HK 3: Hadron Structure and Spectroscopy II

Time: Monday 16:15–18:15 Location: PHIL A 401

Group Report HK 3.1 Mon 16:15 PHIL A 401

Light-Meson Spectroscopy at COMPASS — •Stefan Wallner for the COMPASS-Collaboration — Max Planck Institute for Physics, Garching, Germany

We studied the excitation spectrum of non-strange and strange light mesons with unparalleled precision using the world's largest sample of diffractive scattering of 190 GeV/c negative pions and kaons recorded at the COMPASS experiment at CERN. We performed partial-wave analyses of data on various final states to identify the produced light-meson resonances and to measure their properties, including spin, parity, mass, and width.

We report on recent results for the $\omega\pi^-\pi^0$, $\eta\pi^-\pi^-\pi^+$, and $K^0_S K^-$ final states, which map out a wide range of the non-strange light-meson spectrum. We present measurements of excited a_J and π_J states at high masses, a partly unexplored regime. We also discuss the exotic $\pi_1(1600)$, the lightest hybrid meson, which we found in various decay channels in these final states. Finally, we present the most comprehensive measurement to date of the strange-meson spectrum in the $K^-\pi^-\pi^+$ final state. There, we found the first candidate for an exotic strange meson with $J^P = 0^-$.

HK 3.2 Mon 16:45 PHIL A 401

Pseudoscalar meson-pair production beyond the resonance region at COMPASS — •Henri Pekeler for the COMPASS-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn, Germany

The COMPASS experiment at CERN's SPS provides a uniquely large data set to study the light-meson spectrum in diffractive production reactions of 190 GeV/c beam pions with protons. Among the many different final states accessible, $\eta\pi^-$ and $\eta'\pi^-$ are clean channels to investigate the lightest hybrid-meson candidate, the $\pi_1(1600)$. One challenge in identifying meson resonances is the separation of resonant and non-resonant processes.

To better constrain the non-resonant production mechanism of these final states, we analyze the high-mass region, i.e. $4\,\mathrm{GeV/c^2} < m_{\eta^{(\prime)}\pi^-} < 6\,\mathrm{GeV/c^2}$, using the double-Regge exchange model by Shimada er al., [Nucl. Phys. B 142 (1978)]. The model describes the dependence of the amplitude of a given double-Regge exchange on the invariant variables in terms of Regge trajectories. In addition, form factors are introduced at every vertex to parameterize the t-dependence of the coupling. For the first time, we perform an event-based likelihood fit to the COMPASS data set and show that the high-mass data can be described by only 13 parameters.

Supported by BMFTR.

HK 3.3 Mon 17:00 PHIL A 401

Studying Light-Meson Resonances in $\tau^- \to \pi^+\pi^-\pi^-\nu_\tau$ Decays at Belle (II) — •Godo Kurten, Hans-Günther Moser, Stephan Paul, Claudia Perez-Orive, Stefan Wallner, and Miriam Weiskopf — Max Planck Institute for Physics, Boltzmannstr. 8, 85748 Garching, Germany

We study mainly the a_1 resonances occurring in $\tau^- \to \pi^+\pi^-\pi^-\nu_\tau$ decays. To this end, we develop a two-step partial-wave analysis using simulated samples from the Belle II experiment. First, we perform a partial-wave decomposition fit that disentangles the data into partial-wave amplitudes with well-defined quantum numbers and measure their dependence on the invariant mass of the three pion system $m_{3\pi}$. Secondly, we search for resonances in these amplitudes with a resonance-model fit to the measured partial-wave amplitudes. Thereby, we extract mass and width of the resonances.

We present simulation-based input-output studies for the resonance-model fit, validating the resonance-model fit and assessing sensitivity to signals, such as the $a_1(1420)$.

HK 3.4 Mon 17:15 PHIL A 401

Studying the meson photoproduction mechanism through spin-density matrix elements at GlueX — •Niklas Herrmann and Farah Afzal for the GlueX-Collaboration — Institut für Experimentalphysik I, Ruhr-Universität Bochum, Bochum, Germany

The primary goal of the GlueX experiment is the search for exotic mesons, states that are forbidden within the quark model but permitted by quantum chromodynamics. GlueX located at Jefferson Lab employs a linearly polarized photon beam in the energy range from 8.2 to 8.8 GeV on a liquid hydrogen target. Current searches for exotic hybrid mesons within the meson spectrum require an understanding of the production mechanism. An important experimental tool to study the production mechanism is the measurement of polarization observables as the Spin-Density Matrix Elements (SDMEs) with a linearly polarized photon beam. In this talk, I present the measurement of the polarized SDMEs in the photoproduction of $\rho^-\Delta^{++}$, using GlueX data from 2017 - 2018. The new GlueX data has significantly better statistical precision compared to the existing SLAC data and provides a precise measurement of the t-dependence of the SDMEs for the range 0.025 to 1.4 GeV^2.

HK 3.5 Mon 17:30 PHIL A 401

Particle Identification ($e\gamma\gamma$) of Primakoff-Electroproduction π^0-Events for PRIMA FAIR Phase-0 — Òscar Andújar Sabán[1], Ning Cao[1], Luigi Capozza[1], Jonas Geisbüsch[1], Ravi Gowdru Manjunata[1], Frank Maas[1,2,3], •Antoine Martinet[1], Oliver Noll[1,2], Paul Schöner[1], Christoph Rosner[1], Pierre Vijayan[1], and Sahra Wolff[1] — [1]Helmholtz-Institut Mainz, Mainz, Germany — [2]Institute of Nuclear Physics, Mainz, Germany — [3]PRISMA+ Cluster of Excellence, Mainz, Germany

The FAIR Phase-0 experiment PRIMA, conducted at the Mainzer Mikrotron (MAMI), aims at measuring the π^0 transition form factor (TFF) in doubly-virtual Primakoff kinematics. Improving the TFF uncertainty is crucial, as it contributes a large uncertainty to the Standard Model prediction of the anomalous magnetic moment of the muon. The TFF represents the leading order of the hadronic light-by-light scattering (HLbL) correction. To achieve this, a modified version of the homogeneous $PbWO_4$-based PANDA backward-electromagnetic-calorimeter is used to measure the final state of the scattered electron and the π^0-decay photons. Key to this analysis is the particle identification for the $e\gamma\gamma$ final state. This can be done using the invariant mass of the detected particles, but potentially also using a neural network. This talk presents the current progress on particle identification of electrons and photons using a neural network.

HK 3.6 Mon 17:45 PHIL A 401

Background Modelling in Partial-Wave Analysis of $\tau^- \to \pi^+\pi^-\pi^-\nu_\tau$ decays at Belle II — •Miriam Weiskopf, Godo Kurten, Hans-Günther Moser, Stephan Paul, Claudia Perez-Orive, and Stefan Wallner — Max Planck Institut for Physics, Boltzmannstraße 8, Garching 85748, Germany

We study light mesons appearing as intermediate resonances in the $\tau^- \to \pi^+\pi^-\pi^-\nu_\tau$ decays at the Belle II experiment where τ pairs are produced in e^+e^- collisions. A detailed partial wave-analysis is performed to identify resonances that appear in the 3π system and to measure their properties including spin, parity, mass and width.

We will present our neural-network based approach that is used to model the distributions of backgrounds, such as $\tau^- \to \pi^+\pi^-\pi^-\pi_0\nu_\tau$ or $e^+e^- \to q\bar{q}$, in our data sample. We address challenges such as the high dimensionality of the phase space, limited data coverage, sharp background features, and background distributions that vary across different kinematic regions. The modelled background distributions and their integration into the partial-wave analysis will be presented.

HK 3.7 Mon 18:00 PHIL A 401

Polarization in the two-photon production of pion pairs and how to use it — •Max Lellmann, Achim Denig, Jan Muskalla, and Christoph Florian Redmer — Johannes Gutenberg Universität Mainz

The accuracy of the Standard Model prediction for the hadronic light-by-light contribution to the muon's anomalous magnetic moment a_μ is strongly limited by the knowledge of two-photon couplings of axial and tensor mesons. The coupling of the lightest tensor state, $f_2(1270)$, can be conveniently studied in the process $e^+e^- \to e^+e^-\pi^0\pi^0$, in which the pion pair is produced through the fusion of two virtual photons emitted by the leptons.

A reliable extraction of the tensor state's two-photon coupling requires proper corrections for reconstruction efficiency and other detector effects, which in turn demand accurate Monte Carlo simulations of the process. By implementing such a generator that, for the first time, includes a fully exclusive description of the $e^+e^- \to e^+e^-\pi^0\pi^0$ reaction, additional features of the cross section become accessible and can be used to extract further information from the same data.

This talk will outline the method and introduce the corresponding Monte Carlo generator, HadroTOPS.