off-shell processes. In this work we compute the leading hadronic contribution to this running at low energies, where QCD is fully non-perturbative.

We employ a subset of CLS (Coordinated Lattice Simulations) ensembles with Nf = 2+1 and O(a) improved Wilson fermions in open boundary conditions in time and periodic in space. For each ensemble we have extracted the vacuum polarization function, which is proportional to the running, using the time-momentum representation. The set of ensembles has different particle masses and four lattices spacings, in such a way that we have been able to perform the chiral and continuum extrapolation.

HK 22.6 Wed 15:30 J-HS A

Reconstruction of complex decay channels using genetic algorithm — •Áron Kripkó, Markus Moritz, and Kai Thimas-Brinkmann for the PANDA-Collaboration — II. Physikalisches Institut, Justus Liebig Universität Gießen, 35392 Gießen, Germany

A common problem in the topic of hadron spectroscopy is the reconstruction of complex decay channels. During the procedure cuts are applied to the properties of the reconstructed candidates along the decay tree with the aim of maximizing the significance. In case of complex decay channels, finding the optimal set of cuts is not obvious.

The application of genetic algorithm to this problem was investigated in PANDARoot. Genetic algorithm is an optimisation algorithm inspired by the process of natural selection. PANDARoot is the common simulation framework for feasibility studies of the PANDA experiment.

The talk will present the reconstruction of a complex decay channel of a predicted charmonium exotic state ($\tilde{\eta}_{c1}$) using genetic algorithm.

This work is supported by HIC for FAIR and BMBF.

HK 22.7 Wed 15:45 J-HS A

Results of the TPWA of the reaction γp $\to$ ηp — •Philipp Krönert for the CBELSA/TAPS-Collaboration — HISKP, Uni Bonn

The motivation to study pseudoscalar meson photoproduction is to

improve the current understanding of the quantum mechanical interaction of the initial $|\gamma p\rangle$ and final state $|\eta p\rangle$. Chew, Goldberger, Low and Nambu [1] expressed (in 1957) the fundamental transition matrix in so-called complex electro-magnetic multipoles, which are connected to partial waves.

The technique of truncated partial wave analysis (TPWA) is a straightforward method to extract these multipole parameters, up to an overall phase, from experimental data.

Results of a truncated partial wave analysis will be shown in this presentation for the reaction $\gamma p \to \eta p$. This includes Legendre coefficients as well as multipole parameters for different truncation orders ($l_{max} = 2, 3$).

[1] G. F. Chew, M. L. Goldberger, F. E. Low, and Y. Nambu. Relativistic dispersion relation approach to photomeson production. Phys. Rev., 106:1345*1355, Jun 1957