HK 1: Hadron Structure and Spectroscopy I

Zeit: Montag 16:45–19:00 Raum: F 5

Gruppenbericht HK 1.1 Mo 16:45 F 5

Hadron Spectroscopy with COMPASS — •Stefan Wallner — Physik-Department E18, Technische Universität München

COMPASS is a multi-purpose fixed-target experiment at the CERN Super Proton Synchrotron aimed at studying the structure and spectrum of hadrons. The two-stage spectrometer has a good acceptance for charged as well as neutral particles over a wide kinematic range and is thus able to measure a wide range of reactions. Light mesons are studied with negative (mostly π^-) and positive (p, π^+) hadron beams with a momentum of 190 GeV/c. COMPASS has measured the so far world's largest dataset of the diffractively produced $\pi^-\pi^+\pi^-$ final state. We will report on new results for this final state, which allows to investigate a_J and π_J like light mesons including mesons with spin-exotic $J^{PC} = 1^{-+}$ quantum numbers, which are forbidden for quark-antiquark states. We employ the method of partial-wave analysis (PWA) to extract these states from the data. In this method, the decay into $\pi^-\pi^+\pi^-$ is modeled as subsequent two-body decays and a fixed mass shape for the appearing $\pi^-\pi^+$ resonances is assumed. However, the large size of our dataset also allows us to extract these shapes directly from data. Finally, the resonance parameters of a_J and π_J like mesons are measured by disentangling resonant and non-resonant parts of selected partial waves in resonance-model fits.

This work was supported by the BMBF, the DFG Cluster of Excellence "Origin and Structure of the Universe" (Exc 153), and the Maier-Leibnitz-Laboratorium der Universität und der Technischen Universität München.

Gruppenbericht HK 1.2 Mo 17:15 F 5

ComPWA: Amplitudenanalysen ohne Einschränkungen — •Mathias Michel[1], Klaus Götzen[2], Wolfgang Gradl[3], Frank Nerling[2], Klaus Peters[2], Stefan Pflüger[1], Andreas Pitka[4], Peter Weidenkaff[3] und Miriam Fritsch[4] — [1]Helmholtz-Institut Mainz — [2]GSI Darmstadt — [3]JGU Mainz — [4]RU Bochum

Eine der spannendsten Herausforderungen der Physik der Hadronen ist die Suche nach neuen konventionellen und exotischen hadronischen Zuständen wie zum Beispiel Hybriden und Gluebällen. Um diese experimentell nachzuweisen und auch klassische Zustände entsprechend zu klassifizieren, benötigt man in den meisten Fällen eine Amplitudenanalyse. Von besonderem Interesse ist zusätzlich der Vergleich und die simultane Analyse von Daten mehrerer Experimente. Um dies zu ermöglichen wurde das neue, unabhängige und effiziente Amplitudenanalyseframework ComPWA entwickelt. Es ist modularisiert, was eine einfache Erweiterung durch Modelle und Formalismen ermöglicht. Es bietet verschiedene Abschätzungen der Anpassungsqualität und Schnittstellen zu den Optimierungsbiblitotheken Minuit2 und Geneva. Durch die Modularität werden auch komplizierte Methoden wie die modellunabhängige Extraktion von Wellen ermöglicht. ComPWA wird bereits für die Analyse von BESIII Daten eingesetzt. Weitere Analysen von BESIII-Daten sind vorgesehen und die Schnittstellen für andere auch zukünftige Experimenten wie PANDA sind definiert. In diesem Vortrag werden die Möglichkeiten von ComPWA sowie erste Analysen vorgestellt.

HK 1.3 Mo 17:45 F 5

Open Effective Field Theories from Highly Inelastic Reactions — Eric Braaten[1], •Hans-Werner Hammer[2], and G. Peter Lepage[3] — [1]Department of Physics, The Ohio State University, Columbus, OH 43210, USA — [2]Institut für Kernphysik, TU Darmstadt, 64289 Darmstadt, Germany — [3]LEPP, Cornell University, Ithaca, NY 14583, USA

Effective field theories have often been applied to systems with inelastic reactions that produce particles with large momenta outside the domain of validity of the effective theory. The effects of the highly inelastic reactions have been taken into account in previous work by adding local anti-Hermitian terms to the effective Hamiltonian density. Here we show that an additional modification is required in equations governing the density matrix when multi-particle states are considered. We define an effective density matrix by tracing out states containing high-momentum particles, and show that it satisfies a Lindblad equation, with Lindblad operators determined by the anti-Hermitian terms in the effective Hamiltonian density.

*Supported by BMBF (contract 05P15RDFN1) and by DFG (SFB 1245).

HK 1.4 Mo 18:00 F 5

Extraction of resonance poles with $J^{PC} = 2^{-+}$ from COMPASS data — •Mikhail Mikhasenko[1], Andrew Jackura[2], Bernhard Ketzer[1], and Adam Szczepaniak[2,3] — [1]Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, 53115 Bonn, Germany — [2]Indiana University, Bloomington IN, U.S.A. — [3]Thomas Jefferson National Accelerator Facility, Newport News VA, U.S.A.

The COMPASS experiment at CERN has collected 5×10^6 events of diffractive scattering of 190 GeV pions to the three-pion final state. Since around one hundred resonances observed in light-quark sector are coupled to pionic systems, the spin-density matrices from a partial wave analysis are extremely valuable to extract ordinary and, possibly, exotic mesons.

The aim of the present analysis is to extract three-pion scattering amplitudes from the mass-dependence of the COMPASS spin-density matrices using analyticity and unitarity constraints.

The three-body unitarity problem is very difficult and has not been completely solved. In the approximation of the isobar model, it is reduced to quasi-two-body ($\pi\pi$-subchannel resonance + pion) unitarity requirements. We invoke a unitarization procedure to incorporate non-resonant long-range production processes via pion exchange, i.e. "Deck"-like processes.

This theoretical framework is applied to the COMPASS data. We discuss resonant pole positions and scattering phase shifts for the mesonic $J^{PC} = 2^{-+}$ sector. The project is supported by BMBF.

HK 1.5 Mo 18:15 F 5

Model Selection in Partial-Wave Decomposition — •Florian Kaspar, Karl Bicker, Oliver Drotleff, Boris Grube, and Stephan Paul — Physik-Department E18, Technische Universität München

The measurement of the excitation spectrum of light-quark hadrons often requires to apply partial-wave analysis methods. The building blocks of the physical models used in such analyses are the partial-waves, which describe the quantum numbers and the decay paths of the resonances. In diffractive reactions, in principle infinitely many of these waves can contribute. However, for finite data samples, only a finite number of waves carry relevant information. Finding these waves is in general a difficult task. We present a method that imposes constraints in the form of prior probability density functions on the individual waves in order to build sparse models from systematically constructed sets of possible partial waves. As an example we show results of the application of this method to simulated data for diffractively produced $\pi^-\pi^-\pi^+$ events.

This work was supported by the BMBF, the DFG Cluster of Excellence "Origin and Structure of the Universe" (Exc 153), the computing facilities of the Computational Center for Particle and Astrophysics (C2PAP), and the Maier-Leibnitz-Laboratorium der Universität und der Technischen Universität München.

HK 1.6 Mo 18:30 F 5

Coupled-Channel Partial Wave Analysis of $J/\psi \to \phi\pi^+\pi^-$ and $J/\psi \to \phi K^+K^-$ — •Markus Kuhlmann for the BESIII-Collaboration — Institut für Experimentalphysik I, Ruhr-Universität Bochum

Gluonic bound states like glueballs or hybrids and multiquark states are predicted by QCD. Hadronic decays of charmonia are gluon rich processes, where the production of those exotics is expected. In this talk, preliminary results of the analysis of the decays $J/\psi \to \phi\pi^+\pi^-$ and $J/\psi \to \phi K^+K^-$ are presented, using the worlds largest data sample of about $1.3 \cdot 10^9$ J/ψ events, collected with the Beijing Spectrometer III (BESIII) in positron-electron annihilations at the Beijing Electron-Positron Collider (BEPCII). The data selection, background analysis, and preliminary results of a coupled-channel partial wave analysis will be discussed.

HK 1.7 Mo 18:45 F 5

Partial wave analysis of three pion final states of J/Ψ and Ψ' at BESIII — •Stuart Fegan for the BESIII-Collaboration — Johannes Gutenberg University, Mainz

The BESIII experiment at the Institute of High Energy Physics, Chinese Academy of Sciences, Beijing, has been operating since 2008 with the aim of accumulating large data samples from e+e- collisions for detailed studies in the fields of charm physics and hadron spectroscopy. These data include large samples of J/Ψ and Ψ' decays collected during run periods in 2009 and 2012.

Three pion final states ($\pi+\pi-\pi0$) of J/Ψ and Ψ' decays have been previously studied at several facilities. Despite the same final state, the Ψ' decay shows an unexpectedly low branching fraction and markedly different di-pion mass spectra and Dalitz distributions. One route to explaining these differences, which form the basis of the so-called '$\rho\pi$ puzzle', is to perform partial wave analysis (PWA) of both the J/Ψ and Ψ' decays, testing possible explanations through the intermediate meson states they predict.

The work presented will highlight the progress towards realising PWA of these channels on the BESIII data, and the tools and techniques being developed in Mainz for this purpose.