HK 12: Hadron Structure and Spectroscopy IV

Time: Tuesday 16:15–18:30 Location: PHIL A 401

Group Report HK 12.1 Tue 16:15 PHIL A 401

Search for exotic states in η_c decays at BESIII — Tessa Bertelsmeier[1], Jans Böing[1], Anja Brüggemann[1], Nils Hüsken[2], Nikolai in der Wiesche[1], Lois Kröger[1], Hannah Neuwirth[1], •Frederik Weidner[1], and Alfons Khoukaz[1] — [1]Universität Münster, Germany — [2]Johannes Gutenberg-Universität Mainz, Germany

The BESIII detector at the e^+e^- collider BEPCII in Beijing, China, provides the world's largest data sample of the charmonium J/ψ with more than 10 billion events collected from 2009 to 2019.

Starting from the radiative J/ψ decay into $\gamma\eta_c$, we analyse the reactions $\eta_c \to \eta' h\bar{h}$ (with $h\bar{h} = \pi\pi$, $2(\pi\pi)$, $K\bar{K}$, $\eta\eta$) to determine the corresponding branching ratios as well as the mass and width of the η_c. Moreover, these η_c decays provide the opportunity to investigate possible exotic content in $h\bar{h}$ intermediate states that lie in the mass region below 2 GeV/c^2, where the lightest scalar glueball is predicted.

Our studies are based on a partial wave analysis approach that gives access to the partial decay widths of contributing resonances decaying into the $h\bar{h}$ subsystems. By coupling the considered channels multichannel effects can be correctly incorporated. The extracted widths are directly comparable to theoretical predictions, which assume glueball admixtures carried by certain considered resonances.

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Group Report HK 12.2 Tue 16:45 PHIL A 401

Search for the Lightest Glueball via the Reactions $\psi(2S) \to \phi + \pi\pi, 4\pi, K\bar{K}, \eta\eta$ and $\eta\eta'$ at BESIII — •Nikolai in der Wiesche, Frederik Weidner, Anja Brüggemann, Lois Kröger, Tessa Bertelsmeier, Jans Böing, Hannah Neuwirth, and Alfons Khoukaz for the BESIII-Collaboration — Universität Münster, Germany

The self-interaction of gluons is one of the most fundamental features of QCD, which implies the existence of purely gluonic bound states, called glueballs. However, to this day, no unambiguous experimental evidence of such state has been found. Theoretical calculations predict the mass of the lightest glueball, with quantum numbers $J^{PC} = 0^{++}$, to be between 1.6 GeV and 1.7 GeV. Therefore, the three experimentally observed isoscalar 0^{++} states $f_0(1370)$, $f_0(1500)$ and $f_0(1710)$, are promising candidates to contain admixtures of this glueball. Due to many contradictory measurements of their properties, the assignment of these states is still controversial.

In this talk, the current progress of a large-scale coupled-channel analysis project investigating the reactions $\psi(2S) \to \phi + \pi\pi, 4\pi, K\bar{K}, \eta\eta$ and $\eta\eta'$ will be presented. Using the world's largest $\psi(2S)$ data set obtained at BESIII, this project aims at extracting the properties of the f_0 states, which are produced as intermediate resonances in the recoil systems of the ϕ meson.

This work is supported by the DFG under the project number 547123630 and by the Ministry for Culture and Science of the State North Rhine-Westphalia under funding code NW21-024-E.

HK 12.3 Tue 17:15 PHIL A 401

Partial-Wave Analysis of $B^0 \to J/\psi K^+\pi^-$ at Belle (II) — •Martin Bartl, Hans-Günther Moser, and Stefan Wallner — Max-Planck-Institut für Physik, München

We will present Monte Carlo studies for a partial-wave analysis (PWA) of $B^0 \to J/\psi K^+\pi^-$ at Belle and Belle II. The PWA disentangles contributions from numerous intermediate resonances, e.g. K^* mesons in the $K\pi$ subsystem. Background components are described using neural network techniques. We will discuss the search for exotic, i.e. non-$q\bar{q}$, states, which can appear in the $J/\psi\pi$ and $J/\psi K$ subsystems, complementing recent observations by LHCb.

HK 12.4 Tue 17:30 PHIL A 401

Light Hybrid Mesons with Functional Methods — •Franziska Münster[1], Christian Fischer[2], and Markus Huber[3] — [1]Institute for theoretical physics, JLU, Gießen, Germany — [2]Institute for theoretical physics, JLU, Gießen, Germany — [3]Institute for theoretical physics, JLU, Gießen, Germany

In my talk, I discuss the theoretical description of light hybrid mesons*hadrons composed of a quark, an antiquark, and a gluon. Their explicit gluonic degree of freedom makes them particularly interesting for studying the nonperturbative dynamics of QCD. Unlike ordinary mesons, hybrid mesons can carry exotic quantum numbers that simple quark*antiquark configurations cannot access in the nonrelativistic quark model. Their study is further motivated by some possible experimental candidates reported in recent years. The most prominent candidate for a light hybrid meson is the isovector state $\pi_1(1600)$ 1^{-+}. To investigate such systems, we employ a functional approach based on Dyson*Schwinger and Bethe*Salpeter equations. Hybrid mesons are treated as genuine three-body bound states, which requires solving a three-body Bethe*Salpeter equation that explicitly includes quark, antiquark, and gluon degrees of freedom. I outline the structure of this framework and discuss its implications for the spectrum and internal dynamics of hybrid mesons.

HK 12.5 Tue 17:45 PHIL A 401

First steps towards the mixing of Glueballs and Mesons using the Dyson-Schwinger and Bethe-Salpeter equations — •Jonathan Yigzaw, Christian Fischer, and Markus Huber — Justus-Liebig-Universität Gießen Germany

The spectrum of Quantum Chromodynamics (QCD) contains not only conventional quark-antiquark mesons but also purely gluonic bound states, the glueballs. While glueball masses have been studied extensively in pure Yang-Mills theory, their mixing with mesons of identical quantum numbers remains a largely open question. While in recent years functional methods have been successfully used to produce mass spectra for pure Yang-Mills theory, and the ongoing study of mesons in this framework has led to a fuller understanding of their properties, the effects of their mixing have not been studied yet.

As a first step towards a fully mixed spectrum of mesons and glueballs, I use the Dyson-Schwinger and Bethe-Salpeter equations to calculate the coupled set of equations in the scalar and pseudoscalar channels. I will present the resulting impact on the spectra and discuss the possible implications.

HK 12.6 Tue 18:00 PHIL A 401

Partial Wave Analysis for Baryonic Resonances for the HADES Experiment — •Ahmed Marwan Foda — GSI Helmholtz Centre for Heavy Ion Research, Darmstadt, Germany

The HADES collaboration at GSI investigates baryonic resonances and their decay channels using exclusive channels with pion and proton beams, which enable direct resonance formation at fixed center-of-mass energy ($\sqrt{s}$). This approach complements photo-induced studies and, combined with Partial Wave Analysis (PWA), provides crucial insights into resonance couplings, particularly in two- and three-pseudoscalar meson production. A central focus is the role and medium modification of vector mesons in baryon-dense matter, with pion-induced reactions and PWA offering unprecedented access to ρN and ωN final states, relevant for phenomena such as ρ meson melting and dilepton emissions in heavy-ion collisions.

To advance resonance exploration, a modular PWA software package is being developed, incorporating frameworks such as K-Matrix, N/D methods, and a baryon pseudoscalar fit based on the JuBo coupled-channel model. This enables comparison of electro- and photoproduction predictions with proton-proton data, refining resonance contributions. The effort coincides with recently analyzed proton-induced data together with approved pion beam time at GSI targeting the third resonance region, and a complementary experiment at J-PARC. Current results include illustrative fits from pion-proton reactions in the second resonance region, and proton-proton reactions at 4.5 GeV, demonstrating the framework's potential for upcoming campaigns.

HK 12.7 Tue 18:15 PHIL A 401

Coupled-Channel Partial-Wave Analysis of the Decays $\psi(2S) \to \omega + K\bar{K}, \pi\pi, \eta\eta, \eta\eta', 4\pi$ — •Lois Kröger, Tessa Bertelsmeier, Jans Böing, Anja Brüggemann, Nikolai in der Wiesche, Hannah Neuwirth, Frederik Weidner, and Alfons Khoukaz for the BESIII-Collaboration — University of Münster

The BESIII experiment provides a datasample of 2.7 billion events of the vector charmonium $\psi(2S)$ produced in electron-positron collisions. This high-statistics data sample is utilised to perform a

coupled-channel partial-wave analysis of the decays $\psi(2S) \to \omega + K\bar{K}, \pi\pi, \eta\eta', \eta\eta, 4\pi$. The resonance parameters and the partial widths of the isoscalar, scalar resonances $f_0(1370)$, $f_0(1500)$ and $f_0(1710)$ produced as intermediate states in the analysed decay chains are studied. As these resonances lie in the same mass range as the lightest predicted glueball and also share the same quantum numbers, they are candidates to have an admixture of this predicted purely gluonic state. Therefore, this analysis aims to gain insight on the composition of the f_0 states below 2 GeV via the extracted resonance information in search for the lightest glueball. As a fundamental prediction of QCD, experimental evidence for the lightest glueball would greatly contribute to the understanding of the strong interaction. First results of the analysis will be presented in this talk. This work is supported by the DFG under the project number 547123630.