MESON2026

Thursday, 25 June 2026 - Tuesday, 30 June 2026

Auditorium Maximum

Book of Abstracts

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Plenary session / **128**

Opening

Plenary session / **135**

Observation of a family of all-charm tetraquarks with spin-2 and positive parity

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Observation of a family of all-charm tetraquarks with spin-2 and positive parity

Three structures, denoted as X(6600), X(6900), and X(7100), have been observed in the J/\psi J/\psi mass spectrum and are interpreted as candidates for a family of fully-charm tetraquark states. Using proton-proton collision data collected by the CMS detector corresponding to an integrated luminosity of 315 fb(^{-1}), the J/\psi J/\psi spectrum is studied with substantially improved statistical precision. All three structures, as well as their interference, are found with statistical significances exceeding five standard deviations. The observed interference indicates that these states share common quantum numbers. Their squared masses show an approximately linear dependence on the resonance index, while their natural widths decrease systematically with increasing index, suggesting a pattern consistent with radial excitations of tetraquarks composed of two aligned spin-1 diquarks without orbital excitation. Complementary studies in the J/\psi\psi(2S)\to\mu^+\mu^-\mu^+\mu^- final state further reveal structures associated with the X(6900) and X(7100) states. This talk further presents a dedicated spin-parity analysis of the near-threshold structures in the fully-charm tetraquark sector using the J/\psi J/\psi\to4\mu final state. A matrix-element-based approach is employed to test multiple J^P hypotheses, including (0^+), (0^-), (1^+), (1^-), (2^+), and (2^-), based on the kinematic distributions of the four-muon system. The primary analysis uses decay-only observables, while production angular distributions are also examined as a consistency test. The results favor the quantum-number assignment J^{PC}=2^{++}, establishing the first spin-parity determination of a fully-charm tetraquark family at a hadron collider and providing important constraints on the internal structure and excitation pattern of exotic hadrons.

Collaboration:

Plenary session / **41**

Charm in Photoproduction: The Present and Future

Author: Daniel Winney[1]

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Interest in photoproduction processes involving open- and hidden-charm final states has considerably grown in the last few years, both experimentally and theoretically. This is primarily because of two active research ares: the possibility of exploring exotic hadron candidates in the charm sector in novel production modes and the possible extraction of the gravitational properties of the proton. In this talk, I will review the current state of these ventures surveying both theoretical and experimental results as well as look towards the future to discuss the potential impact new measurements in the near- and long-term can have on our understanding of these processes.

Collaboration:

JPAC

Plenary session / **92**

Recent results on hadron spectroscopy and exotic states at LHCb

Author: Liming Zhang[1]

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The LHCb experiment has delivered groundbreaking results in hadron spectroscopy and exotic state studies, enabled by its large collision dataset. This contribution summarizes the latest discoveries and precision measurements of conventional and exotic hadrons at LHCb, discusses their implications for quantum chromodynamics, and outlines future prospects for hadron physics research at the LHC.

Collaboration:

LHCb

Plenary session / **106**

Emergence of excited hadron states from lattice, phenomenology and effective field theories

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What are the mechanisms behind the labyrinthine spectrum of excited hadrons? This question challenges our understanding of strong interaction and is of relevance to many applications where the exact parameters of these states influence interaction patterns.

In turn, many open questions in this regard hinge on a precise understanding of the multi-hadron dynamics. In the last decade a large progress has been made in this regard triggered and triggering specifically (by) new progress of Lattice QCD and Effective Field Theories. In my talk, I will show recent outcomes of this journey, including recent results on a1(1???), pi(1300) and omega(782) resonances.

Collaboration:

Plenary session / **90**

Hadronic Molecules - Theory

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Since the turn of the century it becomes evident that the naive quark model is not capable to describe the rich phenomenology of hadrons, especially in the doubly heavy sector. For a large number of those states a molecular structure, where the states are understood as analogs to atomic nuclei, appears to be a natural description. In this talk I review the theory of hadronic molecules, how they can be described systematically in effective field theories and what imprint this structure leaves in observables. On a few examples I explain non-trivial predictions emerging from the molecular hypothesis that can be tested in future experiments and lattice QCD calculations, promising deep insights into the inner workings of QCD.

Collaboration:

Plenary session / **14**

Regge theory for discovering exotic mesons

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I will discuss the latest developments in Regge theory, including its applications to the analysis of hadron spectroscopy data, with a focus on exotica.

Collaboration:

JPAC/ExoHad

Plenary session / **91**

Overview of BESIII results

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Since its operation began in 2008, the BESIII experiment has accumulated an integrated luminosity of 50 fb^{-1} in the center-of-mass energy range of 1.84-4.95 GeV. Using these data samples, BESIII has achieved a large number of significant results in areas such as light hadron spectroscopy, charmonium physics, hyperon physics, and the physics of charmed mesons and charmed baryons, providing crucial experimental support for testing theories of the strong and electroweak interactions. By the end of 2024, the upgrade of BEPCII was completed. The BEPCII-U will achieve a luminosity three times higher than before at energies above 4.0 GeV, with the maximum center-of-mass collision energy reaching 5.6 GeV. This upgrade enables the study of charmed baryon pair productions and

decays, the search for XYZ particles, investigations into charm quark fragmentation functions, and related research. This talk will present the latest experimental results from the BESIII experiment and provide an outlook for its future.

Collaboration:

BESIII

Parallel session B1 / 15

Production cross section of the $\bar{K}NN$ nucleus with two-nucleon absorption in the in-flight $^3\mathrm{He}(K^-, \Lambda p)n$ reaction

Authors: Takuto Jimbo[1]; Takayasu Sekihara[1]

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The kaonic nuclei, the antikaon($\bar{K}$)-nuclear quasibound states via the strong interaction, is one of the most interesting topics in nuclear hadron physics. Especially, the simplest system, $\bar{K}NN$ nucleus, has been studied both theoretically and experimentally as a first step to understand the structure and properties of the kaonic nuclei.

Among the experimental searches, the peak structure just below the $\bar{K}NN$ threshold was observed in the $^3\mathrm{He}(K^-, \Lambda p)n$ reaction with K^- beam in the J-PARC E15 experiment [1]. A theoretical reaction calculation suggests that the $\bar{K}NN$ nucleus is really produced in the experiment [2]. However, there remains several problems to compare theoretical calculation with experimental data quantitatively. One of the most important problems is incorporating the contribution of two-nucleon absorption process. Although there are various structure calculations of the $\bar{K}NN$ systems, calculations incorporating two-nucleon absorption are not still sufficiently performed.

In this study, we construct a precise model incorporating the contribution of two-nucleon absorption for the $\bar{K}NN$ nucleus in the framework of Faddeev equation. We then calculate the $^3\mathrm{He}(K^-, \Lambda p)n$ reaction and evaluate the production cross section of the $\bar{K}NN$ nucleus and the Λp invariant mass spectrum. Comparing with the experimental data at J-PARC, we investigate the spin/parity and pole position of the $\bar{K}NN$ nucleus.

[1] T. Yamaga *et al*, Phys. Rev. C, **102**, 044002 (2020).

[2] T. Sekihara, E. Oset, A. Ramos, Prog. Theor. Exp. Phys. **2016**, 123D03 (2016).

Collaboration:

Parallel session A1 / 3

Charm mesons in the LHCb fixed-target experiment: phenomenology and production asymmetry

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The production of open charm mesons in the fixed-target mode of the LHCb experiment provides a unique opportunity to study QCD dynamics at moderate center-of-mass energies and large Bjorken-x. In previous studies, the production of D mesons was investigated within the k_T-factorization approach, including the standard gluon–gluon fusion mechanism, the gluon–charm channel associated with intrinsic charm, and the recombination mechanism.

In this contribution we extend these studies by incorporating a more realistic description of the hadronization stage using the Pythia 8 event generator. This allows us to investigate the role of string fragmentation and the possible impact of color reconnection effects on the resulting D-meson spectra and production asymmetries. In addition, we explore the influence of nuclear effects in proton–nucleus collisions relevant for the fixed-target configuration of LHCb. For comparison, predictions obtained within the MadGraph5_aMC@NLO formalism matched to a parton shower (aMC@NLO+PS) will also be presented.

We analyze rapidity and transverse momentum distributions of D mesons and discuss their sensitivity to the modeling of hadronization in the backward rapidity region. The results are compared with available LHCb measurements, and the implications for the interpretation of charm production mechanisms in the fixed-target regime are discussed.

Collaboration:

Parallel session B1 / 16

Insights into the $\bar{K}N$ interaction and $\Lambda(1405)$ through model analysis of HAL QCD results

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Hadron-hadron interaction has been one of the most important topics in hadron physics, because it contains information on the quark dynamics inside hadrons, which will be a hint to understand the fundamental theory of strong interaction, quantum chromodynamics (QCD). Among various pairs of two hadrons, the $\bar{K}N$ system is one of the most interesting. It is well known that the $\bar{K}N$ interaction is strongly attractive and, as suggested in the chiral unitary model [1], dynamically generates the $\Lambda(1405)$ resonance.

Hadron-hadron interaction has been studied in lattice QCD simulations as well. In particular, the HAL QCD method has been established as a reliable method to study hadron-hadron potentials [2]. However, in the $\bar{K}N$ potential, singular behavior around the origin has been observed in the HAL QCD method [3]. In order to clarify the cause of such behavior in the HAL QCD method, we calculate the R-correlators and local potentials in an effective model of hadron-hadron interaction and compare it with the $\bar{K}N$ potential in the HAL QCD method.

[1] Hyodo and Jido, Prog. Part. Nucl. Phys. 67 (2012) 55.
[2] S. Aoki et al. [HAL QCD], Prog. Theor. Exp. Phys. 2012 (2012) 01A105.
[3] K. Murakami and S. Aoki, PoS LATTICE2023 (2024) 063; PoS LATTICE2024 (2025) 101.

Collaboration:

Parallel session A1 / 22

Two-Photon Exclusive Production of Fully-Charmed Tetraquarks at the LHC

Authors: Longjie Chen[1]; Wolfgang Schafer[1]; Antoni Szczurek[1]

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We present a leading-order NRQCD factorization analysis of the exclusive two-photon production of spin-0 and spin-2 fully-charmed tetraquarks, $\gamma\gamma \to T_{4c}\,(0^{++}, 2^{++})$. The respective short-distance coefficients are collected, enabling predictions for the two-photon decay widths $\Gamma\,(T_{4c} \to \gamma\gamma)$ in terms of non-relativistic long-distance matrix elements. Using these results, we provide estimates for the production cross sections of T_{4c} states via photon–photon fusion in ultra-peripheral collisions at the LHC. Our work provides crucial theoretical input for ongoing experimental searches and establishes a quantitative framework to discriminate between different structural configurations of the of the $X\,(6900)$.

Collaboration:

Parallel session B1 / **75**

Linking the lattice QCD picture of $\Lambda(1405)$ to the $\pi\Sigma - \bar{K}N$ coupled channels model

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In a recent paper [1], we generalized our chirally motivated $\pi\Sigma - \bar{K}N$ coupled channels model [2] to the cubic finite volume and used it to calculate the stationary energy spectrum that appears in a nice agreement with the spectrum obtained in the lattice QCD simulations by the BaSc collaboration [3, 4]. Interestingly, the hadron masses used by the BaSc collaboration were also found quite close to the mass trajectories adopted in [2] when going to the SU(3) flavor symmetric point.

Several other comparisons with the BaSc results were made in [1]. In particular, we demonstrated that the two poles of the scattering matrix found in the complex energy plane by the BaSc collaboration, a resonance just below the $\bar{K}N$ threshold and another one on the real axis close to the $\pi\Sigma$ threshold, transform into the standard two pole picture of the $\Lambda(1405)$ resonance when one reconciles gradually the LQCD hadron masses (and meson decay constants) with their physical values. We have also shown that the relatively large pion mass used in the LQCD simulations represents the main reason why one of the resonance poles degenerated into a virtual state reported by the BaSc collaboration.

References:
[1] P.C. Bruns, A. Cieplý, Eur. Phys. J. A 61, 44 (2025)
[2] P.C. Bruns, A. Cieplý, Nucl. Phys. A 1019, 122378 (2022)
[3] J. Bulava et al. (BaSc collaboration), Phys. Rev. Lett. 132, 051901 (2024)
[4] J. Bulava et al. (BaSc collaboration), Phys. Rev. D 109, 014511 (2024)

Collaboration:

Parallel session A1 / **40**

Three-body approach to T_{cc}^{+} from lattice QCD

Authors: Andre Baiao Raposo[1]; Andreas Stump[2]; Colin Morningstar[3]; Fernando Romero-Lopez[4]; Herzallah Alharazin[1]; Jeremy Green[5]; John Bulava[1]; Miguel Salg[4]; Sebastian Dawid[6]; Stephen Sharpe[7]

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I will discuss recent progress in applying a general theoretical framework to the study of three-body resonances in lattice QCD. As a concrete example, I will focus on the doubly-charmed tetraquark $T_{cc}^+(3875)$ emerging as a state in elastic $DD\pi$ scattering amplitude. After a short overview of the tetraqaurk physics and the finite- and infinite-volume field-theory formalism, I will describe results of the first three-body lattice QCD computation* of this state at pion mass $m_\pi \approx 280$ MeV. Our approach incorporates both DD^* and $DD\pi$ dynamics, including one-pion exchanges, and marks an important next step toward determining the properties of near-threshold three-body resonances directly from QCD.

*–perhaps still ongoing at the time of the conference.

Collaboration:

Parallel session B1 / 85

$\Lambda(1405)$ 'golden channel' measured in p+p at HADES

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Co-authors: Piotr Salabura [1]; Rafał Lalik [1]

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The nature of the (1405) hyperon remains one of the longstanding open questions in hadron physics. Since its prediction and discovery in the 1960s, its structure is still widely debated. With a mass located below the KN threshold, it cannot be explained within the constituent quark model. Furthermore, its line shape deviates from a Breit–Wigner distribution and depends on the production and decay channels. Interpretations of (1405) include a quasi-bound state KN and a dynamically generated meson–baryon molecule with a two-pole structure.

The exclusive channel pK^+ $(1405) \to (\,^0(\to\ (\to \mathrm{p}\pi^-)\gamma)\pi^0(\to \gamma\gamma))$ has been investigated using the HADES detector in proton–proton collisions at a beam energy of 4.5 GeV. The reconstructed invariant mass spectrum of $^0\pi^0$ shows clear contributions from the (1405) and (1520) resonances, as well as an enhancement near the masses of (1600), $\Lambda(1670)$, and $\Lambda(1690)$. Production of these states has been studied in function of the four-momentum transfer between the initial proton and the outgoing K^+. The obtained $(1405) \to\ ^0\pi^0$ mass distribution can be analyzed together with the pK^- invariant mass distribution, which shows an enhancement near the KN threshold. Potential for this study using a K-matrix formalism within a coupled-channel model will also be presented.

Collaboration:

HADES

Parallel session A1 / **78**

Quark mass dependence of the $T_{cc}(3875)^+$ pole

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Recently, several LQCD simulations have proven that the interaction in the isoscalar channel in DD^* scattering is attractive. This channel is naturally connected to the $T_{cc}(3875)^+$ which is observed in the $D^0D^0\pi^+$ invariant mass distribution. However, it remains an open question whether the virtual bound state found in these several LQCD simulations is actually linked to the LHCb experimental observation. In this article we perform an EFT-based analysis of the LQCD data and demonstrate that a proper chiral extrapolation leads to a T_{cc} pole compatible with experiment. At the physical pion mass, we find a virtual bound state with a binding energy $\Delta E = -0.06\,\binom{+1.30}{-2.20}\,\binom{+0.50}{-1.11}$. Moreover, we extract from a global analysis both the light and heavy quark mass dependence of the T_{cc} pole, and study the role of the ρ- and π-meson exchanges.

Collaboration:

Parallel session B1 / **72**

Investigation of the strangeness production in the reaction $pp \to ppK^+K^-$ at HADES

Author: Valentin Kladov[1]

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This talk presents the study of the strangeness production mechanisms in the reaction $pp \to ppK^+K^-$ reaction, analyzed using data collected with the HADES detector and a 4.5 GeV proton beam. The event selection is based on the particle identification, employing a domain-adversarial neural network, and a kinematic refit imposing four-momentum conservation. This results in the purity of the final sample reaching $S/B \approx 30$.
Clear contributions from $\phi(1020) \to K^+K^-$ and $\Lambda(1520) \to pK^-$ are observed, with masses and widths consistent with the PDG data. The differential cross sections are obtained and used in the amplitude and angular analyzes, yielding a number of observables such as non-resonant enhancement in the effective pK^- and K^+K^- FSI scattering-length parameterization and vector meson $\phi(1020)$ spin density matrix elements. Additionally, strong meson-baryon coupling forming the $\Lambda(1405)$ is investigated in the K-matrix formalism with two channels pK^- and $\Sigma^0\pi^0$. This talk focuses on the interpretation of the recent results, comparing the production dynamics insights with the previous studies closer to the production threshold.

Collaboration:

HADES

Parallel session A1 / 35

Recent Progresses on η_c(1S) Decays at BESIII

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The lowest-mass charmonium ground state, the η_c(1S), serves as a crucial laboratory for testing quantum chromodynamics (QCD) and understanding charmonium decay dynamics. Utilizing its world-leading data samples of J/ψ and ψ(3686) events, the BESIII experiment has recently achieved significant progresses in the study of η_c decays. This presentation will report three key results. First, we will present the first observation of the $_c\to^{00}$ decay, a hadronic decay mode involving a baryon-antibaryon pair. Second, we will report the first model-independent measurement of the absolute branching fraction of the $_c\to$ decay, in which a sample of 0.16 million $_c$ events are tagged via the channel $(3686)\to^0 h_c, h_c\to_c$ to avoid interference effects. Third, we will discuss a high-precision study of the magnetic dipole transition $J/\to_c$, where the $_c$ is reconstructed via its decay to $p\bar{p}$. It has significantly improved our knowledge of this key transition between charmonium S-wave states.

Collaboration:

BESIII

Parallel session B2 / 5

Three-body decays with Khuri-Treiman equations

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One of the main issues posed by the presence of hadrons in any reaction is their final-state interactions, which are formally expressed in terms of the unitarity of the amplitude. In two-body scattering, unitarity is usually imposed in the direct channel only, as one is not sensitive to the details of the crossed channels. This is certainly not the case for a three-body decay, where the three possible two-hadron channels are physical, and one ideally wants to impose unitarity in all channels at once. The Khuri-Treiman formalism is a dispersive approach which indeed allows one to do so. In this talk, I will review the contributions made by the JPAC Collaboration to this field with focus on various important applications, e.g. $V \to 3\pi$ ($V = \omega, \phi, J\psi$) and the related transition form factor $V \to \pi^0\gamma^*$, or the exotic $\pi_1(1600) \to 3\pi$ decay.

Collaboration:

Parallel session A2 / 52

Inclusive production of $\Upsilon(1S, 2S, 3S)$ mesons in proton-proton collisions

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Prompt production of Υ(1S,2S,3S) mesons in proton-proton collisions at the LHC within NRQCD k_t-factorization approach [1] will be discussed. Different unintegrated gluon distribution functions are used.We include both direct color-singlet production $gg \to \Upsilon(1S)g$ as well as feed-down from $\chi_b \to \Upsilon(1S)\gamma$ and $Upsilon(2S) \to \Upsilon(1S)X$. We calculate also the ratio of the cross sections for $\chi_b(2)\chi_b(1)$ and the corresponding results will be presented. We will compare our results for Υ production with the CMS experimental data [2] for different intervals of rapidity. Differential distributions in rapidity and transverse momentum of Υ states are calculated and compared to experimental data of the CMS [2] and LHCb [3] collaborations. We will present also results for different values of collision energy.

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Collaboration:

Parallel session A2 / 65

The $B^{(*)}\bar{K}^{(*)}$-coupled-channel system in the hidden-gauge approach

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In this work we provide predictions for bottom-strange molecular states within the Hidden Gauge Formalism. We study the coupled-channel scattering of $B^{(*)}\bar{K}^{(*)}$ states and, by fixing only one free parameter to obtain the mass of a new excited B_s^0 state seen by the LHCb, we predict the pole parameters of six states in this sector. Concretely, we get that the masses of the flavor partners of the $D_{s0}(2317)$ and $D_{s1}(2460)$ states in the bottom sector are 5760 and 5802 MeV for the $B\bar{K}$ ($J^P = 0^+$) and $B^*\bar{K}$ (1^+) states, respectively. Moreover, the recently seen states by the LHCb with masses around 6100 and 6160 MeV can be interpreted as $B\bar{K}^*$ and $B^*\bar{K}^*$ molecular states, according to reasonable values of the pole parameters and the splitting between these two states obtained in our calculation.

Collaboration:

Parallel session B2 / 28

Doubly radiative $\eta^{(\prime)}$ decays: interplay of vector, scalar, and tensor contributions

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We present a theoretical analysis of the doubly radiative decays $\eta^{(\prime)} \to \pi^0\gamma\gamma$ and $\eta' \to \eta\gamma\gamma$, including vector, scalar, and tensor meson exchange contributions. Vector meson dominance and the linear sigma model are used for vector and scalar exchanges, while the $a_2(1320)$ tensor meson is incorporated within a chiral framework. Vector meson exchange dominates all three channels.

For the $\eta \to \pi^0\gamma\gamma$ decay, the tensor meson contribution is small, but its destructive interference with the vector amplitude reduces the decay width by about 18%, bringing our prediction into excellent agreement with the recent KLOE-2 measurement. In $\eta' \to \pi^0\gamma\gamma$, the tensor contribution is negligible, as the decay is largely saturated by the on-shell ω resonance.

For $\eta' \to \eta\gamma\gamma$, scalar exchanges, especially the $\sigma(500)$, provide a sizeable contribution, making this channel a potential probe of the properties of this still poorly understood resonance. Our results provide a unified description of these decays and emphasize the phenomenological impact of vector–tensor interference in the $\eta \to \pi^0\gamma\gamma$ channel.

Collaboration:

Parallel session A2 / 137

Search for the Y(2175) in the Photoproduction Cross Section Measurement of γp → φπ+ π− p at GlueX

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Based on 334 pb−1 of photoproduction data collected with the GlueX detector at Jefferson Lab, we have measured for the first time the cross section of the exclusive reaction γ+ p → φ(1020)π+π−p by reconstructing the final state K+K−π+π−p produced with a photon beam of energies between 8.0 and 11.6 GeV. Based on the measured differential cross section, we have performed a search for the strangeoniumlike exotic candidate Y(2175), recently renamed to φ(2170). This state has been reported by different e+e−annihilation experiments and it is addressed here for the first time in a photoproduction
experiment. We do not find evidence for this state when using the resonance parameters quoted by the Particle Data Group and provide upper limits on the photoproduction cross section. Instead, we find a structure at a mass of m(φππ) = 2.24 GeV/c2 with a statistical significance of about 5σ. The parameters of this structure differ from those quoted by the Particle Data Group for the φ(2170) and are consistent with a previous observation in e+e−annihilation. In addition, there is evidence for a second structure at 1.82 GeV/c2.

Collaboration:

GlueX Collaboration

Parallel session B2 / 6

Studies of inclusive production of protons and charged pions and semi-exclusive channels in π−+C collisions at 0.7 GeV/c with HADES

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At beam energies of a few AGeV the pion production dominates the inelastic NN cross section. At these energies the pion dynamics is crucial to describe the evolution of heavy-ion collisions and drives the thermal properties of nuclear medium. Pion-nucleus scattering is an ideal tool to study properties of baryonic resonances in the nuclear medium.
Previous experiments extensively studied the Δ(1232) resonance region [1,2] and were performed mostly with positive pions focusing on total cross section measurements, including pion absorption or scattering and charge exchange reactions. By contrast, experimental information at higher energies, in particular in the second resonance region (N∗(1440),N∗(1520),N∗(1535), ...) and beyond, is still scarce. Such data are, however, essential as a benchmark for the description of heavy-ion reactions in dense hadronic matter at a few AGeV as will be explored at e.g. the FAIR facility.
In addition, differential pion and proton spectra from pion-induced reactions are highly relevant for the validation and further development of transport and cascade models. This is particularly important since cascade approaches are also widely used in applications such as GEANT4 e.g. by long base line neutrino experiments such as DUNE and T2K.
In this talk I will focus on the analysis of the π−+C data collected with the High Acceptance Di-Electron Spectrometer (HADES) [3], using the pion beam at the GSI facility at an incident pion momentum of 0.7 GeV/c. Pion and proton differential spectra have been measured in various exit channel topologies (inclusive, pπ−, pπ+, pp, π+π−,..., ππpp) and are compared to predictions of the INCL++ cascade [4] and of a set of transport models (SMASH [5], JAM2/RQMD.rmf [6], GIBUU [7]). The results provide stringent tests of the model description of quasi-elastic scattering, multi-pion production, re-scattering, and pion absorption.

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Collaboration:

HADES

Parallel session B2 / 30

Exclusive Measurement of the $^{12}\mathrm{C}(K^-, p)$ Reaction for Probing the $\bar{K}$-Nucleus Interaction at J-PARC

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The antikaon-nucleus ($\bar{K}$-nucleus) interaction is fundamental to understanding the low-energy QCD and the behavior of strangeness in dense nuclear matter. While kaonic atom X-ray spectroscopy has provided valuable information about the interaction at the nuclear surface, the strength of the potential in the nuclear interior has remained a subject of long-standing debate, characterized by the "shallow vs. deep" potential ambiguity. In particular, the imaginary part of the potential (W_0), which describes the absorption dynamics, has been poorly constrained ever. In this talk, we report the first experimental constraint on the imaginary part of the $\bar{K}$-nucleus optical potential through the exclusive measurement of the K^- emission process. The experiment (J-PARC E42) was performed at the K1.8 beamline. We simultaneously measured the inclusive $^{12}\mathrm{C}(K^-, p)$ and exclusive $^{12}\mathrm{C}(K^-, pK^-_{esc})$ reactions at 1.8 GeV/c, where K^-_{esc} is denoted as a quasi-free Kaon emitted without absorption in the core nucleus. Utilizing the large-acceptance Hyperon Spectrometer, we successfully detected the recoil K^- in coincidence with the forward proton. By performing a simultaneous likelihood fit to the inclusive and exclusive spectra, we extracted the potential depths at the nuclear center: $V_0 = -72^{+3}_{-5}(\mathrm{stat.})^{+0}_{-8}(\mathrm{syst.})$ MeV and $W_0 = -100^{+7}_{-1}(\mathrm{stat.})^{+0}_{-16}(\mathrm{syst.})$ MeV. The obtained W_0 is significantly stronger than predictions from standard chiral unitary models based on one-nucleon absorption, providing a quantitative indication of the dominance of multi-nucleon absorption processes ($K^-NN \rightarrow YN$) in the nuclear interior. We will discuss the details of the analysis, the extracted potential parameters, and their implications for the onset of kaon condensation in neutron star interiors.

Collaboration:

J-PARC E42

Plenary session / **101**

The FAIR/GSI facility - Status and future perspectives

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FAIR (Facility for Antiproton and Ion Research) is an international accelerator facility under construction at the site of the GSI Helmholtzzentrum für Schwerionenforschung in Darmstadt. FAIR will deliver a wide range of intense primary and secondary beams at relativistic energies, including radioactive beams of all elements and, in a later stage, antiprotons.
The existing GSI accelerators will become part of the future FAIR facility and serve as the first acceleration stage while simultaneously permitting a cutting-edge scientific programme using the existing installations. Within the currently approved funding scope, the vision of **FAIR2028** is being realised, where the new installations such as the SIS100 synchrotron and the Super-FRS fragment separator together with associated experimental caves and instrumentation is being combined with the existing GSI installations into a world-leading facility.
An overview of the science made possible with the new and upgraded installations will be made, illustrated by a number of recent scientific highlights. Furthermore, the effects and mitigation actions following a fire incident in the UNILAC injector during early 2026 will be elaborated upon.

Collaboration:

Plenary session / **93**

"QCD at FAIR": Hadron Physics Opportunities at FAIR

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A scientific vision is outlined for a decade-long, cross-community hadron-physics program at the GSI/FAIR accelerator complex. Driven by high-intensity proton and secondary pion beams, combined with versatile detector systems, the program will address key questions in 'strong QCD'. It encompasses precision studies of hadron–hadron interactions, hadron spectroscopy, and the electromagnetic structure of hadrons and their transitions, as well as investigations of in-medium modifications under extreme conditions. These efforts have implications for the nuclear equation of state, neutron star physics, and searches for physics beyond the Standard Model. This talk highlights the planned staged roadmap, from current SIS18 capabilities to SIS100 and, ultimately, toward a hadron-physics program exploiting stored antiproton beams at HESR.

Collaboration:

Plenary session / **107**

Future experimental programs at JLab

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Jefferson Lab is entering a transformative era, transitioning from a robust current experimental program to a future defined by high-precision measurements and significant facility upgrades. This presentation will provide an overview of the laboratory's scientific trajectory over the next decade and beyond. We begin by reviewing the ongoing experimental campaigns and the status of imminent projects, most notably the MOLLER experiment, which will provide world-leading constraints on the weak mixing angle.
Looking toward the near-term future, we will discuss the status and physics goals of the K-Long Facility (KLF) and the Hypernuclear physics program, both of which are poised to deepen our understanding of hadron spectroscopy and strange matter. Finally, we will offer a glimpse into the long-range strategic planning for CEBAF, highlighting the development of positron beams and the potential for a 22 GeV energy upgrade. These advancements will ensure that Jefferson Lab remains at the forefront of nuclear physics, offering unprecedented access to the valence quark structure of nucleons and nuclei.

Collaboration:

Plenary session / **63**

Overview of J-PARC: Hadron Experimental Facility – Status and Prospects

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The J-PARC Hadron Experimental Facility was constructed to explore the origin and evolution of matter in the universe through experiments using intense particle beams. Over the past decade, it has delivered significant results in both particle and nuclear physics. To further expand the physics

program into previously unexplored regions, an extension project for the facility is currently under active discussion.
In this presentation, we will outline the current status and future prospects of the Hadron Experimental Facility. In particular, we will highlight recent achievements and discuss the strategy for hadron and strangeness nuclear physics programs.

Collaboration:

Plenary session / **110**

Baryon Semileptonic Decays as Probes: Lattice QCD Determination of Transition Form Factors

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Semileptonic decays of baryons provide a complementary and increasingly powerful avenue for flavor physics beyond meson-based studies. In this talk, I present the current status and future program of lattice QCD calculations of baryon transition form factors, which are essential inputs for interpreting experiments and, in particular, for determining CKM matrix elements through independent cross-checks that may help resolve existing tensions. Beyond CKM phenomenology, baryon decays offer sensitivity to tests of lepton flavor universality, constraints on non-standard interactions, and precision studies of weak currents with distinct hadronic systematics, while also opening connections to neutrino physics. I will review recent lattice results, methodological advances, and ongoing efforts to control systematic uncertainties, and outline planned calculations for key channels of experimental interest, in synergy with measurements at LHCb and BESIII and future opportunities at FAIR (GSI).

Collaboration:

Plenary session / **96**

HADES results on baryon transition form factors

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New information on baryon resonance properties was provided in the recent years by the High Acceptance Di-Electron Spectrometer (HADES) collaboration using proton-proton or pion-proton measurements. In particular, the study of baryon resonance Dalitz decays (B -> N e+e-) allowed for an unprecedented access to the baryon timelike electromagnetic structure.
The main results of this program will be presented, with an emphasis on studies of the second resonance region using the GSI pion beam. Thanks to the combined measurements of two-pion and e+e- channels, the contribution of vector mesons to baryon timelike electromagnetic transition form factors could be quantified. Various theoretical approaches connecting information from hadronic and electromagnetic channels in the spacelike and timelike regime could also be tested, paving the way for an extension of the studies in the third resonance region.
Preliminary studies and prospects for radiative and Dalitz decays of hyperons will also be discussed.

Collaboration:

HADES

Plenary session / **98**

Meson Structure Study via Drell-Yan Production at AMBER Experiment

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Understanding meson structure through parton distribution functions (PDFs) remains a fundamental challenge in QCD. Existing pion PDF measurements rely on sparse, decades-old data from heavy nuclear targets, while kaon structure is constrained by only a few hundred events. Valence quark distributions have minimal experimental guidance, and sea quark and gluon content remain essentially unmeasured.

The AMBER experiment at CERN will address these limitations through high-statistics Drell-Yan measurements using 190 GeV hadron beams on light targets. The Drell-Yan program, approved as part of AMBER Phase-I (2023-2031), will conduct production running starting in 2029 following Long Shutdown 3, with approximately 280 days of data collection planned over two years.

Drell-Yan dimuon production directly probes quark distributions, while J/psi and psi' charmonium production provides complementary access to gluon PDFs. J/psi polarization measurements further constrain production mechanisms by distinguishing quark-antiquark annihilation from gluon fusion processes. The natural kaon component in the hadron beam enables simultaneous kaon structure measurements that will exceed existing datasets by an order of magnitude. AMBER will deliver the world's largest pion-induced Drell-Yan and charmonium sample within this decade, providing essential constraints for global PDF analyses and establishing benchmarks complementary to future Electron-Ion Collider measurements.

Collaboration:

AMBER

Plenary session / **100**

Vector Meson Dominance: Fact or Fiction

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This presentation will discuss the fidelity of the vector meson dominance (VMD) assumption as an instrument for relating the electromagnetic vector-meson (V) production reaction e(lectron) + p(roton) $\to$ e(lectron)' + V + p(roton) to the purely hadronic process V + p $\to$ V + p. It will also describe an alternative reaction model for exclusive photoproduction of light and heavy vector mesons from the proton, which exposes the quark-antiquark content of the photon. The analyses reveal that it is premature to link any γ + p $\to$ V + p data with, for instance, in-proton gluon distributions, the

quantum chromodynamics trace anomaly, or pentaquark production. Further developments in reaction theory and higher precision data are required before the validity of any such links can be assessed.

Collaboration:

Parallel session A3 / 8

Overview of eta/eta' decays

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As the mixing states of the pseudoscalar singlet and octet, eta/eta' offer an important laboratory to test the fundamental symmetries and to search for new physics beyond the Standard Model. In this talk, I will give an overview of the recent related progress and insights on eta/eta' decays at BESIII, KLOE/KLOE2. In addition, I will also include the prospect in eta/eta' decays that could be achieved in future proposed experiments.

Collaboration:

Parallel session C3 / 56

The GSI pion beam program: QCD-driven studies of hadron structure and dynamics

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This contribution describes plans and performance studies for the upcoming pion beam program at GSI. The program will utilize high-intensity secondary pion beams (< 2.8 GeV/c) in conjunction with the High-Acceptance Di-Electron Spectrometer (HADES), which offers large geometric acceptance, high positional and time-of-flight resolution, as well as dedicated dilepton detection capabilities. Aim is to probe the non-perturbative regime of QCD. This initiative is designed to advance our understanding of baryon spectroscopy and structure through precision measurements of baryon-meson coupling constants and electromagnetic transition form factors in the time-like region. The anticipated beam intensities will facilitate comprehensive partial wave analyses and the exploration of rare decay modes, providing critical insights into hadron dynamics and contributing to the refinement of dilepton emission models in heavy-ion collisions.
A key aspect of the program is the investigation of vector meson properties in cold nuclear matter via dielectron spectroscopy, offering a unique window into in-medium modifications and their connection to chiral symmetry restoration. By integrating nuclear, hadron, and heavy-ion physics, this program aligns with the overarching "QCD at FAIR" roadmap, while also complementing global efforts at photon beam facilities. The results are expected to deepen our knowledge of QCD-driven phenomena and foster collaboration across diverse physics communities.

Collaboration:

HADES

Parallel session B3 / 81

Strangeness Production at GlueX

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The GlueX experiment at Jefferson Lab is uniquely suited for exclusive studies of strangeness production using a linearly polarized photon beam and the large acceptance GlueX detector. The combination of exclusive event reconstruction and access to spin observables at photon energies between 8.0 and 8.8 GeV provides a clean environment to study t-channel exchange processes, particularly in reactions with weakly decaying recoil hyperons off the proton target.

In this talk, we focus on precise measurements of spin-dependent observables in $K^*(892)$ photoproduction with a recoiling Λ, which serves as a standard candle for the GlueX strange meson program. The well-established properties of the $K^*(892)$, together with the GlueX detector[1] and analysis framework[2], provide an ideal setting to develop and validate amplitude analysis methodologies that can be extended to more complex strange meson channels. In particular, the GlueX data show clear evidence of the $K^*(892)$ resonance in the $K\pi$ mass spectrum, along with structures at higher masses that may correspond to excited K^* states, enabling precise measurements of the K^* spin-density matrix elements and their correlations with the recoiling Λ polarization. This motivates a complete helicity amplitude based description that can be combined with GlueX's partial-wave analysis framework to fully exploit the statistical precision of the data while maintaining minimal model dependence.

We also highlight newly published measurements of baryon–antibaryon production in particular $\gamma p \to \Lambda\bar{\Lambda}p$[3], where cross sections are measured over a wide kinematic range. These results provide a framework for modeling the reaction mechanism in terms of Regge-like single and double t-channel exchange, enabling further studies of spin correlations and the role of strangeness in hadronization. In the broader context of the GlueX strangeness program, recent results include beam asymmetries in Σ^0 photoproduction[4], spin observables for $\Lambda(1520)$[5], ongoing studies of the $\Lambda(1405)$ lineshape, and investigations of excited $\Xi^{(*)}$ states. Together, these efforts illustrate the breadth of the GlueX strangeness program and its capability to provide a comprehensive picture of strange hadron production.

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Collaboration:

GlueX

Parallel session B3 / 50

First measurement of ϕ meson production in 30 GeV proton-nucleus reactions via di-electron decay at J-PARC

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We report the first result on ϕ meson production in proton-nucleus (copper and carbon) collisions at J-PARC using the 30 GeV proton beam, measured via its dielectron decay channel [1]. This measurement was performed at the newly constructed high-momentum beamline at J-PARC. We employed the dielectron spectrometer developed for the J-PARC E16 experiment [2], which aims to study in medium modifications of the ϕ meson mass spectrum, while analyzing 26.8 hours of E16 commissioning data. The invariant mass of the ϕ meson was successfully reconstructed through the dielectron decay channel. The obtained ϕ yield was converted into the total production cross section by assuming the kinematic distribution derived from the event generator JAM. The results are discussed in comparison with ϕ meson production in proton-proton collisions at comparable energies.
A 30 GeV proton beam incident on a fixed nuclear target corresponds to a nucleon-nucleon center of mass energy of $\sqrt{s} = 7.7$ GeV. This energy region is currently of great interest in heavy ion collision studies of QCD matter at moderate temperature and high baryon density. In particular, an enhancement of hadrons containing s or $\bar{s}$ quarks has been observed in this regime, prompting various theoretical interpretations. Although the present measurement was performed in proton-nucleus collisions, Ref. [3] points out that the strangeness suppression factor γ_s, defined as the relative pair creation probability of s quarks to u and d quarks, may increase even at around normal nuclear density. The present results and future data with improved statistics may provide valuable input for discussing the observed strangeness enhancement. To investigate such in medium effects, dielectron measurements, which are free from final state strong interactions, provide a powerful probe.
This study demonstrates that a dielectron measurement system has been successfully established at J-PARC. In this presentation, we introduce the system and its performance, and report the results obtained from the commissioning data.
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Collaboration:

J-PARC E16

Parallel session C3 / 66

Launch of Physics Data Taking for Dielectron Measurement of Vector Mesons in Nuclei at J-PARC E16

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The J-PARC E16 experiment is designed to study in-medium modifications of vector-meson mass spectra in 30-GeV proton–nucleus reactions through the e^+e^- decay channel. The experiment is being carried out at the high-momentum beamline of the J-PARC Hadron Experimental Facility with a dielectron spectrometer designed for high-rate and large-acceptance measurements in 30 GeV proton–nucleus reactions. Commissioning runs established the basic detector performance and analysis procedure required for dielectron measurements, including reconstruction of vector-meson signals, in particular the ϕ meson, in the presence of substantial hadronic background.

The experiment started physics data taking in November 2025. In this first physics run, 144 hours of physics data were collected with carbon and copper targets. A further data-taking period is planned for April 2026. Based on these data, preliminary analysis toward dielectron measurements of vector mesons in nuclei is in progress. In this presentation, we will describe the current status of the experiment and the spectrometer, together with an overview of the data taking up to April 2026, and present preliminary results from the first physics run.

Collaboration:

J-PARC E16

Parallel session A3 / 9

Electromagnetic isospin-breaking corrections to HVP from BMW lattice data

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Lattice data for the electromagnetic isospin-breaking correction to the hadronic vacuum polarization contribution (HVP) to the anomalous magnetic moment of the muon are analyzed in the framework of a phenomenological hadronic model. We find a steep chiral dependence and non-negligible finite-volume effects, which are quantified within the model.

Collaboration:

Budapest-Marseille-Wuppertal Collaboration (BMW)

Parallel session A3 / 32

Measurements of |Vcd(s)|, decay constants, and form factors in (semi)-leptonic D decays at BESIII

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The BESIII experiment has collected 20.3 fb^{-1} and 7.33 fb^{-1} of e+e- collision data at center-of-mass energies of 3.773 GeV and 4.128-4.226 GeV, respectively.
This presentation will provide an overview of recent studies using (semi)-leptonic D decays at BESIII. We will present the first experimental investigation of $D_s^{*+} \to l^+\nu$ decays, along with improved measurements of the CKM matrix elements |Vcd| and |Vcs|, and the decay constants $f_{D_s^+}$ and f_{D^+} via $D_s^+/D^+ \to \mu^+\nu$ and $\tau^+\nu$ decays. Furthermore, we will summarize the most precise results for the transition form factors in $D_{(s)} \to K, D \to \pi$, and $D_{(s)} \to \eta^{(')}$ decays. Complementing these leptonic studies, we will discuss progress in semileptonic analyses, including amplitude analyses and branching fraction measurements of $D_{(s)} \to hhl^+\nu$ and $hhhl^+\nu$ processes. These studies explore the hadron spectrum through scalar (a_0, f_0, σ), vector (K^*, ϕ), and axial-vector (K_1, b_1) mesons, and will present experimental results for form factors in decays such as $D \to a_0(980)$, $D \to \sigma$, $D \to K^*$, $D_s \to f_0(980)$, and $Ds \to \phi$.

Collaboration:

BESIII

Parallel session B3 / 89

Result of re-analysis of spectral modification of φ Mesons at finite density using PHSD transport approach in 12 GeV pA reactions

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This presentation reports on a re-analysis of the modification of the φ-meson mass spectrum in finite-density matter observed in the KEK-PS E325 experiment, using PHSD transport calculations.

Hadrons are considered to acquire most of their masses through spontaneous chiral symmetry breaking.
On the other hand, the quark condensate, which serves as an order parameter of spontaneous chiral symmetry breaking, is predicted to be partially restored in hot and/or finite-density environments.
Therefore, a direct measurement of hadron masses in environments such as finite-density matter is important for elucidating the mechanism of hadron mass generation.

The KEK-PS E325 experiment observed a modification of the φ-meson mass spectrum in a finite-density environment.
In this experiment, 12 GeV proton beam was incident on nuclear targets such as copper and carbon, and the invariant mass was measured by detecting the e+e- decays of the produced φ mesons.
Since the typical decay length of the φ meson is large compared with the nuclear size, the φ mesons observed in this experiment decay over a wide range of densities.
In the previous analysis, the measured invariant-mass spectra were classified according to the target nucleus and the βγ of the parent particle.
As a result, a significant spectral modification was observed in the spectrum for the larger nucleus and the slower parent particles, where the probability of in-medium decay was expected to be highest.

To quantitatively evaluate this spectral modification, the spatial distribution of the baryon density is crucial.
In the previous analysis, the Woods-Saxon distribution of the target nucleus was assumed for the density profile.
However, the target nucleus may begin to evolve in time due to the effects of the pA collision, and therefore it may be inappropriate to use the Woods-Saxon distribution as the density profile.
In the present work, we introduced PHSD transport calculations and performed a detailed simulation of the time evolution of the baryon spatial distribution during and after the pA collision.
By incorporating these results into the analysis of the experimental data, we carried out a quantitative evaluation of the spectral modification.
Furthermore, we included the theoretically predicted momentum dependence of the φ-meson mass shift and extracted momentum-dependent modification parameters.
In this presentation, we report on the analysis procedure and the results obtained.

Collaboration:

Parallel session C3 / 37

Study of In-Medium ϕ Meson Modification via $\phi \to K^+K^-$ Measurement at J-PARC E88/SAΦRE

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The J-PARC E88/SAΦRE experiment aims to investigate the properties of the ϕ meson inside the nucleus, to study in-medium modification associated with partial restoration of chiral symmetry in nuclear matter. The ϕ meson is measured via the hadronic decay channel $\phi \to K^+K^-$ in proton–nucleus collisions using a 30 GeV/c proton beam. Compared to previous measurements, E88 is expected to collect one million $\phi \to K^+K^-$ events, corresponding to several hundred times higher statistics, enabling precise studies of the ϕ meson spectral shape and its possible modification in nuclear matter. The measurement is complementary to the $\phi \to e^+e^-$ channel studied in the J-PARC E16 experiment, allowing a systematic comparison of hadronic and dilepton decay modes.

The experiment uses the E16 spectrometer, where additional detectors are installed for kaon identification. A dedicated kaon identification system has been developed, consisting of Start Timing Counters (SC), segmented plastic scintillation counters with MPPC readout, together with Multi-gap Resistive Plate Chambers (MRPC) providing time-of-flight measurements, and Aerogel Cherenkov Counters (AC) to suppress pion backgrounds at the trigger level. Combined with tracking detectors, the system enables particle identification, including K/π separation, in a high-rate hadronic environment.

A commissioning beam time is scheduled in April 2026 at J-PARC with a 1/6-scale detector setup. In this talk, we present an overview of the E88 experiment, the detector development, and results from the commissioning beam time.

Collaboration:

J-PARC E88

Parallel session C3 / 83

Development of New Secondary Beam at the J-PARC High-Momentum Beamline and Prospects for Hadron Physics and Interdisciplinary Applications

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At the high-momentum beamline of the J-PARC Hadron Experimental Facility, efforts are underway to develop a secondary beam mode. In the secondary mode, we will be able to utilize meson beams such as pions and kaons as well as anti-protons up to 20 GeV/c for various experiments in hadron physics and other research fields. Charmed-baryon spectroscopy with a 20 GeV/c π^- beam (E50) will become possible, and systematic studies of baryon excited states can be pursued through Ξ baryon spectroscopy with K^- beams (E97). In addition, multi-GeV muon beams could be transported, offering promising opportunities for interdisciplinary applications such as muon radiography.
In the test experiment T106, conducted in January 2025, positively charged secondary particles produced at the Lambertson magnet in the branching section were successfully transported and measured for the first time, providing a proof of principle for the secondary beam mode of the high-momentum beamline. As the next step for the secondary beam mode, the T112 and T113 experiments are expected to be scheduled for November 2026. The T112 experiment will transport

negatively charged secondary particles (π^-, K^-, $\overline{p}$) likewise produced at the Lambertson magnet and will systematically evaluate beamline performance for negative beams—including momentum resolution, beam intensity, and particle composition. The T113 experiment seeks to demonstrate muon radiography using a multi-GeV muon beam obtained from in-flight pion decay.
This talk reports on the current status of secondary beam development and the prospects it opens for hadron physics and interdisciplinary research.

Collaboration:

J-PARC MARQ

Parallel session A3 / 105

Semileptonic decays of hyperons at BESIII

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With the large datasets from e^+e^- annihilation at the J/ψ resonance collected by the BESIII experiment, multidimensional analyses leveraging polarization and entanglement can provide new insights into the hadronic structure of semileptonic decays. Recent studies at BESIII enable the measurement of form factor ratios of (anti)hyperons in the decays $J/\psi \to \Lambda\bar{\Lambda}$ and $\Xi^-\bar{\Xi}^+$. In combination with lattice QCD calculations, This allows to the extraction of the V_{us} matrix element for the first time in more than 20 years.

Collaboration:

Parallel session B3 / 44

Spectroscopy of η'-mesic nuclei in $^{12}\mathrm{C}(p, dp)$ reaction with the WASA-FRS setup

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The masses of mesons belonging to the nonet of pseudoscalar mesons are closely related to fundamental symmetry breaking in QCD. The η' meson, in particular, has an anomalously large mass due to the axial U(1) anomaly arising from nonperturbative gluon dynamics in the QCD vacuum. In the nuclear medium, where chiral symmetry is partially restored, a mass reduction of the η' meson is predicted in a range of 1–150 MeV/c^2 depending on the theoretical model, leading to an attractive potential between the η' meson and a nucleus. Consequently, the formation of η'-mesic nuclei, bound states of the η' meson with a nucleus, is expected if the mass reduction is sufficiently large.

To search for η'-mesic nuclei, we measured the excitation spectrum of the $^{12}\mathrm{C}(p, d)$ reaction near the η' meson production threshold at the FRS in GSI. We employed a 2.5 GeV proton beam incident on a 4 g/cm^2 ^{12}C target. The momenta of the ejectile deuterons were measured using the FRS and $\sim$1 GeV/c protons emitted backward from the decay of η'-mesic nuclei via the two-nucleon absorption process ($\eta' NN \to NN$) were simultaneously tagged using the WASA detector.

We obtained the excitation spectrum of the $^{12}\mathrm{C}(p, d)$ reaction near the threshold with an experimental resolution of 1.6 MeV, in coincidence with the 1 GeV/c protons detected in the WASA detector. The observed spectrum exhibited two structures below the threshold, suggesting the possible formation of η'-mesic nuclei. We fitted the spectrum with a sum of a theoretically calculated spectra

and a 3rd-order polynomial by scanning the real and imaginary parts of the η'-^{11}C optical potential, V_0 and W_0 respectively. A null-hypothesis testing was performed to evaluate the statistical significance, resulting in local and global significances of 3.5σ and 2.1σ, respectively. The analysis result indicated $V_0 = -61 \pm 1 \pm 5$ MeV and $|W_0| \leq 10$ MeV (68\% C.L.).

In this presentation, we discuss the details of the experiment, the data analysis, and the result of the experiment.

Collaboration:

η-PRiME Collaboration and Super-FRS Experiment Collaboration

Parallel session A3 / 118

Neutral and charged pion Form Factors from double-dilaton HQCD model

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We compute the Form Factors of both neutral and charged pion using a non-perturbative running of the strong-coupling constant αs obtained using a double-dilaton Holographic QCD model. These form factors remain poorly understood in the intermediate-energy region, which marks the transition between low- and high-energy physics. In particular, experimental data for the neutral pion Form Factor exhibits a deviation from the expected asymptotic behavior, and the charged pion form factor remains comparatively less explored. To address these issues, we employ the pion distribution amplitude formalism to investigate the Form Factor behavior in this intermediate regime. Our results suggests that non-perturbative physics of the strong interaction is relevant even at energy scales traditionally considered perturbative, implying that the perturbative regime could occur at higher energies than previously thought. Finally, our approach allows us to study isospin-breaking effects through the quadratic pion mass difference.

Collaboration:

Parallel session C3 / 87

Novel Approach for Measuring ISR Photons at BESIII

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Utilizing Initial State Radiation (ISR) events, the hadronic cross section in electron-positron (e^+e^-) production can be measured over a wide energy range at e^+e^- colliders. Due to the high luminosity at beam energies between 1.8 and 5.0 GeV, the BESIII experiment at the BEPCII collider is particularly

well-suited for this purpose. Since ISR photons are predominantly emitted at small angles relative to the incoming particles, a large fraction escapes detection in the existing BESIII detector system. For that reason, a novel detector, the crystal Zero Degree Detector (cZDD), is installed at BESIII to cover very small polar angles and detect ISR photons. Positioned between the beam pipes, it tags ISR photons emitted at small polar angles between 0.1° and 0.7° with respect to the beam axis.
An overview of the detector setup and the prospect of hadronic cross-section measurements using ISR events tagged with the new cZDD is presented. This is especially relevant in the context of data-driven determinations of the muon anomalous magnetic moment.

Collaboration:

BESIII

Parallel session B3 / 23

Comments on the hypertriton binding energy

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The Lambda binding energy (B_L) of the hypertriton (Lambda-p-n) places a major constraint on the Lambda-Nucleon interaction, particularly on its spin dependence. It is also correlated with the hypertriton lifetime [1]. Recent experiments give a broad spectrum of values for B_L: from 63(+38/-31) keV (J-PARC E73 [2]) to 523+/-76 keV (A1, MAMI [3]).

In this talk I will discuss possible ambiguities in the deduction of these two extreme values, suggesting in particular that MAMI's large value of B_L could have arisen from misidentifying the origin of the observed weak-decay pion momentum, which fits also weak decays of the L7He hypernucleus [4].

[1] D. Gazda, A. Perez-Obiol, A. Gal, E. Friedman, PRC 109 (2024) 024001.
[2] T. Akaishi, et al., PLB 873 (2026) 140163.
[3] R. Kino, et al., arXiv:2601.08694 (accepted to PRL).
[4] A. Gal, arXiv:2604.18259

Collaboration:

Parallel session B4 / 76

Analysis of production and decay channels of hyperons in the HADES experiment

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This work presents the first comprehensive study of inclusive Σ(1385)± hyperon production in proton–proton collisions at a kinetic beam energy of 4.5 GeV, performed with the High-Acceptance Di-Electron Spectrometer (HADES) at GSI. The Σ(1385)± resonances were reconstructed via their dominant hadronic decay channels Σ(1385)± ⟶ Λπ±, with subsequent Λ ⟶ pπ- decay. Extraction of a

clean signal was achieved using advanced background suppression techniques, including machine-learning-based event selection.
Efficiency and acceptance corrections were obtained from detailed simulations of various exclusive production channels using the PLUTO event generator, constrained by known cross-section and model calculations. Differential distributions in transverse momentum and rapidity were extracted over a broad kinematic range, benefiting from the extended HADES acceptance provided by a new Forward Detector. The Σ(1385)+ rapidity distribution exhibits forward–backward peaking, consistent with a t-channel production mechanism dominated by pion exchange, in agreement with previous exclusive measurements. In contrast, Σ(1385)− production is more centered around mid-rapidity. The results will be presented and compared to the available model calculations.

Collaboration:

HADES

Parallel session C4 / 18

Exclusive production of $\pi^+\pi^-$ pairs in diffractive photon-proton and in proton-proton collisions within the tensor-pomeron approach

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We discuss the central exclusive photoproduction of $\pi^+\pi^-$ pairs in diffractive photon-proton and in proton-proton collisions at high energies. We consider the resonant (ρ, ω, $f_2(1270)$) and non-resonant (Drell-S\"oding) contributions. Our calculation is based on the tensor-pomeron approach. We present a completely new calculation of the non-resonant term for the reaction $\gamma p \to \pi^+\pi^- p$. Our result is derived in the framework of Quantum Field Theory (QFT). We extend the calculation to virtual photons with $Q^2 < 1.5$ GeV^2. For the $pp \to pp\pi^+\pi^-$ reaction, we calculate differential cross sections as a function of the two-pion invariant mass. We discuss the important role of the Drell-S\"oding mechanism in shaping the resonance line. Our research is relevant in the context of ALICE, ATLAS, CMS, and LHCb measurements in proton-proton collisions at the LHC, even when the leading protons are not detected and instead only rapidity-gap conditions are checked experimentally. Our results can also serve as basis for the description of coherent dipion production in ultra-peripheral pA and AA collisions. This approach can be directly applied to the analysis of photoproduction and small-Q^2 electroproduction in ep collisions at high energies. Such data exist from the HERA experiments and will be obtained in the future at the electron-ion colliders.

The presentation is based on arXiv:2508.06334 [hep-ph], in print in JHEP.

Collaboration:

Parallel session A4 / 17

Mechanisms of $D\bar{D}$ pair production in $e^+e^- \to e^+e^- D\bar{D}$ and $AA \to AAD\bar{D}$ reactions and production of exotic charmonia

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We discuss the production of $D\bar{D}$ pairs in e^+e^- collisions,
where D refers to either D^0 or D^+ [1].
The continuum mechanism with the t/u-channel vector-meson D^*
exchanges are considered. The results of the calculation depend
on the parameter of the off-shell form-factor for the virtual D^*
mesons. The $D^*D\gamma$ coupling constants are found from
the $D^* \to D\gamma$ decays.
We find relatively large contribution for the $D^0\bar{D}^0$ channel
and much smaller contribution in the D^+D^- channel.
In the second case we consider also the $D^\pm$ exchanges.
We conclude that the bump at $M_{D^0\bar{D}^0} = 3.8$~GeV
observed by the Belle and BaBar Collaborations has rather
continuum origin than it corresponds to the broad resonance
$\chi_{c0}(3860)$.
We discuss also production of the $\chi_{c2}(3930)$ resonance
which is a candidate for the $\chi_{c2}(2P)$ state.
This state can decay into both $D\bar{D}$ channels, however
the branching fractions are not well known at present.
From a comparison of our model results to the BaBar data we find
$B(\chi_{c2}(3930) \to D\bar{D}) = 0.58 \pm 0.13$
using the two-photon width $\Gamma_{\gamma\gamma} = 0.544$~keV
(obtained for the Buchm{\"u}ller-Tye potential)
evaluated within the light-front approach (NRQCD limit).
Our finding of
$\Gamma_{\gamma\gamma} \times B(\chi_{c2}(3930) \to D\bar{D}) = 0.32 \pm 0.07$~keV
is close to the Belle and BaBar results.
Realistic predictions of the differential distributions in several variables
and integrated cross-sections are given for the Belle~II kinematics.

We discuss also a possibility to measure $D\bar{D}$ production in
ultraperipheral heavy ion collisions.

1) I. Babiarz, P. Lebiedowicz, W. Sch\"afer and A. Szczurek,
"Competition of $\chi_c(2P)$ quarkonia and continuum in $e^+e^- \to e^+e^-D\bar{D}$",
Phys. Let. B75 (2026) 140307.

Collaboration:

Parallel session B4 / 26

Compositeness of near-threshold exotic hadrons in systems with Coulomb and short-range interactions

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Recent experiments have discovered various exotic hadrons near scattering thresholds, stimulating interest in their internal structure. For short-range s-wave interactions, the structure of near-threshold states has been clarified based on the low-energy universality: shallow bound states below threshold tend to be dominated by the hadronic molecular component [1], whereas narrow resonances slightly above threshold do not [2]. Near-threshold states also appear in systems with the Coulomb plus short-range interactions, such as two-baryon systems with heavy quarks studied in lattice QCD [3] and exotic nuclei [4]. For charged systems, the Coulomb interaction modifies the scattering amplitude even in the low-energy region, and the structure of near-threshold states cannot be understood by directly applying the pure short-range results.

In this work, we investigate near-threshold states in systems with Coulomb plus short-range interactions, describing the scattering amplitude using the Coulomb scattering length and the Coulomb effective range [5,6,7]. To quantify their internal structure, we evaluate the compositeness, which characterizes the molecular nature of the eigenstate [8]. We show that the behavior of the compositeness near the threshold is governed by the competition between the short-range and Coulomb interactions. In particular, when the Bohr radius is larger than the magnitude of the effective range, the compositeness increases in the near-threshold region as a remnant of the short-range low-energy universality, whereas this enhancement disappears when the Coulomb interaction becomes dominant with smaller Bohr radius [6,7]. Applying this framework to exotic hadrons and hypernuclei, we obtain results consistent with experimental observations, precise few-body calculations, and findings from the lattice QCD studies, and show that the molecular nature of near-threshold states can be understood as a common consequence of the remnant of the low-energy universality.

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[3] Y. Lyu, H.Tong, et al. [HAL QCD Coll.], Phys. Rev. Lett. 127 (2021) 072003.
[4] E. Hiyama, M. Isaka, T. Doi, and T. Hatsuda, Phys. Rev. C 106, 064318 (2022).
[5] R. Higa, H. W. Hammer, and U. van Kolck, Nucl. Phys. A 809, 171 (2008).
[6] T. Kinugawa and T. Hyodo, arXiv:2507.22399 [hep-ph].
[7] T. Kinugawa and T. Hyodo, arXiv:2602.20678 [hep-ph].
[8] T. Kinugawa, T. Hyodo, Eur. Phys. J. A 61, 154 (2025).

Collaboration:

Parallel session C4 / 7

Scalar Mesons: $q\bar{q}$–Tetraquark Mixing

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The Particle Data Group (PDG) lists three scalar nonets, denoted $0^+_A, 0^+_B, 0^+_C$: one containing $[a_0(980), K^*_0(700)]$, another containing $[a_0(1450), K^*_0(1430)]$, and the third containing $[a_0(1710), K^*_0(1950)]$. We begin by noting that, within the tetraquark picture, two distinct color-spin structures are required to describe the tetraquark configurations of the $[a_0(980), K^*_0(700)]$ and $[a_0(1450), K^*_0(1430)]$ nonets. A notable challenge in understanding these states is the unexpectedly small mass difference between $a_0(1450)$ and $K^*_0(1430)$. In this work, we explore an additional mixing mechanism to address this puzzle, namely the $q\bar{q}$–tetraquark mixing, which may account for the $[a_0(1450), K^*_0(1430)]$ and $[a_0(1710), K^*_0(1950)]$ nonets [Reference: PRD 111, 054016 (2025)].

Collaboration:

Parallel session A4 / 49

Investigation of the $D\pi$ spectrum from a neural-network tuned heavy-quark action

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We present the spectrum of the $D\pi$ meson-meson scattering system on the 2+1-flavor lattice ensembles X451 and N451 produced by the CLS consortium with pion masses of approximately 287 MeV. The spectrum was produced for center-of-mass momenta up to $P^2 = 4$. The employed heavy-quark action was tuned non-perturbatively using a neural network and continuum charmonium ground-state masses. Meson correlation functions were produced using the stochastic distillation scheme. Investigating the $D\pi$ spectrum is an initial step for the extraction of scattering amplitudes to perform a full scattering analysis of the $D\pi$ system using L\"uscher's finite volume method.

Collaboration:

Parallel session B4 / 31

The Sill distribution for p-wave and beyond

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The description of short-lived resonances in high-energy physics is commonly based on the relativistic Breit–Wigner spectral function, which, despite its phenomenological success, does not satisfy certain fundamental constraints, most notably the presence of a non-zero energy threshold. More consistent approaches are therefore required; one such alternative is the Sill distribution (see, e.g., Eur. Phys. J. A 57 (2021) 336), which incorporates the correct threshold behaviour and has been employed in experimental analyses, including by the ALICE collaboration (Eur. Phys. J. A 61 (2025) 194). In this work, we extend this framework beyond the s-wave case by constructing its p-wave (and, more generally, l-wave) generalisation, obtaining simple expressions depending on a small set of parameters, suitable for applications in collider data analyses, such as those for Δ resonances.

Collaboration:

Parallel session C4 / 21

Baryon-Meson Couplings using Partial Wave Analysis Techniques at the HADES Experiment

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The High Acceptance Di-lepton Spectrometer (HADES) at GSI plays a crucial role in exploring baryonic resonance characteristics and their mesonic decay channels. The pion-beam facility at GSI enables the direct formation of baryonic resonances at a fixed center of mass energy ($\sqrt{s}$) in the s-channel. This provides a distinct advantage over proton-induced reactions and complements photo-induced studies conducted at other facilities. Partial Wave Analysis (PWA) techniques are indispensable for unraveling the intricate coupling of these resonances to various final states, particularly those involving two and three pseudoscalar meson production. Elementary pion-induced reactions on the proton, coupled with rigorous PWA, will yield unprecedented insights into the couplings of baryonic resonances to ρN and ωN final states. Such studies are vital for shedding light on phenomena like the melting of the ρ meson in heavy-ion collisions and the role of intermediary vector mesons in dilepton emissions.\\

In anticipation of a more comprehensive exploration of the resonance regions in pion-nucleon and nucleon-nucleon collisions a modular Partial Wave Analysis software package is currently under development. This experiment-agnostic package implements advanced frameworks, including the K-Matrix and N/D methods, designed for a refined and robust mapping of these resonance regions. This development is particularly timely given the approval of significant pion beam time at the GSI facility for the upcoming years, specifically targeting the third resonance region. Furthermore, a proposed pion beam experiment at the J-PARC facility in Japan is anticipated to complement the pion beam experiments at HADES, underscoring the long-term importance and applicability of this versatile PWA framework.\\

We will present the current status of this software, showcasing illustrative fits of the HADES pion-proton reactions in the second resonance region, demonstrating its capabilities and the significant potential of this new analytical framework for the upcoming experimental campaigns.

Collaboration:

HADES

Parallel session A4 / 74

Revealing the puzzle of the two D_0^* resonances and their connections with the flavor multiplets from analysis of Lattice QCD

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One or two D_0^* resonances with strangeness $S = 0$, isospin $I = 1/2$ dynamically generated in pseudo-scalar meson octet and heavy mesons scattering are still a puzzle. In this talk, I will present that there are two D_0^* resonances generated by ChPT up to NLO. The LECs of the interaction are constrained by the energy levels simulated by LQCD in $(S, I) = (0, 1/2), (1, 0), (-1, 0)$, and $(-1, 1)$ sectors. By studying the pion mass dependence of the two resonances and extrapolating to SU3 flavor symmetry point, we show that one resonance is connected to irreducible presentation **3**, and the other resonance is connected to **6**.

Collaboration:

Parallel session B4 / 64

Beta Decay Correlations Program at the Spallation Neutron Source

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Recent progress in both theory and experiment has left the unitarity of the quark mixing matrix (CKM) somewhat of an open question. The Nab experiment at the Spallation Neutron Source is designed to improve precision of the extraction of the first matrix element and shed light on experimental tensions within the neutron beta decay dataset. Nab's asymmetric spectrometer allows coincident reconstruction of the decay proton and electron energies, which are used to determine the electron-neutrino correlation coefficient. Additionally, its design lends itself to future use for a program of polarized decay correlation coefficient measurements in the same apparatus.
This talk will present preliminary results from Nab's first data collection runs, plans for the upcoming campaign and proposed measurements for the future. Finally, we will present an outlook for the program's sensitivity in tests of CKM unitarity and to new physics beyond the Standard Model.

Collaboration:

Parallel session C4 / **27**

Studying Production Mechanism of the N^* and Δ in Proton-Proton Collisions using HADES data

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Excited nucleon states (N^* and Δ resonances) provide an important probe of the non-perturbative regime of Quantum Chromodynamics (QCD) and the internal structure of baryons. In this work, we study the production mechanisms of these resonances in the reaction $pp \to NN\pi$, which also serves as a baseline for interpreting heavy-ion collision data. The High Acceptance Di-Electron Spectrometer (HADES) at GSI Darmstadt, a versatile magnetic spectrometer with large angular acceptance, is well suited for such studies.

This analysis focuses on the exclusive production of N^* and Δ channels in proton–proton collisions at $\sqrt{s} = 3.47$ GeV and aims to extract their coupling strengths. We present results from the analysis of proton–proton scattering data collected by the HADES collaboration in February 2022, together with preliminary comparisons to fits obtained using the Jülich–Bonn (JüBo) dynamical coupled-channel model. Finally, we discuss the applicability of the fitting framework, implemented with AmpTools, to other exclusive channels, including reactions involving strangeness.

Collaboration:

HADES

Plenary session / **111**

Light meson spectroscopy at BESIII

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Using the world's largest samples of J/ψ and ψ(3686) events produced in e+e- annihilation, BESIII is uniquely positioned to investigate light hadrons in radiative and hadronic charmonium decays. This includes detailed studies of exotic hadron candidates such as multiquark states, hybrid mesons and glueballs. Recent highlights on the light exotics searches, including a glueball-like particle X(2370) , exotics state π1(1600), new production mode of exotics ⊠1(1855), as well as the new strangeonium state X(2300), will be presented.

Collaboration:

BESIII

Plenary session / **117**

Meson spectroscopy at JLab

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Meson spectroscopy provides key insight into the non-perturbative regime of Quantum Chromodynamics (QCD), including confinement and the role of gluonic excitations. In particular, the search for exotic and hybrid mesons beyond the conventional quark–antiquark picture remains a central goal of current hadron physics. At Jefferson Lab, a comprehensive program combines measurements from the CLAS and CLAS12 detectors in Hall B with the GlueX experiment in Hall D. CLAS/CLAS12 enable detailed studies of exclusive meson electroproduction and photoproduction over a broad kinematic range, while GlueX focuses on photoproduction with linearly polarized photons to identify hybrid mesons.
Recent results and ongoing analyses are presented, together with developments in AI-based tools for event reconstruction and data analysis, enabling efficient extraction of rare signals from high-dimensional datasets.

Collaboration:

Plenary session / **2**

Photophoroduction of Mesons

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The search for exotic hybrid mesons—states with explicit gluonic degrees of freedom—is a primary goal of modern hadron spectroscopy. Understanding the production mechanisms of conventional

mesons is a prerequisite for identifying these exotic states. Photoproduction at Jefferson Lab provides a unique laboratory for this, utilizing the high-energy, linearly polarized photon beams of the GlueX and CLAS12 experiments.

A central theme of this discussion is the utilization of polarization observables for spectroscopy. We evaluate the extraction of spin density matrix elements (SDMEs) and beam asymmetries using both real and virtual polarized photon beams.

Furthermore, we discuss the current status of the search for exotic J^{PC} states. We highlight how the high-precision spin-physics data from JLab constrain the production models necessary for robust Partial Wave Analysis (PWA).

This presentation will include the latest available results and a look toward future developments in the JLab hadron spectroscopy program.

Collaboration:

Plenary session / **36**

Light-Meson Spectroscopy at COMPASS

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The COMPASS experiment at the CERN SPS is a multi-purpose fixed-target experiment designed to study the strong interaction. Using a 190 GeV/c hadron beam, COMPASS has recorded the world's largest data set of diffractive scattering reactions. These data provide a unique opportunity to study the excitation spectrum of non-strange and strange light mesons with masses up to about 2.5 GeV/c^2, as well as to investigate exotic states beyond the constituent quark model. This is achieved by performing comprehensive partial-wave analyzes of various final states, which decompose the data into amplitudes with well-defined quantum numbers and allow for the extraction of resonance parameters of the contributing mesonic states.
Of special interest is the exotic $\pi_1(1600)$, the lightest hybrid meson candidate with $J^{PC} = 1^{-+}$, which has been observed at COMPASS in all predicted dominant decay channels, including $\eta'\pi^-$ and $f_1(1285)\pi^-$, both observed in the $\pi^-\pi^-\pi^+\eta$ final state, and $b_1(1235)\pi^-$, observed in the $\omega\pi^-\pi^0$ final state. The $K^0_S K^-$ final state allows for a precise measurement of a_J states with even spins J and enables an exclusive study of these mesons at high masses, which is a hitherto unexplored region. We further present the analysis of the $K^-\pi^-\pi^+$ final state, representing the most comprehensive measurement of the strange-meson spectrum to date, revealing the first evidence for a supernumerary $J^P = 0^-$ state.
In addition, we discuss the analysis of the non-resonant double-Regge exchange process using $\eta^{(\prime)}\pi$ data in the high-mass region. It is the first event-based likelihood fit to the full COMPASS data set in this regime and improves our understanding of non-resonant production mechanisms in light-meson spectroscopy.

Collaboration:

COMPASS

Plenary session / **95**

J/ψ Near-threshold Quasi-Real Photoproduction at CLAS12

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J/ψ near threshold photoproduction plays a key role in the physics program at the Thomas Jefferson National Accelerator Facility (JLab) 12 GeV upgrade due to the wealth of information it has to offer. J/ψ photoproduction is predicted to proceed through the exchange of gluons in the t-channel, enabling unique insight about the nucleon mechanical form factors and the nucleon mass radius.

The JLab-based CLAS Collaboration, using the CEBAF Large Acceptance Spectrometer (CLAS12), aims to measure the near-threshold quasi-real J/ψ photoproduction cross section across a range of targets. Recent measurements on a liquid helium target have studied J/ψ production on the free proton, enabling estimates of the proton mechanical form factors from the measured cross sections. Measurements on a liquid deuterium target provide the opportunity to compare proton and neutron mechanical form factors and mass radii, through a first determination of cross sections off bound neutrons within the deuteron. CLAS12 has also collected data on a range of heavier nuclear targets, from carbon to lead, which will be used to study possible modifications of the gluon structure of bound nucleons in nuclei. Measurements with a longitudinally polarised target may further clarify the near-threshold production mechanism, crucial for relating J/ψ production to the gluon structure of the nucleon. Finally, the approved upgrade of CLAS12 to a muon spectrometer (μCLAS12) will enable high-statistics J/ψ electroproduction at larger quasi-real photon virtualities.

This talk will review recent, ongoing, and proposed measurements of near-threshold quasi-real J/ψ photoproduction at CLAS12, outlining a coherent research programme to probe the gluon structure of the nucleon.

Collaboration:

CLAS

Parallel session B5 / **47**

Testing charge conjugation invariance: From pions to positronium

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Bound systems composed of matter-antimatter are known to provide substantial testing ground for fundamental symmetries and decay dynamics. For example the lightest quark-antiquark system, the neutral pion π_0, which decays predominantly into two photons ($\sim$ 98.82$\%$). Due to Charge conjugation (C) symmetry π_0 cannot decay into three photons. However, if calculated the branching ratio (BR) of $\pi_0 \to 3\gamma$ with respect to $\pi_0 \to 2\gamma$, with amplitude consistent with gauge invariance and Bose symmetry intact, the BR is extremely suppressed ($\sim 10^{-31}$). Such decays are a straightforward test for the invariance of C-symmetry. The present experimental upper limit on this decay channel is 3×10^{-8} at 90 $\%$ C.L.

Since the π_0 production typically requires high energy proton beams or photons of GeV scale, a low-energy alternative is the electron-positron bound state called Positronium (Ps). Ps is produced in the interaction of positron with electron in a porous material medium into two states - singlet, para-Positronium (p-Ps) and triplet ortho-Positronium (o-Ps). Due to C-symmetry, o-Ps (p-Ps) decays

into even (odd) number of photons. The decay dynamics of p-Ps is additionally constrained by the bosonic nature of the photons, which forbids its decay into a configuration of 4 photons flying off in the direction of a regular tetrahedron vertices. Hence, observation of o-Ps decaying into this particular configuration could be used to test the violation of C-symmetry while mitigating the major background from p-Ps. Utilizing the triggerless data acquisition in the modular J-PET detector, we obtain a non-zero detection efficiency for such rare events. In this presentation, the ongoing study of this forbidden decay with the J-PET detector shall be discussed.

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Collaboration:

J-PET

Parallel session A5 / 19

Central exclusive production of η and η' mesons in diffractive proton-proton collisions at the LHC

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We discuss central exclusive production (CEP) of η and $\eta'(958)$ mesons in diffractive proton-proton collisions at high energies [1]. The amplitudes, including pomeron and f_{2R}-reggeon exchanges, are calculated within the tensor-pomeron model. Absorption effects are also taken into account at the amplitude level. We fit some undetermined model parameters (coupling constants and cutoff parameters in form factors) to the WA102 experimental data and then make predictions for the LHC energy $\sqrt{s} = 13$ TeV. Cross sections and differential distributions are presented and discussed. For $pp \to pp\eta$, we find an upper limit for the total cross section of 2.5 μb for pseudorapidity of the η meson $|\eta_M| < 1$ and 5.6 μb for $2 < \eta_M < 5$. For $pp \to pp\eta'$, we predict the cross section to be in the range of 0.3–0.7 μb for pseudorapidity of the η' meson $|\eta_M| < 1$ and 0.9–2.1 μb for $2 < \eta_M < 5$. This opens the possibility to study diffractive production of pseudoscalar mesons in experiments at the LHC.
We also discuss CEP of the pseudovector meson $f_1(1285)$ in diffractive proton-proton collisions. We show that for a scalar pomeron these pomeron-pomeron fusion reactions are not possible. Thus, experimental observation of any of these particles in the above CEP processes at the LHC would give striking evidence against a scalar character of the pomeron.

[1] Central exclusive production of η and η' mesons in diffractive proton-proton collisions at the LHC within the tensor-pomeron approach, Phys. Rev. D112 (2025) 3, 034016

Collaboration:

Parallel session A5 / 61

Study of exclusive η meson production in proton-proton collisions with HADES

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Proton–proton collisions at a beam energy of 4.5 GeV, measured with the HADES detector at GSI, provide a great opportunity to study the production mechanisms of mesons. At this energy, the production of mesons occurs in the transition region between near-threshold energies, well described by effective Lagrangian models, and the regime, where Regge phenomenology can be applied. Measurements at these energies help to bridge both descriptions and contribute to a better understanding of nonperturbative QCD dynamics. In addition, these studies are also important to provide a reference for the interpretation of dilepton spectra in proton–proton and heavy-ion collisions.

The collected data provide high statistics of η mesons reconstructed in the $\pi^+\pi^-\pi^0$ decay channel. The recently installed Forward Detector enables measurements in previously inaccessible regions of phase-space. The analysis includes kinematic fitting with missing π^0 mass constraint, background subtraction and acceptance and efficiency corrections.

In this contribution, preliminary total and differential cross sections for exclusive η production will be presented. The differential results include angular distributions and invariant-mass spectra, which are crucial for probing the underlying production dynamics. The results will also be compared with selected effective Lagrangian models calculations.

Collaboration:

HADES

Parallel session B5 / 62

Leptophobic B-boson searches with $\eta \to \pi^0\gamma\gamma$ and $\phi \to \pi^0\eta\gamma$ decays

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The possibility for the existence of a leptophobic $U(1)$ gauge boson associated to baryon symmetry is scrutinized in the MeV-GeV mass range by means of an exhaustive analysis of the corresponding golden channels $\eta \to \pi^0\gamma\gamma$ and $\phi \to \pi^0\eta\gamma$.
Using the latest experimental data on these two processes and taking also into account the Standard Model contributions from scalar and vector meson exchanges, we are able to obtain the best 95% exclusion limits up to date for the mass m_B and coupling α_B to known particles of this hypothetical B boson.

Collaboration:

Parallel session B5 / 102

A new measurement of the $K^+ \to \pi^+\nu\bar{\nu}$ branching ratio at the NA62 experiment

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The $K^+ \to \pi^+\nu\bar{\nu}$ decay is a golden mode for flavour physics. Using data collected in 2016–2022, NA62 announced the first observation of this decay with a signal significance above 5σ and the measurement $B(K^+ \to \pi^+\nu\bar{\nu}) = \left(13.0^{+3.3}_{-3.0}\right) \times 10^{-11}$. New results from the analysis of the 2023–2024 dataset are presented. This dataset doubles the effective sample size, leading to a 5σ expected sensitivity for the Standard Model process. Reconstruction and selection algorithms have been improved, boosting sensitivity and reducing the background contamination. An updated measurement of the branching ratio is presented and prospects for the full 2016–2026 dataset are discussed.

Collaboration:

NA62

Parallel session A5 / 55

The Curious Case of the $a_1(1420)$

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The unique nature of QCD leads to a rich spectrum of hadronic resonances. It is well understood that hadronic resonances, which arise from genuine QCD dynamics, are typically identified through peaks in the invariant mass distributions in experiments. However, there are also kinematic effects which produce peaks even though they don't correspond to any underlying QCD effect. One such example is the Landau singularity corresponding to the triangle diagram, which is a logarithmic singularity that can mimic a resonance. Such an effect was observed in the COMPASS experiment close to the $a_1(1260)$ meson in the $f_0(980)\pi$ p-wave final state, which was tentatively called the $a_1(1420)$ meson. However, further analyses improved our understanding that this was, in fact, a consequence of the Landau singularity arising from $K^*(892)K$ rescattering. In a previous work, we studied this effect using a unitary three-body formalism (IVU) applied to a $a_1(1420)$ meson-like toy-model without any ad-hoc assumptions, which further supported the Landau singularity hypothesis. We improve on this work, and apply the unitary three body formalism (IVU) to physical system and fit to the COMPASS data.

Collaboration:

Parallel session A5 / 60

Search for $\pi_1(1600)$ in a three-pion system at GlueX

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The GlueX experiment in Hall D at Jefferson Lab is designed for studies of the light meson spectrum with an emphasis on searches for hybrid mesons that have exotic quantum numbers and therefore cannot be classified as conventional hadrons. The experimental facility employs a tagged linearly polarized photon beam in the energy range from 8.2 to 8.8 GeV incident on a liquid hydrogen fixed target. The detector setup consists of a spectrometer with a nearly 4π angular coverage, which has excellent capabilities for reconstruction of charged particle tracks, reconstruction of electromagnetic showers, and charged particle identification. Advanced searches for spin-parity exotic mesons are performed through the application of Partial Wave Analysis (PWA) techniques.
I present the search for the $\pi_1(1600)$ meson with 1^{-+} quantum numbers by means of the PWA of the $\pi^+\pi^-\pi^-$ system produced in the $\gamma\, p \to \pi^+\pi^-\pi^-\Delta^{++}(\to p\pi^+)$ reaction. In the approximation of an isobar decay, data with the selected three-pion final states are fitted as coherent sums of partial-wave amplitudes defined in the reflectivity basis. The PWA techniques are applied in bins of $m(3\pi)$ allowing to extract the overall $m(3\pi)$ lineshape for each of the model contributions. The main interest lies in establishing the existence of a resonant 1^{-+} contribution in the P-wave $\rho\,\pi^-$ and D-wave $f_2\,\pi^-$ configurations.

Collaboration:

GlueX

Parallel session B5 / 70

Precision Studies of Ortho-Positronium Decays at J-PET

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Precision measurements of simple leptonic systems offer a powerful approach to testing fundamental symmetries and exploring physics beyond the Standard Model. This study focuses on the ortho-positronium (o-Ps) state, which predominantly decays into three photons. Owing to the absence of hadronic effects,positronium provides a uniquely clean system for precise tests of Quantum Electrodynamics.High-precision measurements of the o-Ps lifetime enable stringent tests of QED predictions and offer sensitivity to new physics, such as Mirror Matter (MM), a potential dark matter candidate [1].
We present ongoing analysis of the o-Ps decay rate using the modular J-PET setup [2, 3, 4], optimized for high-resolution timing and angular measurements. Dedicated reconstruction algorithms and Monte Carlo simulations are employed to identify three-photon annihilation events and suppress background contributions.
The primary goal is a high-precision determination of the o-Ps lifetime. Any deviation from QED predictions may indicate oscillations into mirror states, enabling constraints on the photon–mirror photon kinetic mixing parameter. The experiment aims to improve sensitivity by at least one order of magnitude with respect to present values $\Gamma = 7.039979(11) \times 10^6 s^{-1}$ [5], allowing for competitive constraints on mirror matter models and other scenarios involving invisible decay channels.
We acknowledge support from the National Science Centre of Poland through Grants No. 2019/35/B/ST2/03562, 2020/38/E/ST2/00112, SPUB/SP/627733/2025 and the SciMat and qLife Priority Research Area budget under the auspices of the program Excellence Initiative-Research University at Jagiellonian University. We also acknowledge Polish high-performance computing infrastructure PLGrid (HPC Center: ACK Cyfronet AGH) for providing computer facilities and support within computational grant no. PLG/2024/017688 and PLG/2025/018762.

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Collaboration:

J-PET

Poster session - Board: 1 / **124**

Dark Photon Search at BESIII using Initial State Radiation

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One of the greatest unsolved mysteries of modern physics is the observation of invisible yet gravitationally attractive dark matter. The dark photon A' is a proposed new U(1) gauge boson that offers a unique vector portal between the Standard Model and the dark sector.
This poster presents a new, ongoing search at BESIII for the creation and visible decay of a massive dark photon via the initial state radiation process $e^+e^- \to A'\gamma_{ISR} \to l^+l^-\gamma_{ISR}, (l = e, \mu)$. This analysis uses the newly acquired BESIII data on the $\psi(3770)$ resonance with a luminosity of $(20.275 \pm 0.077)\,\mathrm{fb}^{-1}$, currently the world's largest data set at $\sqrt{s} = 3.773\,\mathrm{GeV}$. The final state l^+l^- invariant mass spectra are scanned to search for a narrow dark photon resonance atop the irreducible QED background.

Collaboration:

BESIII

Poster session - Board: 10 / **82**

Study of mean transverse momentum of strange hadrons in relativistic heavy-ion collisions

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High-energy nuclear collisions provide important information on the characteristics of strongly interacting matter at extreme temperatures and densities. Among the most used experimental observables that provides valuable insight into the system dynamics and the kinetic freeze-out stage are the

transverse momentum spectra of the produced particles. We present a study of the mean transverse momentum <pT> of identified strange hadrons (K^0_S, Λ, $\bar{\Lambda}$, Ξ^-, $\bar{\Xi}^+$, ϕ, Ω^-,$\bar{\Omega}^+$) produced in Au+Au collisions at RHIC-BES energies (7.7-39 GeV). Its dependence on the collision energy and centrality will be presented. The power-law exponent, α, of the N_{part} dependence decreases with energy indicating the shift from baryon-dominated hadronic matter to a regime where partonic degrees of freedom and non-equilibrium dynamics become important. The mass dependence of the α parameter can indicate a competition between the mass-dependent hydrodynamics and flavor-dependent decoupling during the fireball's expansion.

Collaboration:

Poster session - Board: 11 / **112**

Pion scattering in finite volume within the Inverse Amplitude Method: Extension to moving frame

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We study the effect of a finite volume for pion-pion scattering within Chiral Perturbation Theory (ChPT) and the Inverse Amplitude Method (IAM) in a box for different boost's. Our full ChPT calculation takes into account the discretization not only in the s-channel loops but also in the t, u-channels and tadpole contributions. Hence, not only the unitarity right-hand cut but also the continuum contributions to the left-hand cut are calculated in the finite volume. A proper extension of the standard Veltman-Passarino identities is needed, as well as a suitable projection on the internal space spanned by the irreducible representations (irreps) of the finite groups, based on either a finite set of kubic harmonics or the matrices which represent the irreps properly. From the ChPT we construct the IAM in the internal space, which provides the full volume dependence of the interacting energy levels of two pions scattering in the finite volume. Our results for various sets of low-energy constants show sizable corrections with respect to previous analyses in the literature for $m_\pi L < 2$, being compatible with lattice data on energy levels.
We expect that our analysis and results will help to optimize the process of determining energy levels and phase-shifts with higher accuracy.

Collaboration:

Poster session - Board: 12 / **125**

Infrared finiteness in axion production through heavy meson decays

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Axions as dark matter candidates may be produced via an infrared freeze-in mechanism from heavy meson decays in the early universe. In this scenario, higher-order corrections to the axion production

rate contain infrared divergences. We demonstrate how holomorphic cutting rules, together with the Kinoshita-Lee-Nauenberg theorem, allow one to identify the minimal set of contributions required to achieve infrared-finite results. The procedure is systematic and can be straightforwardly generalized to other production processes.

Collaboration:

Poster session - Board: 13 / **43**

Development of an ultra-thin-walled gas target for spectroscopy of deeply bound pionic atoms in inverse kinematics

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We plan to perform missing-mass spectroscopy of deeply bound pionic Xe atoms using an inverse kinematics reaction. So far, the (d, ^{3}He) reaction in normal kinematics has been employed to measure excitation-energy spectra of pionic states in Sn and Pb isotopes [1–5]. In the new experiment, we adopt, for the first time, the inverse-kinematics (^{136}Xe, ^{3}He) reaction for the spectroscopy of pionic atoms. This method has the potentials to overcome the limitation of the spectral resolution in the normal kinematics and to enlarge the region of the pionic atoms in the nuclear chart, leading to experimental evaluation of density dependence of quark condensate at finite nuclear density.

One of the key components of this new experiment is a deuterium gas target. The target is required to have a pressure of ~1 bar and a length of a few centimeters to ensure sufficient reaction yield. At the same time, the window thickness must be as thin as a few times 100 μg/cm^2 (~ μm) to minimize energy straggling of the emitted low-energy ^{3}He particles. We have constructed prototype gas targets equipped with ultra-thin windows made of materials such as silicon nitride and graphenic carbon, and are currently evaluating their stability and radiation tolerance under heavy-ion irradiation.

In this contribution, we will discuss the current status of the R&D and the outlook for this new experiment, including recent test results and simulation studies.

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Collaboration:

Poster session - Board: 14 / **122**

Orbital angular momentum in the pion and kaon

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Orbital angular momentum (OAM) is not a Poincar\'e invariant quantity; so, its value is observer dependent. Notwithstanding that, in quantum chromodynamics, a Poincar\'e-invariant theory, OAM is part of every hadron wave function. Using continuum Schwinger function methods, we elucidate both the subjective character of in-hadron OAM and expose some of its impacts on pion and kaon structure and observables. For instance, working with light-front projections of their Bethe-Salpeter wave functions, it is found that the pion is a roughly 50/50 mix of light-front OAM zero and one components and the kaon is a 60/40 system. The overall picture is that (near) Nambu-Goldstone modes are complex bound states, each with significant intrinsic OAM, independent of the observer's reference frame. This feature must be accounted for in the calculation of observables. Inductively, the same is true for all hadrons.

Collaboration:

Poster session - Board: 15 / **123**

Onset of scaling violation in pion and kaon elastic electromagnetic form factors

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Using a symmetry-preserving truncation of the quantum field equations describing hadron properties, parameter-free predictions are delivered for pion and kaon elastic electromagnetic form factors, $F_{P=\pi,K}$, thereby unifying them with kindred results for nucleon elastic electromagnetic form factors.
Regarding positive-charge states, the analysis stresses that the presence of scaling violations in QCD entails that $Q^2F_P(Q^2)$ should exhibit a single maximum on $Q^2 > 0$.
Locating such a maximum is both necessary and sufficient to establish the existence of scaling violations.
The study predicts that, for charged π, K mesons, the $Q^2F_P(Q^2)$ maximum lies in the neighbourhood $Q^2 \simeq 5\,\mathrm{GeV}^2$.
Foreseeable experiments will test these predictions and, providing their Q^2 reach meets expectations, potentially also provide details on the momentum dependence of meson form factor scaling violation.

Collaboration:

Poster session - Board: 16 / **113**

Revealing the puzzle of the two D_0^* resonances from analysis of Lattice QCD

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One or two D_0^* resonances with strangeness $S = 0$, isospin $I = 1/2$ dynamically generated in pseudo-scalar meson octet and heavy mesons scattering are still a puzzle. In this talk, I will present that there are two D_0^* resonances generated by ChPT up to NLO. The LECs of the interaction are

constrained by the energy levels simulated by LQCD in $(S, I) = (0, 1/2)$, $(1, 0)$, $(-1, 0)$, and $(-1, 1)$ sectors. By studying the pion mass dependence of the two resonances and extrapolating to SU3 flavor symmetry point, we show that one resonance is connected to irreducible presentation **3**, and the other resonance is connected to **6**.

Collaboration:

Poster session - Board: 17 / **127**

Study of $S = -2$ baryonic states with stopped antiprotons at the CERN AD facility

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The study of the baryon-baryon interaction is a basic tool to investigate the strong interaction. Especially in the strangeness $S = -2$ sector the available data are strongly limited. Most studies in this field were devoted to the search for the H-particle, a $(B = 2, S = -2)$ system with the quark configuration $(uuddss)$ first proposed by Jaffe [1]. Experimentally, $S = -2$ baryonic systems are accessed predominantly through the cascade hyperon Ξ, produced in K^-- or p-induced reactions. Slow Ξ particles can go into interacting ΞN systems which can couple to YY or might also directly connect to the H particle [2].

With stopped antiprotons a very efficient reaction chain for the production of slow Ξ hyperons can be initiated. In a first step a $\bar{K}^*$ beam is produced in the annihilation of a stopped antiproton on a nucleon. The production of $S = -2$ systems proceeds then in a second step via the double strangeness and charge exchange reaction $(\bar{K}^*, K)$. Due to the short decay length of a few fm both, $\bar{K}^*$ production and the double strangeness and charge exchange reaction have to take place in the same nucleus. The special feature of this reaction channel is the low momentum of the produced Ξ hyperon. The magic $\bar{K}^*$ momentum at which the Ξ can be produced at rest is at around 200~MeV/c which is very close to the momentum of the produced $\bar{K}^*$ in the first reaction step.

The initial measurements will focus on pure Ξ production, exemplified by the reaction $\bar{p}d \to \Xi^- K^0_s K^{*+}$. To investigate the ΞN, $\Lambda\Lambda$ or H systems a ^{3}He target has to be used. The slow Ξ hyperons with recoil momenta down to even zero MeV/c have a high probability of producing a $(B = 2, S = -2)$ system. A further extension of the programme may be the production of double hypernuclei. With the technique of recoil-free kinematics the Ξ can also be produced and deposited in more extended nuclei. A highly efficient production of double hypernuclei is expected with this method. From the experimental point of view the delayed decays of the strange exit particles allows a highly selective trigger on these reaction channels and the event reconstruction is relatively simple. A non-magnetic detection system with track reconstruction ability is sufficient for the complete kinematical reconstruction.

The CERN AD facility provides a unique opportunity to realize such a programme. Antiprotons with well defined low emittance beam, makes the $(\bar{K}^*, K)$ reaction on light nuclear targets such as deuterium and ^{3}He experimentally accessible with realistic statistics. A dedicated setup based on a cryogenic gas target surrounded by a non magnetic tracking system would provide the first systematic measurement of $S = -2$ baryonic systems produced at rest, offering a unique low-background environment for the search of the H-dibaryon and double hypernuclei.

In this contribution, the physics motivation and the proposed experimental concept for such a programme at the CERN AD facility will be presented.

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Collaboration:

Poster session - Board: 2 / **12**

Radiative Quarkonium Transitions in Relativistic Light-Front Approach

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Renewed interest in the structure and internal properties of quarkonia and quarkonium-like states has prompted further investigation. We will analyse the radiative transitions of specific $Q\bar{Q}$ states within the light-front wave function framework. Particular attention is given to higher excited states, which may provide insight into possible exotic states. Our model applies the Melosh transform to the spin component, which effectively accounts for relativistic quark spin rotations. Meanwhile, the radial component is obtained from the Schrödinger equation and mapped onto the light front via the Terentiev prescription.
We will present the calculated decay widths for several representative radiative quarkonium transitions, including both electric dipole (E1) and magnetic dipole (M1) processes.

Collaboration:

Poster session - Board: 3 / **69**

Studies of exclusive production of η' and $f_1(1285)$ mesons in $p+p$ collisions at 4.5 GeV with HADES

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Studies of the axial-vector $f_1(1285)$ meson production at near threshold energies with HADES is particularly interesting because of its production mechanism. It involves vector meson fusion VV $(\rho\rho, \omega\omega) \rightarrow f_1$ which provide information about the $\rho\rho f_1$ and $\omega\omega f_1$ coupling constants. This in turn is very important for calculations of hadronic light-by-light (HLbL) scattering contributions to the muon anomalous magnetic moment and might give information about the unknown structure of the f_1 meson.

This contribution presents analysis of exclusive $f_1(1285)$ and η' production in the reaction $p+p \rightarrow p+p+f_1/\eta'$ at the center-of-mass energy of 3.46 GeV, utilizing data collected by the HADES experiment at GSI/FAIR.

The analysis focuses on the decay channel $f_1/\eta' \rightarrow \eta + \pi^+ + \pi^-$, followed by the eta decay $\eta \rightarrow \pi^0 + \pi^+ + \pi^-$, and includes the implementation of a kinematic fit utilizing a π^0 missing mass constraint for the η reconstruction. Because of its higher production yield, the η' signal will be used as a "standard candle" to estimate the $f_1(1285)$ production cross section.

Collaboration:

HADES

Poster session - Board: 4 / **119**

Phenomenology of axion-meson mixing and scattering processes

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We investigate axion-meson mixing and its consequences for low-energy scattering and decay processes within the framework of Chiral Perturbation Theory (χPT). Starting from the most general effective Lagrangian, we derive mixing terms between a general axion-like-particle (ALP) and light pseudoscalar mesons and compute their impact on 4-body, axion-meson amplitudes, including isospin breaking contributions. We also do a full perturbative calculation of the ALP mass up to second order in the decay constant. This study contributes to bridging theoretical models of axion physics with potential experimental observables in the flavor sector.

Collaboration:

Poster session - Board: 5 / **116**

Algebraic techniques for meson masses and decays in the unquenched quark model

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Novel algebraic methods are applied to quarkonium spectrum in the unquenched quark model, which incorporates the coupling between $Q\bar{Q}$ and $(Q\bar{q})(q\bar{Q})$ degrees of freedom. Working in the discrete position basis, the calculation of matrix elements simplifies considerably in comparison to other approaches, leading not only to improvements in computational efficiency, but also more flexibility in constructing the model and analysing its output. We illustrate several methods for the extraction of hadron parameters including masses, rms radii and decay widths, and explore qualitatively the effect of incorporating meson-meson interactions (via pion exchange) on the meson spectrum. We also investigate whether the $Q\bar{Q} \to (Q\bar{q})(q\bar{Q})$ coupling can effectively be absorbed into a modified $Q\bar{Q}$ potential.

Collaboration:

Poster session - Board: 6 / **38**

Systematic Study of the Leakage Peak in the Partial-Wave Decomposition of the $\eta\pi$ Final State at COMPASS

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The production of $\eta\pi$ and $\eta'\pi$ has been studied by COMPASS using a $190\,\mathrm{GeV}/c$ pion beam from CERN SPS. The corresponding partial-wave decompositions (PWD) show a pronounced peak in the exotic $J^{PC} = 1^{-+}$ P-wave at around $1.4\,\mathrm{GeV}/c^2$ in the $\eta\pi$ channel and around $1.65\,\mathrm{GeV}/c^2$ in the $\eta'\pi$ channel. In the $\eta\pi$ final state, the strong dominance of the $a_2(1320)$ enhances possible feed-through into other partial waves. This becomes particularly evident in the $J^{PC} = 4^{++}$ G-wave, where an unphysical peak appears in the mass region around $1.3\,\mathrm{GeV}/c^2$.

In this work, we perform a systematic input–output study to investigate this leakage effect using generated pseudo data. The pseudo data samples are produced with a fully controlled input model, allowing us to investigate the origin of the leakage peak in detail. Thus, systematic effects of the PWD like incomplete acceptance corrections or certain model assumptions my be studied in detail.

Collaboration:

COMPASS

Poster session - Board: 7 / **120**

Waveform Pattern Alignment for Hadron Beam Diagnostics

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We present two recently patented methods for estimating hadron beam energy and energy spread. The measurement data supporting these methods were acquired at The Henryk Niewodniczanski Institute of Nuclear Physics Polish Academy of Science in Krakow. The collected datasets from C-230 at Cyclotron Center Bronowice (CCB) and cyclotron AIC-144 demonstrate the practical effectiveness of the diagnostics in real-time monitoring of hadron therapy beams.

Collaboration:

Poster session - Board: 9 / **68**

Search for Axion Like Particles using η meson decays in the HADES experiment

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The High-Acceptance Di-Electron Spectrometer (HADES) operates at the GSI Helmholtzzentrum für Schwerionenforschung in Darmstadt with pion, proton and heavy-ion beams provided by the synchrotron SIS-18 [1]. In February 2022, the HADES collaboration conducted measurements with proton beam at 4.5 GeV kinetic energy using the upgraded setup within the FAIR-Phase0 program collecting statistics of 6 pb^-1 [2]. One of the objectives of the HADES physics program is to test the predictions of the Standard Model and search for potential hints of new phenomena beyond current theoretical frameworks (BSM–Beyond Standard Model Physics).
To this end, the collected large data sample opens a possibility to search for Axion-Like Particles (ALPs) via the pseudoscalar portal, through which they couple to Standard Model particles [3]. Such particles, with masses in the MeV–GeV range, can be experimentally accessible through their couplings to Standard Model particles. A set of calculations was done which predicts a possible existence of ALPs with a mass m_a = O(1–100) MeV and decay constant f_a = O(1–10) GeV [4] with additional PQ-breaking contribution to their masses. In particular, by studying η meson decays into dilepton (e+e−) channels, we investigate the possible existence of an ALP [5-7]. In this scenario, an intermediate state of the η meson decay into π+π-e+e- could involve the creation of a new particle through the sequence $\eta \longrightarrow \pi^+\pi^- a(\longrightarrow e^+e^-)$. These studies are further motivated by observed anomalies in the invariant mass distribution of e+e− pairs in nuclear transitions of 8Be and 4He nuclei [8-9].
In this presentation, we will discuss the general motivations for ALP studies, show analysis steps of experimental data and simulation to extract $\eta \longrightarrow \pi^+\pi^-$e+e- decay, and share preliminary results.

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Collaboration:

HADES

Public lecture / **136**

From Schrödinger's Cat to Quantum Technologies: A Revolution Unfolding

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Quantum mechanics was born to describe the world of atoms and elementary particles, and since the beginning it challenged our deepest intuitions about reality. Schrödinger's famous cat became the symbol of a quantum world governed by superposition, entanglement and tunneling concepts that still inspire both scientific and philosophical debate. Today, these once paradoxical ideas are driving a technological revolution. Quantum technologies are transforming the way we communicate, process information, and probe the fundamental laws of nature. At the same time, they raise new questions about measurement, decoherence, and the boundary between the quantum and classical worlds. In this public lecture, Catalina Curceanu will guide the audience from the foundations of quantum physics to the frontiers of modern research. Drawing on her work in experiments testing quantum foundation in the Gran Sasso underground laboratory, she will show how fundamental experiments both deepen our understanding of reality and inspire new quantum technologies.

The lecture will highlight how curiosity-driven research, born from profound questions about nature, can lead to transformative discoveries with scientific, technological, and cultural impact.

Collaboration:

Plenary session / 24

A broad review of phenomenology of gamma-gamma interaction

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Photon-photon interactions provide a clean probe of hadron structure, resonance dynamics, and precision QCD observables. In my talk, I will give a broad overview of the phenomenology of real and virtual two-photon processes, with emphasis on recent progress based on analyticity, unitarity, and dispersion relations. I will discuss dispersive descriptions of $\gamma^{(*)}\gamma^{(*)} \to \pi\pi/K\bar{K}$ and $\gamma^{(*)}\gamma^{(*)} \to \pi\eta/K\bar{K}$, the emergence of scalar and tensor resonances, and the connection to pion polarizabilities and hadronic light-by-light scattering in the muon $g-2$. I will also comment on our recent applications to virtual Compton scattering off the proton, where two-photon dynamics enters as input to the t-channel dispersion integrals, and on related applications to $\phi \to \pi^0\pi^0\gamma$, as well as on Monte Carlo tools for two-photon production at e^+e^- facilities.

Collaboration:

Plenary session / 97

Three-body hadronic interactions: from femtoscopy at LHC to the equation of state of Neutron Stars

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Understanding the interaction between strange baryons and nucleons is essential for describing dense baryonic matter. In neutron star interiors, the presence of hyperons is expected to significantly soften the equation of state (EoS), thereby reducing the maximum mass such stars can support. Addressing this problem requires improved constraints not only on two-body interactions but also on multi-body hyperonic forces. So far, efforts to include three-body contributions have largely relied on limited experimental input from hypernuclei, where existing data are less precise than theoretical predictions and remain particularly scarce for Ξ^- systems.

Femtoscopic measurements in high-energy collisions at the LHC offer a novel and complementary approach to probe hyperon–nucleon–nucleon interactions. In particular, preliminary theoretical studies of the p–p–Λ correlation function indicate sensitivity to three-body forces, with potentially sizable effects. In this contribution, recent measurements and developments in the study of p–p–Λ correlations across different collision systems are presented. Comparisons between systems and event centralities provide insight into how the sensitivity to three-body forces evolves with the size of the emitting source. In addition, new results on p–p–Ξ^- correlations, probing systems with double strangeness, are discussed together with future perspectives.

Collaboration:

Plenary session / **73**

Vector Meson–Baryon Femtoscopic Insights into Spectroscopy and Chiral Symmetry

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Femtoscopy provides indirect access to fundamental QCD phenomena beyond vacuum interactions, particularly chiral symmetry breaking and its partial restoration, through its sensitivity to hadron–hadron interactions. In vacuum, spontaneous chiral symmetry breaking leads to distinct hadronic excitations and nondegenerate spectral functions, such as those of the ρ and a_1 mesons. In a nuclear medium, the reduction of the quark condensate modifies these spectral functions, inducing broadening, possible mass shifts, and eventual overlap, which signals partial chiral symmetry restoration. A quantitative description of these effects requires reliable input on vector–baryon interactions, notably the ρ–N system.

Recent femtoscopic measurements of ϕ–p and ρ^0–p correlation functions~\cite{ALICE:2021cpv,ALICE:2025flv} provide the first direct access to interactions of short-lived vector mesons. While initial analyses relied on the Lednicky–Lyuboshitz approximation~\cite{Lednicky:1981su}, later studies~\cite{Feijoo:2024bvn,Abreu:2024qqo} demonstrate the need for fully unitary coupled-channel approaches to reliably extract scattering parameters. Building on measurements in the $S = 0$ sector, current efforts extend to systems with nonzero strangeness~\cite{Encarnacion:2025luc,Lin:2025mtz}, where near-threshold states and coupled-channel dynamics are expected to play a key role. The strong sensitivity of correlation functions to these effects establishes femtoscopy as a versatile tool to study hadronic interactions, exotic states, and threshold phenomena across flavor sectors. The content of this latter set of developments will be addressed in detail in my talk.

Collaboration:

Plenary session / **48**

Overview on partial-wave analysis efforts for (light) baryon spectroscopy

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I give an overview of selected analysis tools and PWA approaches used to extract the spectrum of light baryon resonances with and without strangeness from experimental data. Differences and similarities, e.g. in the construction of the amplitude or the channel space, will be illustrated. I will show selected recent results and briefly discuss the status of the PDG listings for N^*, Δ^*, Λ^* and Σ^* states.

Collaboration:

Plenary session / **86**

The vector charmonia at BESIII - and how to interpret them

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The charmonium spectrum is well understood below the open-flavour threshold. Above threshold, however, experiments have found a large number of new, potentially exotic hadrons that do not always match our expectations for regular charmonium hadrons - the XYZ states. Using e^+e^- annihilation to produce pairs of charm and anti-charm quarks, the BESIII experiment is particularly well suited to study the vector charmonia. In this talk, I will discuss recent measurements of open- and hidden-charm production above the open-flavour threshold, as well as a path towards a common interpretation of that data using a coupled-channel approach.

Collaboration:

BESIII

Plenary session / **99**

Scattering information from production experiments

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Rescattering is an inherent part of production processes. In this talk, I will an overview of how scattering information is related to production reactions. Threshold cusp effects and dispersive methods will be discussed.

Collaboration:

Plenary session / **71**

Recent results from GlueX

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The detailed understanding of the hadron spectrum is currently one of the biggest open issues in the field of hadron physics. Most of the observed states are classified as quark-antiquark mesons or three-quark baryons. However, quantum chromodynamics (QCD) allows for a much richer spectrum with more complex, non-conventional configurations, such as multi-quark states, hybrid mesons and glueballs. Hybrid mesons, which manifest gluonic degrees of freedom, serve as an ideal testing ground for the non-perturbative regime of QCD and understanding the role of gluons in hadron formation.
The main goal of the GlueX experiment is to search for exotic hybrid mesons and to map out their spectrum in the light-quark sector. The experiment is located in Hall D at Jefferson Lab, USA, and uses a linearly polarized photon beam with energies of up to 12 GeV incident on a liquid hydrogen target and consists of a high-acceptance spectrometer with excellent charged as well as neutral

particle detection capabilities. This allows us to study the production mechanisms and decays of a wide range of hadronic resonances.
This talk gives an overview of the recent results from GlueX.

Collaboration:

GlueX

Plenary session / **104**

Meson spectroscopy from Lattice QCD

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Determining the meson spectrum directly from Quantum Chromodynamics (QCD) remains a central challenge, since QCD is strongly coupled at low energies and most excited states appear as resonances in hadronic decay channels. Advances in lattice QCD and scattering theory now provide a systematic framework for extracting meson spectra and resonance properties from first principles. In this talk, I will present an overview of this program and review current state-of-the-art calculations in meson spectroscopy from lattice QCD. I will highlight recent progress in the extraction of resonant and coupled-channel amplitudes, along with frontier developments in three-body dynamics and the determination of meson photo-couplings. Together, these advances are bringing us closer to a comprehensive first-principles description of the excited meson spectrum.

Collaboration:

Parallel session B6 / **33**

Light meson decays at BESIII

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The world's largest sample of J/ψ events accumulated at the BESIII detector offers a unique opportunity to investigate η and η' physics via two body J/ψ radiative or hadronic decays. In recent years the BESIII experiment has made significant progresses in η/η' decays. A selection of recent highlights in light meson decays at BESIII are reviewed in this report, including the precision measurement of Dalitz plots, transition form factor measurements, as well as the search for rare/forbidden decays of η/η'.

Collaboration:

BESIII

Parallel session A6 / 20

Hadron structure measurements from CLAS12

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Quantum Chromodynamics (QCD) reveals its complexity at large distances and low energies. Understanding the internal structure of the nucleons is therefore essential for a complete understanding of QCD in this regime. Generalized Parton Distributions (GPDs) play a crucial role in this effort, as they provide a means to map both the spatial and the longitudinal momentum distributions of partons in the nucleons. Beyond offering a three-dimensional view of the proton's internal structure, GPDs are also closely linked to the nucleon's spin structure and its internal force distribution. As a result, GPDs have been the focus of intense global experimental efforts.
In Experimental Hall B of Jefferson Lab, extensive measurements have been conducted with the CLAS12 experiment to study GPDs, primarily through exclusive reactions such as Deeply Virtual Compton Scattering (DVCS)—the exclusive electroproduction of a real photon at the partonic level. In addition to DVCS, other exclusive processes, including Timelike Compton Scattering, and the exclusive electroproduction of mesons, have been investigated. These results provide a detailed picture of the valence structure of the nucleon. Looking ahead, future experiments with CLAS12 will further leverage the capabilities of the CEBAF accelerator.

Collaboration:

Parallel session B6 / 29

Partial Wave Analysis of Resonances in K+K- and KK* with CLAS12

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There are many states predicted by quantum chromodynamics (QCD) that haven't been observed experimentally. Furthermore, QCD predicts mesons that cannot exist according to the naive quark model, known as exotic mesons, which include glueballs, hybrid mesons, tetraquarks and meson molecules. The identification and study of these new forms of matter are of great importance to better understand the theory of the strong force. This talk concerns the electroproduction of meson resonances off the proton, which subsequently decay into kaon pairs, to better address the decay of flavour-blind, gluonic objects such as glueballs and regular hybrids, which are expected to couple strongly to this channel. Due to the vast complexity of the mesonic spectrum, simple bump hunting is insufficient to distinguish between the many broad and overlapping resonances produced in this channel, so moments analysis and partial wave analysis are employed to disentangle these resonances and determine their properties. This talk will present results from the partial wave analysis of the K^+K^- final state performed in collaboration with the JPAC theory group and based on data collected with the CLAS12 detector at Jefferson Laboratory. Several well-known resonances, such as $\phi(1020)$, $a_0^2(1320)$ and $f'_2(1525)$, are identified, and spins, masses and widths are obtained. To extract these resonances cleanly, a new analysis technique has been developed, which involves improved particle and event identification, longitudinal phase space plots to remove baryon resonance contamination and the application of an MCMC-based algorithm for the fitting procedure. Additionally, preliminary results will also be shown for the partial wave analysis of the KK^* final state, with the intention to expand the search for missing and exotic states.

Collaboration:

Parallel session A6 / 13

Sigma0 Cross Section Measurements Towards a Glimpse of its Dalitz Decay

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The Σ^0 hyperon production in proton-proton collision events at GeV beam energies have intriguing dynamics involving multiple hadronic resonances in an interplay that has remained poorly understood. In addition, unraveling this mystery has proven to be an essential step towards novel measurements, such as the rare Σ^0 Dalitz decay ($\Sigma^0 \to \Lambda e^+ e^-$), the study of which may provide a unique probe of the hadron structure. This unraveling begins at the HADES experiment, where proton-proton data has been collected at a beam kinetic energy of 4.53 GeV, and with the pursuit of measuring Σ^0 production cross sections from its radiative decay ($\Sigma^0 \to \Lambda\gamma$). Such studies, as presented in this talk, are essential as a reference channel for measurement of the Dalitz decay branching fraction but also to understand the dominating background, production channel specific reconstruction efficiencies and the production of realistic Monte Carlo models. Furthermore, it sheds light on the role of resonances in the production of strange mesons in multi-body reactions.

Collaboration:

HADES

Parallel session B6 / 10

A double-Regge exchange model for high-energy $\eta^{(\prime)}\pi$ photoproduction

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The study of $\eta^{(\prime)}\pi$ photoproduction is particularly interesting for the search for the lowest lying hybrid meson with exotic quantum numbers, the $\pi_1(1600)$, at the GlueX experiment at Jefferson Lab. In this talk, I will present a model based on the double-Regge exchange of vector trajectories for photoproduction at high energies. The model successfully describes CLAS data at large $\eta^{(\prime)}\pi$ invariant mass and predicts a sizable forward-backward angular asymmetry at GlueX energies, larger in $\eta'\pi$ than in $\eta\pi$, indicating the presence of strong exotic partial waves also in the resonance region, particularly in the $\eta'\pi$ channel.

Collaboration:

Joint Physics Analysis Center (JPAC)

Parallel session A6 / 80

Sivers effect on the single transverse-spin asymmetries in J/psi production in the collinear pQCD approach

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The origin of the large single transverse-spin asymmetry (SSA) has been a long-standing mystery in high-energy spin physics since it was first observed experimentally in the late 1970s. Previous theoretical studies have shown that the Sivers effect in a transversely polarized proton could be a source of this large asymmetry. Although the quark Sivers functions have become relatively well understood over the past couple of decades, the gluon Sivers function, by contrast, remains largely unknown. Determining it is one of the key goals of future experiments such as the EIC and LHCspin. Within the conventional perturbative QCD framework, the Sivers effect can be described in terms of collinear twist-3 distribution functions. In this talk, we present our recent work on the SSA in J/\psi production within the twist-3 framework. This observable is ideal for investigating the gluon Sivers effect.

Collaboration:

Parallel session A6 / **114**

P371 experiment at CERN - towards the first measurement of antiproton polarization in proton-nucleus interactions

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A polarized antiproton beam would open a broad physics program relevant to meson and hadron-structure studies, ranging from a direct determination of the spin-dependent components of the $\bar{p}p$ total cross section and of spin-flip amplitudes of the antinucleon-nucleon ($\bar{N}N$) interaction to a measurement of the transversity distribution via polarized Drell-Yan processes, as proposed by the PAX collaboration. It would also provide unique access to spin observables in $\bar{p}p$ annihilation into mesonic final states, including light and charmonium systems, complementing ongoing programs with polarized protons. Despite decades of effort, no efficient method for producing polarized antiproton beams suitable for long measurement campaigns has been established. A particularly attractive possibility is that the antiproton production process itself generates a non-zero transverse polarization, in analogy with the well known polarization of Λ and other hyperons produced in unpolarized pp and pA collisions, where values of 20-30% have been reported. Despite the different production mechanisms, spin-dependent nonperturbative QCD dynamics may give rise to an analogous effect in the baryon-antibaryon sector, which has never been tested experimentally. If confirmed, a polarized secondary beam could be prepared by selecting a narrow azimuthal region of the production cone, without additional spin manipulation techniques.

The P371 experiment at the T11 beam line at CERN PS aims to determine the antiproton polarization, if it exists, using secondary antiprotons at 3.5 GeV/c produced with the primary 24 GeV/c proton beam. The transverse polarization is accessed via the left-right asymmetry of elastic $\bar{p}p$ scattering

in the Coulomb Nuclear Interference region (CNI), where the analyzing power is predicted to reach 4.5% based on one-boson exchange calculations of the $\bar{N}N$ potential. The detection setup combines scintillator triggers, an aerogel Cherenkov veto for π^- rejection, a scintillating fiber hodoscope, a liquid hydrogen analyzer target, straw tube trackers, and a DIRC detector for offline $\pi^-/\bar{p}$ identification. Detailed Monte Carlo studies, recently published in Eur. Phys. J. C 86, 390 (2026), show that with an integrated luminosity of ~ 1.18 nb^{-1} ($\sim$8 weeks of data taking), a polarization of 12% can be distinguished from the null hypothesis at the 5σ level and 7% at the 3σ level, within the optimal angular range $6.7 < \theta < 35$~mrad.

This talk presents the physics motivation for polarized antiproton beams, the P371 experimental setup, and the sensitivity studies, together with the status of the first test runs at the T11 beam line.

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Collaboration:

CERN/P371

Parallel session B6 / **39**

Σ beam asymmetry of the a_0^0(980) photoproduction at GlueX

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The light scalar meson sector, encompassing mesons with mass around 1 GeV and positive parity, is not fully understood. This lack of understanding is due to the overlap of the widths of neighboring resonances and the numerous underlying background processes. This work seeks to shed some light onto one member of this sector, namely the neutral a_0^0(980) meson, by way of polarized photoproduction. Using the Hall D polarized photon beam at Jefferson Lab and the GlueX Detector, preliminary results of the beam asymmetry of the photoproduction of this meson, measured as a function of the invariant momentum transfer t, are presented, illustrating a qualitative agreement with theory predictions. This work was supported in part by the U. S. Department of Energy, Office of Science, Office of Nuclear Physics, under award No. DE–SC0016583.

Collaboration:

GlueX

Parallel session A6 / **46**

What do we learn from exclusive vector meson production from ep to AA collisions

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The exclusive production of vector mesons in reactions on protons and nuclei induced by real and virtual photons has been the source of much knowledge on the structure of both the produced mesons as well as the targets.
Recently ultraperipheral collisions of protons and nuclei at the LHC have provided data on light vector mesons (ρ and its excited states) as well as heavy quarkonia $J/\psi, \psi(2S)$ in an unprecedented range of energies.
We will discuss the current status of the theoretical description of these data and their implications on future experiments at electron-ion colliders.

Collaboration:

Parallel session B6 / **51**

Spin-Density Matrix Elements in the reaction $\gamma p \rightarrow \rho^- \Delta^{++}$ at GlueX

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The GlueX experiment, located in Hall D at Jefferson Lab, aims to map the full spectrum of light-quark mesons with an emphasis on hybrid mesons, states in which the gluonic field is excited and contributes to the quantum numbers of the meson. The experiment employs a linearly polarized photon beam produced via coherent bremsstrahlung with an energy around 8.2-8.8 GeV on a liquid hydrogen target. The GlueX spectrometer provides large acceptance for both charged and neutral particles in the final state.
The search for exotic hybrid mesons requires a detailed understanding of the underlying production mechanisms. Polarization observables, such as the spin-density matrix elements (SDMEs), provide an important experimental tool to investigate these mechanisms.
In this talk, I present the measurement of the unpolarized and polarized SDMEs in the photoproduction of $\rho^- \Delta^{++}$ using GlueX data collected in 2017-2018.
Compared to a previous measurement from SLAC, the new dataset provides significantly improved statistical precision and allows a high-resolution determination of the t-dependence of the SDMEs in the range $0.025 \leq -t \leq 1.4$ GeV^2.

Collaboration:

GlueX

Parallel session A7 / **77**

Rapidity dependence study of charged pion production in relativistic nuclear collisions using Tsallis distribution

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Relativistic heavy-ion collisions provide a unique opportunity to study nuclear matter under extreme conditions. In such collisions, the created system exhibits strong collective behavior, and the shapes of particle transverse momentum spectra reflect the system's global properties, such as the temperature and flow velocity at kinetic freeze-out. To account for both equilibrium and non-equilibrium features of the p_T spectra, we employ the Tsallis distribution, a statistical distribution that generalizes the Boltzmann–Gibbs distribution to include deviations from thermal equilibrium. In this analysis, transverse momentum spectra of charged pions produced in relativistic nuclear collisions in a wide energy range from $\sqrt{s_{NN}}$ = 2.4 GeV to 200 GeV are studied using Tsallis distribution. The energy and rapidity dependence of the Tsallis fit parameters, Tsallis temperature and non-extensivity parameter, a parameter characterizing the degree of non-equilibrium for the systems produced in these collisions will be presented. The mean transverse momentum extracted in this analysis is studied in correlation with the temperature. The physics implications of these results on the collision dynamics and kinetic freeze-out will be discussed.

Collaboration:

Parallel session B7 / 1

Hunting the pseudoscalar glueball

Author: Francesco Giacosa[1]

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The pseudoscalar glueball has seen a revival of interest following the observation of the pseudoscalar resonances $X(2370)$ and $X(2600)$ at BESIII, which are among the most promising candidates. On the theory side, the pseudoscalar glueball is deeply connected to the chiral anomaly, a fundamental feature of QCD. In this talk, we confront theoretical expectations with experimental findings and review the current status of the candidate states, including predictions for their decay patterns. How close are we to identifying the pseudoscalar glueball? What remains to be done to make a definitive claim? We will highlight both the progress and the key open questions that need to be addressed by future studies.

Collaboration:

Parallel session A7 / 79

Anisotropic flow of strange hadrons emitted from Ag+Ag collisions at beam energy of 1.6\textit{A} GeV measured with HADES

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The High Acceptance Di-Electron Spectrometer (HADES) [1] installed at the SIS18 accelerator in GSI Darmstadt registers products of heavy-ion collisions (as well as of elementary interactions) at energies of a few GeV per nucleon. The nuclear matter produced in such collisions reaches extreme densities and temperatures [2,3,4], comparable to those expected in Neutron Star mergers [5].

Particles containing (anti)strange quarks are of particular interest, as they are produced sparsely in this energy regime and the study of their interaction with the medium is of high relevance. For charged kaons it is predicted that, due to their interaction with nuclear matter, their effective mass and decay constant should change [6]. This phenomenon was investigated by other experiments, but so far without a definitive conclusion [7]. Another interesting particle species is the Λ baryon, due to its role in the so-called hyperon puzzle [8], where its interaction potential with nuclear matter is an important piece of the "puzzle".

It is predicted that the anisotropic flow of strange hadrons should be sensitive to their interaction with the surrounding nuclear medium [7,9]. This contribution will contain preliminary distributions of anisotropic flow coefficients $v_n(p_t, y_0)$ of the 1st and 2nd order of strange hadrons – $K^{\pm}$ mesons and Λ baryons – emitted from Ag+Ag collisions at a beam energy of 1.6 GeV/nucleon. The distributions were measured in a broad centrality class of 5-25 % most central collisions and cover a large area of the momentum phase space with $-0.9 < y_0 < 0.7$ and $100 < p_t[\mathrm{MeV/c}] < 1500$. The measurement of the anisotropic flow of Λ baryons would be the lowest energy at which such a measurement was carried out.

HADES allows the direct measurement of charged kaon four-momenta, while the Λ baryon must be reconstructed via its primary decay channel: $\Lambda \rightarrow p\pi^-$. The background is then subtracted using a mixed event technique. Neural networks are used to maximize the signal extraction. All of the flow results are corrected for the resolution of the event-plane measurement and possible inefficiencies due to high detector occupancies will be discussed, as well as selected aspects of systematic uncertainties.

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Collaboration:

HADES

Parallel session B7 / 25

Tomography of light hadron structures through electromagnetic form factors

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In this talk, I will first introduce the transverse momentum factorization scheme, and then discuss how to use dispersion relations and form factor data to achieve an accurate extraction of the fine

structure (light-cone distribution amplitudes) of light hadrons, including $\pi, K, \eta^{(\prime)}$ mesons and proton.

Collaboration:

Parallel session A7 / 57

Dilepton production in p+p at 1.58 and 4.5 GeV beam kinetic energy

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Spectra of inclusive dileptons emitted in hadron collisions are crucial in studying the electromagnetic structure of resonances by constraining model descriptions and validating the commonly used assumption of the Vector Meson Dominance.
While interesting in its own right, this provides a decisive input to theoretical understanding of QCD matter at extreme conditions of temperature and/or density, investigated in heavy-ion and $p + A$ collisions.
On the experimental side, $p + p$ (and $n + p$) results constitute a baseline for separating cold or hot medium effects.

The High-Acceptance DiElectron Spectrometer (HADES), operating at the Heavy-Ion Synchrotron (SIS18) in Darmstadt, Germany, is a fixed-target, multi-purpose setup. It has been specifically designed for high precision dilepton measurements, but it is also well capable of reconstructing hadronic observables in proton-, deuteron-, and pion-induced or heavy-ion collisions in the energy regime of a few GeV.

In this contribution, preliminary results on dilepton spectra in proton-proton collisions at 1.58 and 4.5 GeV beam kinetic energy, measured in February 2022, will be presented and compared with available model calculations.
They will also be put in the context of the measurements in Au+Au and Ag+Ag collisions.

Collaboration:

HADES

Parallel session B7 / 34

Recent results for X- and Z-states at BESIII

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The BESIII experiment, with its unique data samples collected in the $\sqrt{s}$ = 4.0 − 4.95 GeV region, continues to provide important inputs for the understanding of charmonium and exotic XYZ states. In this talk, we will present recent activities related to X- and Z-states. Key results include a multi-channel joint analysis of the Zc(4020), a search for a charmonium-like state with exotic quantum numbers $J^{PC} = 0^{--}$, and searches for Zcs states in K+ccbar final states. With recent upgrades to the BEPCII accelerator, BESIII will remain a key player in the field of XYZ physics for years to come. An outlook on these future possibilities will also be presented.

Collaboration:

BESIII

Plenary session / **131**

The ePIC detector and the physics program of the future Electron-Ion Collider

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The future Electron-Ion Collider (EIC) will open a new precision frontier for QCD studies in collisions of polarized electrons with polarized protons and with a broad variety of nuclei. Its scientific program addresses key questions about the spin, flavor, and charge spatial structures in the nucleon, about the origin of nucleon mass, and on the role of gluons in nucleons and nuclei.

The ePIC detector is being developed for the main general-purpose experiment at the EIC. It is designed to provide a near-hermetic coverage equipped with high-resolution tracking and calorimetry, comprehensive particle identification, and dedicated far-forward and far-backward instrumentation. These capabilities are essential to meet the broad and demanding requirements of the EIC physics program.

This talk will present an overview of the ePIC detector concept and of its physics opportunities, with particular emphasis on measurements of relevance to the meson community. Key topics include exclusive and diffractive meson production as probes of gluon imaging and saturation, as well as semi-inclusive measurements of identified pions and kaons for studies of flavor and spin structure and of hadronization dynamics. The role of tagged measurements with light nuclei in accessing neutron structure will also be discussed. Finally, the status of the project and recent progress in physics-readiness efforts will be summarized.

Collaboration:

ePIC

Plenary session / **4**

Kaonic Atoms X-ray Spectroscopy: an amazing tool to study fundamental interactions

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Kaonic atoms, exotic systems in which a negatively charged kaon replaces an electron, provide a unique laboratory for probing both the strong and electromagnetic interactions. The X-ray transitions emitted during their atomic cascade are modified by the strong interaction in the innermost levels, enabling precision studies of kaon–nucleon and kaon–nucleus interactions and offering direct access to non-perturbative QCD in the strangeness sector.
In addition, transitions between high principal quantum number (high-n) levels, governed purely by quantum electrodynamics (QED), can be exploited to test bound-state QED (BSQED) in regimes of extremely strong electromagnetic fields. These studies extend beyond the Schwinger critical field, providing access to QED under extreme conditions that are currently inaccessible in ordinary atomic systems.
The SIDDHARTA-2 collaboration, exploiting the high-quality low-energy kaon beam delivered by the DAΦNE collider at Frascati (Italy) and state-of-the-art fast, high-resolution X-ray detectors such as Silicon Drift Detectors (SDDs), has performed unique high-precision X-ray spectroscopy of a series of kaonic atoms. This program includes measurements of kaonic helium-4, neon, and, for the first time, deuterium, providing essential experimental input for low-energy QCD in the strangeness sector.
In this contribution, I will present the scientific case, the experimental techniques, and the latest results from SIDDHARTA-2. I will discuss the impact of these measurements on our understanding of non-perturbative QCD and highlight the promising role of kaonic atoms in future BSQED investigations under extreme field conditions. I will conclude by outlining future perspectives for systematic kaonic-atom measurements at DAΦNE and/or J-PARC, together with the rapidly evolving enabling radiation-detector technologies.

Collaboration:

SIDDHARTA-2

Plenary session / **103**

Status and Prospects for the Measurement of the Pion Vector Form Factor

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The anomalous magnetic moment of the muon (a_μ) is one of the most precisely measured quantities in physics, thus providing an extremely sensitive probe for physics beyond the Standard Model (SM). However, the picture for the SM prediction of this quantity is not as clear as for the experimental results. Large tensions in the evaluation of the Hadronic Vacuum Polarization (HVP) contribution to a_μ prevent an unambiguous SM prediction.
The (time-like) pion vector Form Factor (FF), i.e. the cross section for the production of two charged pions in e^+e^- annihilation, accounts for 75\% of the HVP contribution evaluated through the dispersive approach.
Over the last decades, several experimental collaborations have performed measurements of the pion FF with a claimed accuracy of 1\% or better. Nevertheless, these data sets show significant discrepancies. Consequently, depending on the data set used, the resulting SM predictions either show good agreement with the experimental value or exhibit a tension exceeding 5σ.
In this contribution, the to-date most precise results on the pion FF will be summarized, hints on the origin of the observed discrepancies will be discussed, and perspectives towards new measurements provided.

Collaboration:

Plenary session / **109**

η and η′ Mesons as Probes of Axion-Like Particles, Hidden Sectors, and CP Violation: Experimental Status and Prospects

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Open problems in particle physics, e.g. the strong CP problem, the nature of dark matter, baryon asymmetry, and anomalies in nuclear transitions [1,2], motivate searches for light weakly coupled particles: ALPs, dark photons, and hidden sector mediators [3]. Light pseudoscalar mesons η and η' ($J^{PC} = 0^{-+}$) provide a uniquely clean environment for such searches, with suppressed SM backgrounds, rich radiative and leptonic decay channels, and sensitivity to CP-odd phases in the final state.

Over the past two decades, a series of dedicated experiments has established η and η' mesons as precision probes of BSM physics. Studies at WASA-at-COSY, KLOE-2, and BESIII have progressively refined sensitivity to CP-violating observables, dark photon production, and ALP signatures, reaching branching ratio limits at the 10^{-5}-10^{-7} level [4-7]. In parallel, the HADES experiment at GSI contributes precision dielectron spectroscopy in hadronic fixed-target collisions,probing the ALP-relevant low-mass e^+e^- region [8].

The most significant future advance will come from REDTOP [9], targeting production rates of 10^{13}~η and 10^{12}~η' per year at high-intensity proton or pion beams. This would push accessible branching ratios to the 10^{-11}-10^{-12} level, probe ALP-electron couplings at $g_{Ae} \sim 10^{-7}$, and reach CP asymmetries at the 10^{-4} level, covering the viable QCD-axion space in the MeV range and discriminating between competing explanations for BSM physics.

This talk presents an experimental overview of current results and the physics potential of future η and η' programs, with emphasis on the interplay between achievable meson yields, detector performance, and sensitivity to ALPs, dark mediators, and CP violation.

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Collaboration:

Plenary session / **94**

Hyperon Physics at BESIII

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Based on the large J/ψ and $\psi(3686)$ data samples collected at BESIII, recent studies have established significant transverse polarization in hyperon–antihyperon pairs, including $\Lambda\bar{\Lambda}$, $\Sigma\bar{\Sigma}$, $\Xi\bar{\Xi}$, and $\Omega^-\bar{\Omega}^+$. These measurements have enabled the first model-independent determination of the Ω^- spin. The observed nonzero polarization further allows independent determinations of hyperon and antihyperon decay parameters, providing precise tests of direct CP violation.

BESIII also provides a unique opportunity to search for hyperon electric dipole moments (EDMs) using entangled hyperon–antihyperon pairs produced in J/ψ decays. This method is expected to reach sensitivities of order $10^{-19}\, e\cdot\mathrm{cm}$ for Λ, Σ^+, Ξ^-, and Ξ^0, surpassing previous limits by several orders of magnitude. These studies demonstrate the strong potential of hyperon physics as a probe of physics beyond the Standard Model, with further advances expected at the future STCF.

Collaboration:

BESIII

Plenary session / **115**

Unexpectedly large violation of isospin symmetry in nucleus-nucleus collisions at CERN SPS energies

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NA61/SHINE at the CERN SPS is a multipurpose fixed-target detector for charged and neutral hadron measurements. The research program of the experiment includes studies of strong interactions as well as reference measurements for neutrino and cosmic-ray physics. A significant advantage of NA61/SHINE over collider experiments is its extended coverage of phase space available for hadron production. This includes the nearly entire forward hemisphere for charged hadrons and additionally a large part of the backward hemisphere for specific neutrals, with no cut-off at low transverse momenta.
This talk presents the recent NA61/SHINE measurements of an unexpectedly large violation of isospin symmetry in the kaonic sector of multiparticle production. An excess of charged over neutral kaon production in Ar+Sc collisions at $\sqrt{s_{\mathrm{NN}}}$=8.8 and 11.9 GeV is observed, reaching (18.4$\pm$6.1)% at mid-rapidity at the higher energy. Although with much larger error bars, experimental data from other experiments confirm the NA61/SHINE results. The effect cannot be explained by theoretical models including known sources of violation of isospin symmetry. Future plans for studies of the system size and energy dependence of this phenomenon in charge-symmetric hadron-nucleus and nucleus-nucleus collisions will also be discussed.

Collaboration:

NA61/SHINE

Plenary session / **129**

Posters awards

Plenary session / **134**

Studying meson-nucleus interactions - the long way to first indications for the existence of η' mesic states

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Pionic and kaonic atoms are well known systems bound by the electromagnetic interaction between charged mesons and nuclei. Systems of a neutral meson bound to a nucleus only by the strong interaction have not been observed so far. The talk describes the long way to the first indication of η'⊗11C mesic states. In a series of photoproduction experiments the interaction between the η' meson
and nuclei has been studied. The real part of the η' nucleus potential has been extracted from the measurement of excitation functions and momentum distributions of η' mesons produced off various nuclei. The imaginary part of the η'-nucleus potential has been deduced from the measurement of transparency ratios. These measurements revealed a strong η'-nucleus attraction and a relatively weak imaginary potential, favourable conditions for the existence of meson-nucleus bound states. In a dedicated experiment using the 12C(p,d) reaction at the WASA@FRS setup at GSI the excitation energy spectrum of 11C has been investigated near the η' production threshold. Thereby the decay of possibly formed η'⊗11C mesic states has been tagged via the η'NN →Np decay channel. In coincidence with protons from this decay channel the 11C excitation energy spectrum shows structures in the bound state region which may be interpreted as the searched for η'⊗11C mesic states. The talk will give an overview over the steadily improved experiments with photon and proton beams which finally led to the result we dreamed of when starting this series of experiments many years ago.

Collaboration:

CBELSA/TAPS, eta-PRiME Collaboration, Super_FRS Experiment Collaboration

Plenary session / **130**

Closing ceremony