MENU 2023 - The 16th International Conference on Meson-Nucleon Physics and the Structure of the Nucleon

Sunday 15 October 2023 - Friday 20 October 2023

Book of Abstracts

Contents

Plenary talk / **124**

Nucleon Form Factors - JLab

Author: Gordon Cates[1]

[1] *University of Virginia*

Corresponding Author: cates@virginia.edu

Plenary talk / **80**

Nucleon Structure from Lattice QCD

Author: Constantia Alexandrou[1]

[1] *University of Cyprus and The Cyprus institute*

Corresponding Author: alexand@ucy.ac.cy

We will provide an overview of recent lattice results on nucleon structure. Specifically, we will describe recent progress in the determination of nucleon charges, form factors and second Mellin moments. We will discuss the main ingredients involved in the analysis that yield results with controlled systematics reaching, for some observables, percent accuracy. We will also review lattice QCD calculations that determine the generalised parton distributions and the transverse momentum dependent parton distributions.

Parallel Session:

Invited Plenary Talk

Plenary talk / **47**

Hadron Spectroscopy with Lattice QCD

Author: John Bulava[1]

[1] *Ruhr-Universität Bochum*

Corresponding Author: john.bulava@ruhr-uni-bochum.de

The current status and challenges of computing the spectrum of hadrons from lattice QCD are reviewed. While determinations of QCD-stable hadron
masses routinely achieve percent-level accuracy, the situation for resonances and shallow bound states is more difficult since they must be identified as poles in the scattering matrix analytically continued to complex center-of-mass energies. In addition to typical lattice QCD issues like finite-volume and cutoff effects, scale setting, and tuning the quark masses to the physical point, computations of scattering amplitudes face additional challenges, such as the treatment of multi-hadron states and the inference of infinite-volume amplitudes from finite-volume energies. Despite this, some recent milestones reviewed in this talk include lattice investigations of doubly-heavy tetraquarks, dibaryons, and the first coupled channel meson-baryon scattering amplitude in the Lambda(1405) channel.

Parallel Session:

Invited Plenary Talk

Plenary talk / **136**

Baryon Spectroscopy at JLab

Author: Volker Crede[1]

[1] *Florida State University*

Corresponding Author: crede@fsu.edu

High-energy electrons and photons are a remarkably clean probe of hadronic matter, essentially providing a microscope for examining atomic nuclei and the strong nuclear force. One of the most striking phenomena of Quantum Chromodynamics (QCD) is the formation of the nucleon out of massless gluons and almost massless quarks. This system of confined quarks and gluons serves as the basic constituent of ordinary baryonic matter and exhibits the characteristic spectra of excited states, which are sensitive to the details of quark confinement. While the last few years have seen significant progress toward the mapping of the non-strange nucleon and Δ spectrum, experimental information on the spectrum, structure, and decays of strangeness -2 Ξ baryons remains sparse compared to non-strange and strangeness -1 baryons. Moreover, the photoproduction mechanism for these so-called Cascade resonances is not very well understood and expected to proceed via highly excited intermediate singly strange hyperons in reactions such as $\gamma p \to K\,Y^*\,(\Lambda^*,\,\Sigma^*) \to KK\,\Xi^{(*)}$.

Jefferson Lab has accumulated high-statistics samples of photoproduction data in recent years on both polarization observables for the N^* program at CLAS and on hyperons at higher incident-photon energies at GlueX and CLAS12. Since the lowest-lying Cascade states are expected to have narrow widths (as compared to the broad and overlapping N^* states), GlueX will be able to shed more light on the systematics of the spectrum of excited states and their properties. Copious data for excited strangeness -1 baryons have also been collected, e.g., for the $\Lambda(1405)$ and $\Lambda(1520)$, along with the data for Ξ baryons in this experimental hyperon program. In this talk, I will discuss preliminary results on photoproduced Ξ baryons, recent results for excited strangeness -1 baryons, and give a brief outlook on the GlueX potential for a spectroscopy program on excited nucleon and Λ baryons.

Parallel Session:

Invited Plenary Talk

Plenary talk / **68**

Hadron Spectroscopy at Belle and Belle II

Author: Seongbae Yang[1]

[1] *Korea University*

Corresponding Author: sbyang@korea.ac.kr

Belle II, which commenced data acquisition in 2019, has already yielded research results in hadron spectroscopy. The e^+e^- collision data, taken at or near the $\Upsilon(4S)$ resonance, are well-suited for studying hadrons with a high-performance detector system. In this presentation, we will show the latest research outcomes in hadron spectroscopy, including searches for the hidden bottom

transitions between $\Upsilon(10753)$ and bottomonia, measurements of the energy dependence of the $e^+e^- \to B^{(*)}\bar{B}^{(*)}$ cross-section, and lifetime measurements of charmed hadrons. The talk also covers recent results from the Belle experiment, which ended operation in 2010. Notably, we will reveal a threshold cusp observed at the $\Lambda\eta$ threshold in the pK^- system and new $\Lambda\pi$ signals observed near the $\bar{K}N$ mass threshold in the Λ_c^+ decays.

Parallel Session:

Invited Plenary Talk

Plenary talk / **36**

Hadron Spectroscopy with GlueX

Author: Justin Stevens[1]

[1] *William & Mary*

Corresponding Author: jrstevens01@wm.edu

The GlueX experiment, located in Jefferson Lab's Hall D, provides a unique capability to study the spectrum of hadrons in photoproduction, utilizing a high-energy, linearly polarized photon beam. An overview of results from the initial phase of GlueX, completed in 2018, will be presented with unprecedented statistics to study the production mechanisms of known hadrons as well as search for new states in the hadron spectrum, including those with gluonic degrees of freedom. The second phase of GlueX with enhanced particle identification and an ongoing upgrade of the forward calorimeter will be discussed as well.

Parallel Session:

Hadron Spectroscopy

Low Energy Nucleon Structure / **131**

Two topics in strong interaction physics with electromagentic probes

Corresponding Author: meissner@hiskp.uni-bonn.de

Symmetries and New Physics / **130**

Uncovering new-physics signals in nucleons and nuclei with lattice QCD

Author: Zohreh Davoudi[None]

Corresponding Author: davoudi@umd.edu

In this talk, I will discuss opportunities for Lattice Quantum Chromodynamics (LQCD) in the research frontier in fundamental symmetries and signals for new physics. LQCD, in synergy with effective field theories and nuclear many-body studies, provides theoretical support to ongoing and

planned experimental programs using nucleonic and nuclear targets, including searches for electric dipole moments of the nucleon, nuclei and atoms, decay of the proton, neutron-antineutron oscillations, neutrinoless double-β decay of a nucleus, conversion of muon to electron, and direct dark-matter detection, among others. I will comment on research priorities for the program for the upcoming years, and elaborates on the areas that will likely demand a high degree of innovation in both numerical and analytical frontiers of the LQCD research.

Parallel Session:

Fundamental Symmetries / New Physics Searches

Hadron spectroscopy / **22**

Recent Results from the CBELSA/TAPS Experiment

Author: Annika Thiel[1]

[1] *HISKP, Uni Bonn*

Corresponding Author: thiel@hiskp.uni-bonn.de

The exact dynamics of the quarks and gluons inside the nucleon are a long-standing question in hadron physics. To shed more light on this topic, the excitation spectrum of the nucleons needs to be measured and compared to theoretical models like constituent quark models or lattice QCD calculations. Until now, several predicted resonances - especially at high masses - have not been found by experiments, which is the well-known missing resonances problem.
The search for the missing resonances is a recent research project by several different experiments. One of them is the CBELSA/TAPS experiment, which is located at the ELSA accelerator in Bonn. The CBELSA/TAPS experiment features a detector system with nearly full 4π angular coverage and a high detection efficiency for photons, which makes it the ideal tool for the measurement of final states comprising neutral mesons. One of its special features is the use of linearly or circularly polarized photon beams impinging on a longitudinally or transversely polarized butanol target. This allows for the measurement of single or double polarization observables, which are of major importance in the identification of small resonance contributions.
In this talk, an overview of the recent status in baryon spectroscopy at the CBELSA/TAPS experiment will be given. This includes the measurement
of different polarization observables, as well as a review of the impact of the polarization data on the excitation spectra of the nucleons. In addition, an outlook on the future possibilities for baryon spectroscopy at the ELSA facility will be given.

Parallel Session:

Hadron Spectroscopy

Low Energy Nucleon Structure / **83**

Recent and Future Measurements of Nucleon Polarizabilities at HIGS

Author: Gerald Feldman[1]

[1] *George Washington University*

Corresponding Author: feldman@gwu.edu

The High Intensity Gamma-Ray Source (HIGS) at Duke University delivers monoenergetic photon beams with high linear or circular polarization by backscattering of free-electron laser (FEL) photons [1]. To exploit the unique capabilities of this facility, we are conducting an ambitious program of Compton scattering studies on light nuclei aimed at determining the nucleon electromagnetic polarizabilities. Our cryogenic target can liquefy ^1H, ^2H, and ^4He for the purpose of Compton scattering, and we have recently upgraded the cooling (and recovery) system to enable us to liquefy ^3He as well. To measure the scattered photons, we have implemented two of the world's largest NaI detectors – BUNI (from Boston University) and DIANA (from University of Kentucky) – each having better than 2% photon energy resolution. We are also using an array of medium-sized NaI detectors to enhance our angular coverage and to serve as out-of-plane detectors for polarized photon measurements.
Initial experiments have been performed on ^2H and ^4He below 85 MeV with unpolarized photons [2,3]. Experiments on ^2H will elucidate the EM polarizabilities of the neutron (α_n and β_n) and provide high precision data for comparison with chiral Effective Field Theory calculations [4]. We have obtained data on ^2H at two incident photon energies covering two backward angles (150° and 115°) with BUNI and DIANA and four forward angles with the other NaI detectors. The analysis of these two data sets is nearing completion.
In our first polarization experiment, we measured the photon beam asymmetry Σ_3 using linearly polarized photons (81 MeV) on the proton at three polar angles (55°, 90°, 125°). These data enabled us to accomplish one of the first extractions of the proton polarizabilities (α_p and β_p) from polarized data [5], and our results are compared to independent data from Mainz [6].
An approved experiment for unpolarized Compton scattering on ^3He will constitute the first Compton data ever taken on a ^3He target and will start running in early 2024. This will provide an alternate means of accessing the neutron EM polarizabilities in an entrance channel independent of the usual deuteron experiments. This is the motivation for the cryotarget upgrade to enable liquefying ^3He, which requires a lower base temperature than ^4He.
Overall, our Compton scattering program at HIGS is fairly broad, and this talk will provide an overview of the experimental activities. The results of our recent work will be reviewed, preliminary results of our ongoing measurements will be shown, and prospects for future experiments and their impact will be discussed.

[1] H.R. Weller et al., "Research Opportunities at the Upgraded HIGS Facility,"Prog. Part. Nucl. Phys. 62, 257 (2009).

[2] X. Li et al., "Compton Scattering from ^{4}He at the TUNL HIGS Facility,"Phys. Rev. C101, 034618 (2020).

[3] M.H. Sikora et al., "Compton Scattering from ^{4}He at 61 MeV,"Phys. Rev. C96, 05209 (2017).

[4] H.W. Griesshammer et al., "Using Effective Field Theory to Analyse Low-Energy Compton Scattering Data from Protons and Light Nuclei,"Prog. Part. Nucl. Phys. 67, 841 (2012).

[5] X. Li et al., "Proton Compton Scattering from Linearly Polarized Gamma Rays,"Phys. Rev. Lett. 128, 132502 (2022).

[6] V. Sokhoyan et al., "Determination of the Scalar Polarizabilities of the Proton Using Beam Asymmetry Σ_3 in Compton Scattering,"Eur. Phys. J. A53, 14 (2017).

Parallel Session:

Low-Energy Nucleon Structure

Symmetries and New Physics / 10

R measurement at BESIII

Author: Beijiang Liu[1]

[1] *Institute of High Energy Physics*

Corresponding Author: redmer@uni-mainz.de

The R value, defined as the ratio of inclusive hadronic cross section over dimu cross-section from electron-positron annihilation, is an important quantity that contributes to the SM prediction of the muon anomalous magnetic moment, and in the determination of the QED running coupling constant evaluated at the Z pole. At BESIII, the R value is measured with a total of 14 data points with the corresponding c.m. energy going from 2.2324 to 3.6710 GeV. The statistical uncertainty of the measured R is less than 0.6%. Two different simulation models, the LUARLW and a new Hybrid generated, are used and give consistent detection and initial-state radiation corrections.
An accuracy of better than 2.6% below 3.1 GeV and 3.0% above is achieved in the R values. The precise measurement will be used to calculate the muon anomalous magnetic moment and QED running coupling.

Parallel Session:

Fundamental Symmetries / New Physics Searches

Hadron spectroscopy / **6**

Combination of Bayesian Statistics with Truncated Partial-Wave Analysis

Author: Philipp Krönert[1]

Co-authors: Yannick Wunderlich [1]; Farah Afzal [1]; Annika Thiel [1]

[1] *University Bonn*

Corresponding Author: kroenert@hiskp.uni-bonn.de

Within the strong interaction, the emergence of so-called baryon resonances, such as the nucleon resonance N(1535)1/2-, can be observed. These states can be predicted by the theory of quantum chromodynamics, for example by quark models. However, more resonances are theoretically predicted than have been experimentally found, which is known under the name of the missing-resonance problem. Partial wave analyses describe experimental data with a suitable statistical model in order to extract resonance parameter and explain and verify predicted resonances. Hereby, mathematical ambiguities are an inherent property. A truncated partial-wave analysis is a simpler model and allows among other things to study these mathematical ambiguities. In this project, Bayesian statistics is combined with truncated partial-wave analysis for the first time in order to study the structure of emerging ambiguities and their relevance in comparison to each. The experimental data of the six polarization observables $\sigma_0, \Sigma, T, E, F$ and G of η-photoproduction are used for the analysis. The final results are marginal distributions for the electromagnetic multipole parameters. In this presentation, an overview about the method and arising ambiguities will be given. In addition, first model-independent predictions for polarization observables, which have not yet been measured, will be shown.

Parallel Session:

Hadron Spectroscopy

Symmetries and New Physics / **105**

Study of neutron beta decay with the Nab experiment

Author: Stefan Baessler[1]

[1] *University of Virginia*

Corresponding Author: baessler@virginia.edu

One of the current problems of the Standard Model of Elementary Particle Physics is the about three sigma failure of the first-row unitarity test of the Cabbibo-Kobayashi-Maskawa matrix. A long-standing goal of the study of free neutron beta decay is to better determine its upper left element ("Vud"). That is possible with measurements of the neutron lifetime and a correlation coefficient (the beta asymmetry or the neutrino-electron correlation coefficient). The Nab collaboration is working on an improvement in the accuracy of neutrino electron correlation coefficient that - if achieved - is large enough to base the determination of Vud on neutron data alone. In this talk, I will give a status report and an outlook.

Parallel Session:

Fundamental Symmetries / New Physics Searches

Low Energy Nucleon Structure / **74**

Recent and Future Measurements of Nucleon Polarizabilities at MAMI

Author: David Hornidge[1]

[1] *Mount Allison University*

Corresponding Author: hornidg@uni-mainz.de

A central problem of modern physics research is the solution to QCD in the non-perturbative regime. One method of testing QCD in this low-energy region is by measuring certain structure constants of hadrons - called polarizabilities - that show particular promise of allowing a direct connection to the underlying quark/gluon dynamics through comparison to modern QCD-inspired model calculations, and to solutions of QCD done computationally on the lattice. This talk will report on recent measurements and possible future results on the nucleon polarizabilities from the Institute for Nuclear Physics in Mainz, Germany.

Parallel Session:

Low-Energy Nucleon Structure

Hadron spectroscopy / **56**

Production of N* resonances with hidden strangeness in various reactions

Author: Bing-Song Zou[1]

[1] *ITP, CAS*

Corresponding Author: zoubs@itp.ac.cn

The three narrow P_c states decaying to J/ψp observed by the LHCb experiment are consistent with earlier predictions for one $\bar{D}\Sigma_c$ and two $\bar{D}^*\Sigma_c$ bound states. Their strange partners are expected to exist. Here we present evidence for the production of these N^* resonances with hidden strangeness in various reactions, such as γp → ϕp, γp → KΛ, $\gamma p \to K\Sigma$, γp → KΣ*, γp → KΣ, pp → pKΛ,

$J/\psi \to K_S \bar{n}\Lambda$+c.c., $\chi_{c0} \to \bar{p}K^{*+}\Lambda$+c.c. , etc., which give clear supports of the existence of the strange molecular partners of P_c states. More production processes of these N^* resonances with hidden strangeness are proposed to further test the hadronic molecular picture.

Parallel Session:

Hadron Spectroscopy

Low Energy Nucleon Structure / **79**

Recent and Future Measurements of the Generalized Proton Polarizabilities

Author: Nikos Sparveris[1]

[1] *Temple University*

Corresponding Author: sparveri@temple.edu

The polarizabilities of a composite system such as the proton are elementary structure constants. They describe its response to an external electromagnetic (EM) field and quantify the deformation of the charge and magnetization distributions inside the proton caused by the electric or magnetic field, respectively. When studied through the virtual Compton scattering process, the virtuality of the photon gives access to the generalized polarizabilities and allows to map out the resulting deformation of the densities in a proton subject to an EM field. These measurements provide unique access to the underlying system dynamics and are a key for decoding the proton structure in terms of the theory of the strong interaction that binds its elementary quark and gluon constituents together. Of particular interest are puzzling measurements of the proton's electric generalized polarizability, that have challenged the theoretical predictions in recent years. This talk will present an overview on the topic, followed by the discussion of new results and of future prospects.

Parallel Session:

Low-Energy Nucleon Structure

Symmetries and New Physics / **116**

Status of V_{ud}, V_{us} and the CKM unitarity

Author: Misha Gorshteyn[1]

[1] *JGU Mainz*

Corresponding Author: gorshtey@uni-mainz.de

I review the current status of CKM unitarity tests in the top row. Recent developments in the SM radiative corrections to decays of free and bound neutrons, pions and kaons led to an apparent 2,5 σ deficit which, if confirmed, could point to the BSM physics.

Parallel Session:

Fundamental Symmetries / New Physics Searches

Hadron spectroscopy / 25

On the nature of the N^* and Δ resonances via coupled-channel dynamics

Author: Yu-Fei Wang[1]

[1] *Institute for Advanced Simulation, Forschungszentrum Jülich*

Corresponding Author: yuf.wang@fz-juelich.de

This talk focuses on a recent work aiming at determining the composition of certain N^* and Δ resonances, i.e. whether they are compact states formed directly by quarks and gluons, or hadronic molecules generated from the meson-baryon interaction. The information of the resonance poles is provided by a comprehensive coupled-channel approach, the J\"{u}lich-Bonn model. 13 states that are significant in this approach are studied. Two criteria for each state are adopted in this paper, the comparison thereof roughly indicates the model uncertainties. It is found that the conclusions for 8 resonances are relatively certain: $N(1535)\frac{1}{2}^-$, $N(1440)\frac{1}{2}^+$, $N(1710)\frac{1}{2}^+$, and $N(1520)\frac{3}{2}^-$ tend to be composite; whereas $N(1650)\frac{1}{2}^-$, $N(1900)\frac{3}{2}^+$, $N(1680)\frac{5}{2}^+$, and $\Delta(1600)\frac{3}{2}^+$ tend to be compact.

Parallel Session:

Hadron Spectroscopy

Low Energy Nucleon Structure / 5

First Computation of 4He Compton Scattering and Nucleon Polarisabilies: the Transition Density Formalism

Author: Harald W. Griesshammer[1]

[1] *George Washington University*

Corresponding Author: hgrie@gwu.edu

In few-nucleon systems, the transition-density formalism is highly efficient to compute interactions with perturbative probes. One- and two-body transition densities that encode the nuclear structure of the target are evaluated once and stored for one nucleus. They are then convoluted with an interaction kernel to produce observables. The same densities can be used with different kernels. This method exploits factorisation between nuclear structure and interaction kernel in Chiral EFT. It takes full advantage of the numerical power of modern few-nucleon methods, is markedly more computationally efficient and applicable to a wide array of nuclei and reactions. In this contribution, the formalism is first introduced and then applied to present the first theory description of 4He Compton scattering. It uses the same Compton kernels familiar from proton, deuteron and 3He Compton scattering in Chiral Effective Field Theory with explicit Delta degrees of freedom, applicable between about 50 and 130MeV. The result compares well to data from HIγS, MAXlab and Illinois. We also address the sensitivity of cross section and beam asymmetry on the (static) scalar-isoscalar polarisabilities of the nucleon which parametrise the stiffness of charge distributions against deformations. The project is part of the synergetic international effort of experimentalists and theorists in Compton scattering on one- and few-nucleon systems.

Work in collaboration with J.~A.~McGovern (U.~of Manchester), A.~Nogga (FZ J\"ulich) and D.~R.~Phillips (Ohio U.).

Parallel Session:

Few-Body Systems

Symmetries and New Physics / 64

Probe hyperon electric dipole moments at electron-positron colliders

Authors: Jinlin Fu[1]; Hai-Bo Li[2]; Jian-Peng Wang[3]; Fu-Sheng Yu[3]; Jianyu Zhang[1]

[1] *University of Chinese Academy of Sciences*

[2] *Institute of High Energy Physics, Chinese Academy of Sciences*

[3] *Lanzhou University*

Corresponding Author: zhangjianyu@ucas.ac.cn

The electric dipole moment (EDM) of elementary particles, serves as a powerful probe for new physics beyond the Standard Model (SM) and holds the potential to provide novel insights in unraveling the enigma of the matter-dominated universe. Hyperon EDM is a largely unexplored territory. In our recent paper (**arxiv:2307.04364**), we present a novel method that focuses on entangled hyperon-antihyperon pairs in J/ψ decays for the indirect extraction of hyperon EDM. Leveraging the statistics from the BESIII experiment, the estimated sensitivity for Λ EDM can reach an impressive level of 10^{-19} e cm, demonstrating a **three-order-of-magnitude improvement** over the only existing measurement in a fixed-target experiment at Fermilab with similar statistics. The estimated sensitivities for the Σ^+, Ξ^-, and Ξ^0 hyperons at the same level of 10^{-19} e cm will mark the first-ever achievement and the later two will be the first exploration in hyperons with two strange valence quarks. The EDM measurements for hyperons conducted at the BESIII experiment will be a significant milestone and serve as a litmus test for new physics such as SUSY and left-right symmetrical model. Furthermore, at the STCF experiment, the sensitivity of hyperon EDM measurements can be further enhanced by two orders of magnitude.

Parallel Session:

Fundamental Symmetries / New Physics Searches

Hadron spectroscopy / 33

Pole determination of $P^{\Lambda}_{\psi s}(4338)$ and possible $P^{\Lambda}_{\psi s}(4255)$ in $B^- \to J/\psi\Lambda\bar{p}$

Author: Satoshi Nakamura[1]

Co-author: Jiajun Wu [2]

[1] *Shandong University*

[2] *University of Chinese Academy of Sciences*

Corresponding Author: satoshi@sdu.edu.cn

First hidden-charm pentaquark candidate with strangeness, $P^{\Lambda}_{\psi s}(4338)$, was recently discovered in $B^- \to J/\psi\Lambda\bar{p}$ by the LHCb Collaboration. $P^{\Lambda}_{\psi s}(4338)$ shows up as a bump at the $\Xi_c\bar{D}$ threshold in the $J/\psi\Lambda$ invariant mass ($M_{J/\psi\Lambda}$) distribution. The $M_{J/\psi\Lambda}$ distribution also shows a large fluctuation at the $\Lambda_c\bar{D}_s$ threshold, hinting the existence of a possible $P^{\Lambda}_{\psi s}(4255)$. In this work, we determine the $P^{\Lambda}_{\psi s}(4338)$ and $P^{\Lambda}_{\psi s}(4255)$ pole positions for the first time. For this purpose, we fit a $B^- \to J/\psi\Lambda\bar{p}$ model to the $M_{J/\psi\Lambda}$, $M_{J/\psi\bar{p}}$, $M_{\Lambda\bar{p}}$, and $\cos\theta_{K^*}$ distributions from the LHCb simultaneously; $\chi^2/\mathrm{ndf} \sim 1.21$. Then we extract $P^{\Lambda}_{\psi s}$ poles from a unitary $\Xi_c\bar{D}$-$\Lambda_c\bar{D}_s$ coupled-channel scattering amplitude built in the model. In our default fit, the $P^{\Lambda}_{\psi s}(4338)$ pole is found at $(4338.2\pm1.4)-(1.9\pm0.5)\,i$ MeV while the $P^{\Lambda}_{\psi s}(4255)$ pole at 4254.7 ± 0.4 MeV. The $P^{\Lambda}_{\psi s}(4338)$ and $P^{\Lambda}_{\psi s}(4255)$ are mostly $\Xi_c\bar{D}$ bound and $\Lambda_c\bar{D}_s$ virtual states, respectively. Through our analysis, the data disfavors a hypothesis of $P^{\Lambda}_{\psi s}(4338)$ as merely a kinematical effect. This pole determination, which is important in its own right, sets a primary basis to study the nature of the $P^{\Lambda}_{\psi s}$ states. This contribution is based on Phys. Rev. D 108 L011501 (2023).

Parallel Session:

Hadron Spectroscopy

Low Energy Nucleon Structure / **23**

Proton and neutron electromagnetic charge radii and magnetic moments from lattice QCD

Author: Miguel Salg[1]

Co-authors: Dalibor Djukanovic ; Georg von Hippel ; Harvey Meyer ; Konstantin Adrian Bernhard Ottnad ; Hartmut Wittig

[1] *University of Mainz*

Corresponding Author: msalg@uni-mainz.de

We present results for the electromagnetic form factors of the proton and neutron computed on the $(2+1)$-flavor Coordinated Lattice Simulations (CLS) ensembles including both quark-connected and -disconnected contributions. The Q^2-, pion-mass, lattice-spacing, and finite-volume dependence of our form factor data is fitted simultaneously to the expressions resulting from covariant chiral perturbation theory including vector mesons amended by models for lattice artefacts. From these fits, we determine the electric and magnetic charge radii and the magnetic moments of the proton and neutron. To assess the influence of systematic effects, we average over various cuts in the pion mass and the momentum transfer, as well as over different models for the lattice-spacing and finite-volume dependence, using weights derived from the Akaike Information Criterion (AIC).

Parallel Session:

Low-Energy Nucleon Structure

Mixed / **62**

Partial Wave Analysis for Pion-Induced Resonance Studies in the HADES Experiment

Author: Ahmed Marwan Foda[1]

[1] *GSI Helmholtzzentrum für Schwerionenforschung, FAIR Forschung NRW*

Corresponding Author: a.foda@gsi.de

The High Acceptance Di-lepton Spectrometer (HADES) collaboration at GSI employs a pion beam to examine the characteristics of baryonic resonances and their decay channels. This pion-beam facility enables the generation of baryonic resonances at a fixed center of mass energy ($\sqrt{s}$), i.e. in the S-channel. Consequently, these beams possess a significant advantage over proton-induced reactions and are complementary to photo-induced studies conducted elsewhere. Partial Wave Analysis (PWA) techniques are used to study the coupling of the resonances to different final states. HADES has a particular interest in studying the role and medium modification of vector mesons in heavy-ion collisions in baryon-dense matter. Elementary pion-induced studies on the proton combined with a PWA will provide insights into the couplings of baryonic resonances to ρN and ωN final states in greater detail will provide insights into the impact of the melting of the ρ meson in heavy ion collisions and the involvement of intermediary vector mesons in dilepton emissions.\\

In anticipation of conducting a more comprehensive exploration of the resonance regions in pion-proton collisions, a new implementation of the K-Matrix \& N/D frameworks is currently under development. This updated implementation aims to offer a refined mapping of these regions. Example fits will be presented showing current status and the potential of the new framework.

Parallel Session:

Hadron Spectroscopy

Hadron spectroscopy / **94**

Scalar and tensor charmonium resonances from lattice QCD

Author: David Wilson[1]

[1] *University of Cambridge*

Corresponding Author: dw504@cam.ac.uk

I will discuss scalar and tensor charmonium resonances determined using lattice QCD. Working at $m_\pi \approx 391$ MeV, more than 200 finite-volume energy levels are computed and these are used in extensions of the Lüscher formalism to determine infinite volume scattering amplitudes. Working in the approximation where charm-annihilation is forbidden, the ground state $\chi_{c0}(1P)$ and $\chi_{c2}(1P)$ states are stable. Below 4100 MeV we find a single χ_{c0} and a single χ_{c2} resonance, both strongly-coupled to several decay channels consisting of pairs of open-charm mesons. Both resonances are found on the closest unphysical sheet just below 4000 MeV with a widths of ≈ 60 MeV. The largest couplings are to the closed $D^*\bar{D}^*$ channels in S-wave, but several open-charm channels are also found to be large and significant in both cases.

Parallel Session:

Hadron Spectroscopy

Mixed / **61**

Production of S=-2 systems near the threshold in the $^{12}C(K^-, K^+)X$ reaction at 1.8 GeV/c

Author: Wooseung Jung[1]

Co-authors: JungKeun Ahn [1]; Yudai Ichikawa [2]

[1] *Korea University*

[2] *ASRC, JAEA*

Corresponding Author: aswe11@korea.ac.kr

While studying the double Λ hypernuclei and Ξ^- hypernuclei is essential in further understanding baryon-baryon interaction with S=-2 systems, experimental data still need to be provided. Several earlier experiments, such as KEK-PS E373 and J-PARC E07, reported possible attractive Ξ–nucleus interaction from bound Ξ^- hypernuclear states.
Recently, the E42 experiment which has a primary goal to search for an H-dibaryon collected 300K $^{12}C(K^-, K^+)X$ reaction events in the ranges of $\theta_{K+} < 25^\circ$ and p_{K^+} 0.5 GeV/c via 1.8 GeV/c K^- beam at the J-PARC. A large time-projection chamber (HypTPC) highlights the E42 detector, facilitating a charged particle reconstruction for subsequent decays of the double-strangeness system produced near the threshold region in the $^{12}C(K^-, K^+)X$ reaction. Therefore, the E42 data would first measure all decay channels involving charged particle emission from $^{12}C(K^-, K^+)X$ reaction with high statistics.
This talk will present the preliminary results of the J-PARC E42 experiment.

Parallel Session:

Hadron Spectroscopy

Low Energy Nucleon Structure / **11**

Recent results of Baryon electromagnetic form factors at BESIII

Author: Beijiang Liu[1]

[1] *Institute of High Energy Physics*

Corresponding Author: xial@ustc.edu.cn

The electromagnetic form factors (EMFFs) and the pair production cross sections of various baryons have been studied at BESIII, including the nucleon EMFFs and the hyperons. Anomalous enhancement behavior
on the Lambda and Lambdac pair are observed. Besides, measurements on the SU(3) decuplet baryon have been
performed, such as Omega and Delta, and will be presented.

Parallel Session:

Low-Energy Nucleon Structure

Hadron spectroscopy / **71**

The two-pole nature of the $\Lambda(1405)$ from lattice QCD

Author: Bárbara Cid-Mora[1]

Co-authors: André Walker-Loud [2]; Andrew D. Hanlon [3]; Ben Hörz [4]; Colin Morningstar [5]; Daniel Mohler ; Fernando Romero-López [6]; John Bulava [7]; Joseph Moscoso [8]; Sarah Skinner [5]; Amy Nicholson [8]

[1] *GSI Helmholtzzentrum für Schwerionenforschung*

[2] *Lawrence Berkeley National Laboratory, USA*

[3] *Brookhaven National Laboratory, USA*

[4] *Intel Deutschland GmbH, Germany*

[5] *Carnegie Mellon University, USA*

[6] *MIT*

[7] *DESY*

[8] *University of North Carolina, USA*

Corresponding Author: b.cidmora@gsi.de

The PDG lists the $\Lambda(1405)$ state, a baryon with quantum numbers $I(J^P) = 0(\frac{1}{2}^-)$ and strangeness $S = -1$, an object of interest given the difficulties encountered in obtaining this state from quark models. There are discrepancies in the literature whether experimental data is compatible with one or two nearby poles in this region, and what the position of those poles in the complex plane would be. This work presents results of a lattice QCD computation of the coupled channel $\Sigma\pi - N\bar{K}$ scattering amplitude in the $\Lambda(1405)$ region, representing the first coupled channel meson-baryon computation in lattice QCD. The calculation was carried out using a single CLS ensemble with a heavier-than-physical pion mass of $m_\pi = 200\,\mathrm{MeV}$. The scattering amplitude analysis was based on Lüscher's formalism and finite-volume stationary-state energies, and was extracted using several parametrizations of the two-channel K-matrix. The results support the two-pole picture exhibiting a virtual bound state below $\Sigma\pi$ threshold and a resonance pole below the $N\bar{K}$ threshold.

Parallel Session:

Hadron Spectroscopy

Mixed / 8

Production of $d_{N\Omega}$ dibaryon in kaon induced reactions.

Author: Jing Liu[1]

Co-authors: Qi-Fang Lü [2]; Chun-Hua Liu [1]; Dian-Yong Chen [1]; Yu-Bing Dong [3]

[1] *Southeast University*

[2] *Hunan Normal University*

[3] *Institute of High Energy Physics, Chinese Academy of Sciences*

Corresponding Author: jingliu@seu.edu.cn

In this work, we propose to investigate the $d_{N\Omega}$ dibaryon production in the process $K^- p \to d_{N\Omega}\bar{\Xi}^0$ by utilizing the kaon beam with the typical momentum to be around 10 GeV, which may be available at COMPASS, OKA@U-70 and SPS@CERN. The cross sections for $K^- p \to d_{N\Omega}\bar{\Xi}^0$ are estimated and in particular, the magnitude of the cross sections are estimated to be $404.38^{+358.45}_{-201.89}$ nb at $P_K = 20$ GeV.
Considering that $d_{N\Omega}$ dominantly decay into $\Xi\Lambda$ and $\Xi\Sigma$,
we also estimate the cross sections for $K^- p \to \Xi^0\Lambda\bar{\Xi}^0$ and $K^- p \to \Xi^-\Sigma^+\bar{\Xi}^0$, where the dibaryon $d_{N\Omega}$ can be observed in the invariant mass distributions of $\Xi^0\Lambda$ and $\Xi^-\Sigma^+$, respectively.

Parallel Session:

Hadron Spectroscopy

Low Energy Nucleon Structure / **123**

Low-energy constants in the chiral Lagrangian with baryon octet and decuplet fields from Lattice QCD data on CLS ensembles

Author: Matthias F.M. Lutz[1]

[1] *GSI*

Corresponding Author: m.lutz@gsi.de

Hadron spectroscopy / **43**

Meson-baryon interactions and $\Lambda(1405)$ in chiral effective field theory

Author: Xiu-Lei Ren[1]

Co-authors: Evgeny Epelbaum [2]; Jambul Gegelia [2]; Ulf-G. Meißner [3]

[1] *Helmholtz-Institut Mainz*

[2] *Ruhr-Universität Bochum*

[3] *Bonn University*

Corresponding Author: xiulei.ren@uni-mainz.de

We investigated the meson-baryon scattering using time-order perturbation theory (TOPT) based on the covariant chiral effective field theory. Renormalized scattering amplitudes are obtained by solving the integral equations with the full off-shell dependence of effective potentials and applying subtractive renormalization. Our formalism has been successfully applied to the pion-nucleon scattering at leading order and extended to the meson-baryon scattering in the S=-1 sector. By solving the coupled-channel integral equations, we obtained the two-pole structure of the $\Lambda(1405)$ resonance. Furthermore, we would like to present the preliminary results of the ongoing work at the next-to-leading order on the meson-baryon interactions.

Parallel Session:

Hadron Spectroscopy

Mixed / **16**

Hyperon-Nucleon Interactions

Authors: Beijiang Liu[1]; Jielei Zhang[2]

[1] *Institute of High Energy Physics*

[2] *Henan University*

Corresponding Author: zhangjielei@ihep.ac.cn

Scattering experiments of pions and kaons impinging on nuclear targets have a rich history, providing important insight into the strong interaction. Similar experiments with hyperon beams are much harder to realize given higher masses and shorter lifetimes. Two-body J/\psi decays represent a clean source of hyperons so that the high statistics sample of 10 billion J/\psi events collected with

the BESIII detector enables studies of hyperon-nucleon interactions using the BESIII beampipe as an effective nuclear target. Here, we will present the novel method of studying hyperon-nucleon interactions at an e^+e^- collider and discuss first results for the reaction \Xi^0 + {}^9\textrm{Be}\to \Xi^- + p + {}^8\textrm{Be}.

Parallel Session:

Miscellaneous Session

Low Energy Nucleon Structure / **60**

Nucleon self-energy including two-loop contributions

Author: Nils Conrad[1]

Co-authors: Ashot Gasparyan [2]; Evgeny Epelbaum [2]

[1] *Ruhr-Universität Bochum, Institut für Theoretische Physik II, Physik der Hadronen und Kerne*

[2] *Ruhr University Bochum*

Corresponding Author: nils.conrad@ruhr-uni-bochum.de

The nucleon self-energy is calculated in SU(2) covariant chiral perturbation theory to study the pion mass dependence of the nucleon mass up to chiral order $\mathcal{O}(q^6)$, i.e., including two-loop diagrams. The contributions of the diagrams are expressed by a small set of (scalar) master integrals. The extended on-mass-shell (EOMS) renormalization scheme is applied, where (besides the divergent pieces) infrared regular parts of the integrals are systematically subtracted, making the renormalized expressions consistent with the power counting.
The master integrals are evaluated in two ways: Firstly, they are calculated by means of the chiral expansion in d dimensions, using the strategy of regions to differentiate between the infrared singular and regular part. This yields the physical nucleon mass in an $1/m_0$ expansion (with m_0 being the nucleon mass in the chiral limit) and is in agreement with the infrared renormalization result. Secondly, the master integrals are solved numerically using the sector decomposition method.

Parallel Session:

Low-Energy Nucleon Structure

Hadron spectroscopy / **37**

Analysis of rescattering effects in 3π final states

Author: Dominik Stamen[1]

Co-authors: Bastian Kubis ; Malwin Niehus ; Mikhail Mikhasenko ; Tobias Isken

[1] *Bonn University*

Corresponding Author: stamen@hiskp.uni-bonn.de

Decays into three particles are often described in terms of two-body resonances and a non-interacting spectator particle. To go beyond this simplest isobar model, crossed-channel rescattering effects need to be accounted for. We quantify the importance of these rescattering effects in three-pion systems for different decay masses and angular-momentum quantum numbers. We provide amplitude decompositions for four decay processes with total $J^{PC} = 0^{--}$, 1^{--}, 1^{-+}, and 2^{++}, all of which

decay predominantly as $\rho\pi$ states. Two-pion rescattering is described in terms of an Omnès function, which incorporates the ρ resonance. Inclusion of crossed-channel effects is achieved by solving the Khuri-Treiman integral equations. The unbinned log-likelihood estimator is used to determine the significance of the rescattering effects beyond two-body resonances; we compute the minimum number of events necessary to unambiguously find these in future Dalitz-plot analyses. Kinematic effects that enhance or dilute the rescattering are identified for the selected set of quantum numbers and various masses.

Parallel Session:

Hadron Spectroscopy

Low Energy Nucleon Structure / **78**

Towards data-driven evaluation of the nucleon polarizability effects contributing to the Lamb shift

Author: Volodymyr Biloshytskyi[1]

[1] *KPH JGU Mainz*

Corresponding Author: vbiloshy@uni-mainz.de

The Bernabéu-Tarrach sum rule, the "virtual sibling" of the Baldin sum rule, will be discussed. It could potentially offer an additional data-driven constraint on the electric polarizabilities of the nucleon. Moreover, its convergence implies the sum rule for the unknown subtraction function in the two-photon exchange contribution to the Lamb shift. The verification of these sum rules will be demonstrated within the framework of covariant chiral perturbation theory and the naive parton model.

Parallel Session:

Low-Energy Nucleon Structure

Hadron spectroscopy / **29**

Three-body unitary coupled-channel analysis on η(1405/1475)

Authors: Satoshi Nakamura[1]; Qi Huang[2]; Haiping Peng[3]; Yinchun Zhu[3]; Yan Zhang[3]

[1] *Shandong University*

[2] *Nanjing normal University*

[3] *University of Science and Technology of China*

Corresponding Author: wujiajun@ucas.ac.cn

The recent BESIII data on Jpsi-> gamma eta(1405/1475) -> gamma KKbar pi
, which is significantly more precise than earlier eta(1405/1475)-related data, enables quantitative discussions on eta(1405/1475) at the previously unreachable level. We conduct a three-body unitary coupled-channel analysis of experimental Monte Carlo outputs for Jpsi-> gamma eta(1405/1475) -> gamma KKbar pi. The KKbar pi Dalitz plot distributions from the BESIII, and branching ratios of "gamma pi pi eta" and "gamma gamma pi pi" final states relative to that of "gamma KKbar pi". Our model systematically considers (multi)loop diagrams and an associated triangle singularity, which

is critical for making excellent predictions on eta(1405/1475) -> pi pi pi line shapes and branching ratios. The eta(1405/1475) pole locations are revealed for the first time. Two poles for eta(1405) are found on different Riemann sheets of the K*Kbar channel, while one pole is found for eta(1475). The eta(1405/1475) states are described by two bare states dressed with continuum states. The lower bare state would be an excited eta' state, while the higher one could be an excited eta('), hybrid, glueball, or a mixture of these. This work presents the first-ever pole determination based on a manifestly three-body unitary coupled-channel framework applied to experimental three-body final state distributions (Dalitz plots).

Parallel Session:

Hadron Spectroscopy

Low Energy Nucleon Structure / **121**

New spin polarizabilities results (remote)

Plenary talk / **26**

The light baryon resonance spectrum in a coupled-channel approach – recent results from the Juelich-Bonn model

Author: Deborah Rönchen[1]

[1] *Forschungszentrum Jülich, IAS-4*

Corresponding Author: d.roenchen@fz-juelich.de

In order to connect predictions for the baryon spectrum in the non-perturbative energy regime from quark models or lattice calculations to experimental data, coupled-channel frameworks are especially suited. In those approaches a simultaneous partial-wave analysis of multiple reactions with different initial and final states is performed.
I will present recent results from the Juelich-Bonn dynamical coupled-channel approach, where the spectrum of nucleon and Delta resonances is extracted based on a combined study of the pion- and photon-induced production of piN, etaN, KLambda and KSigma final states. The amplitudes of the Juelich-Bonn model also enter the study of electroproduction reactions as constraints at Q^2=0.

Parallel Session:

Hadron Spectroscopy

Plenary talk / **82**

Hadron Spectroscopy at BESIII

Author: Meike Küßner[1]

[1] *Ruhr-Uni Bochum*

Corresponding Author: mkuessner@ep1.rub.de

Despite mesons being one of the longest known type of particles, there are still many open questions. Besides well understood states that can be clearly attributed to meson nonets, there are many candidates which could have an exotic nature instead. Such exotic particles e.g. glueballs, hybrids and tetraquarks can be especially studied in clean, gluon-rich environments.
The BESIII experiment, which is in operation at the BEPCII electron-positron collider in Beijing since 2009, has collected world leading high statistic data samples in the charmonium region. This allows to study rare reactions that are considered to be suppressed. This offers unique possibilities to study exotic QCD states in the charmonium sector at BESIII, but also the light meson spectrum which can be accessed via charmonium decays. Especially radiative J/ψ decays offer a gluon-rich environment in which gluebells and hybrid states can be expected. Since these states are often hard to identify and disentangle, partial wave analysis are needed to determine the different contributions.
In the talk recent studies carried out by the BESIII experiment will be discussed and their implications pointed out. Special focus will be put on recent results from sophisticated amplitude analyses.

Parallel Session:

Hadron Spectroscopy

Plenary talk / **72**

Hadron Spectroscopy at LHCb

Author: Zan Ren[1]

[1] *UCAS*

Corresponding Author: zan.ren@cern.ch

The LHCb experiment has been at the forefront of particle physics research. It has been developed to a general-purpose experiment on forward-region physics, and the detector performance is optimized for heavy-flavour signal reconstructions. Over the past few years, the LHCb Collaboration has conducted groundbreaking studies in both conventional and exotic hadron spectroscopy in the heavy flavor sector, furthering our understanding of QCD. I will review these important results on behalf of LHCb.The Run3 upgrade and the resulting physics prospects will also be discussed.

Parallel Session:

Invited Plenary Talk

Nucleon Structure in DIS / **99**

Multidimensional partonic imaging at the future Electron-Ion Collider

Author: Salvatore Fazio[1]

[1] *University of Calabria and INFN Cosenza*

Corresponding Author: sfazio@bnl.gov

With the project to build a future Electron-Ion Collider (EIC) at BNL, equipped with a new state-of-the-art detector (ePIC), and advancements in theory and further development of phenomenological

tools, we are now preparing for the next step in subnuclear tomographic imaging. The EIC's large range of center-of-mass energies in combination with high luminosity and polarization of both the lepton and the hadron beams, will open a unique opportunity for high precision measurements of both cross sections and spin-asymmetries in e+p(A) collisions. Generalized parton distributions (GPDs) describe the multi-dimensional partonic structure of a nucleon in coordinate space, while Transverse-Momentum Dependent parton distributions (TMDs) lead us to 3D imaging in momentum space. Thus, a precise extraction of both GPDs and TMDs will allow us for a detailed investigation of the partonic substructure of hadrons in multi-dimensions, providing new information about the internal dynamics of quarks and gluons inside free nucleons and nuclei.
Measurements hard exclusive processes, like Deeply Virtual Compton Scattering (DVCS) and Hard Exclusive Meson Production (HEMP), with all related probes, are the best way in constraining GPDs and achieve precision spatial partonic tomographic images. Instead, TMDs are constrained by precise measurements of SIDIS and jets. This talk will highlight key experimental challenges, ongoing and future simulation efforts and finally discuss the EIC's expected impact over the current knowledge of GPDs and TMDs.

Parallel Session:

Nucleon Structure in DIS

Facilities / **41**

Progress of the Future Super Tau-Charm Facility

Author: Xiao-Rui Lyu[1]

[1] *University of Chinese Academy of Sciences*

Corresponding Author: xiaorui@ucas.ac.cn

The proposed super τ-charm facility (STCF) is a symmetric electron-positron collider, designed to provide e^+e^- interactions at a center-of-mass energy from 2.0 to 7.0 GeV. This energy region corresponds to the transitions between non-perturbative quantum chromodynamics (QCD) and perturbative QCD. Hence, a large variety of topics in elementary particle physics can be pursued at STCF, including exploring QCD and hadron spectroscopy, precisely measurement of electroweak interactions and flavor physics as well as searching for the new physics beyond the standard model. The peaking luminosity at STCF is designed to be at least $0.5\times10^{35}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$ and is expected to deliver more than 1 ab^{-1} of integrated luminosity per year. In this talk, the physics potentials will be introduced, as well as the recent progress on the project R&D.

Parallel Session:

Future Facilities and Directions

Hadron spectroscopy / **12**

Observation of e+e- to chi_c1 at BESIII

Author: Beijiang Liu[1]

[1] *Institute of High Energy Physics*

Corresponding Author: a_drie04@uni-muenster.de

In electron-positron annihilation, the process of e+e- -> chi_c1 can occur via the
production of two virtual photons or through neutral current, therefore being suppressed with

respect to the normal annihilation process via one virtual photon. Using a dedicated scan sample around the chi_c1 mass, the direct production of chi_c1 has been established for the first time in experiments. This provides a new approach for the study of the internal nature of hadrons.

Parallel Session:

Hadron Spectroscopy

Nucleon Structure in DIS / **81**

Future meson structure studies with AMBER

Author: Michela Chiosso[1]

[1] *University of Torino and INFN*

Corresponding Author: michela.chiosso@cern.ch

AMBER is a new fixed-target facility at the M2 beam line of the CERN SPS, devoted to various QCD measurements aiming at addressing some fundamental issues of strong interaction in the medium and long-term future.
In particular the world-unique SPS M2 beam line, when operated with high-energy pions and kaons, can be used to shed light on the meson structure and the origin of hadron masses. This is deeply connected to the parton dynamics and how it differs in protons or mesons.
The rich physics program planned at the AMBER facility with pion(kaon)-induced Drell-Yan and charmonium and direct-photon production will be presented in this talk. World competition and timelines will be also discussed.

Parallel Session:

Nucleon Structure in DIS

Facilities / **122**

The AMBER Experiment at CERN

Author: Jan Friedrich[1]

[1] *TU Munich*

Corresponding Author: jan@tum.de

NA66/AMBER has been approved by CERN in 2020 as a new multi-purpose facility for experiments in meson and baryon physics. In a first beamtime in 2023, data have been taken for the determination of antiproton production cross-sections in proton-helium collisions, needed for the interpretation of cosmic antimatter observations. Preparations are ongoing for a measurement of the proton charge radius in high-energy muon-proton scattering. This measurement will feature substantially different systematics than other approaches and aims at clarifying the present discrepancies. Further, experiments to study the partonic structure of mesons in Drell-Yan processes and strange-meson spectroscopy are on the menu of AMBER.

Parallel Session:

Future Facilities and Directions

Hadron spectroscopy / **21**

Decays of beauty to double open-charm hadrons at LHCb

Author: Marian Stahl[1]

[1] *CERN*

Corresponding Author: marian.stahl@cern.ch

Latest LHCb results on beauty decays to two open charm hadrons are presented. Those decays probe QCD factorization, are dominant sources of backgrounds in beauty to charm lepton universality measurements involving taus, and are crucial inputs to the spectroscopy of exotic states like penta- or tetra-quarks. Results shown include first observations and branching fraction measurements using data from Run1 and Run2 of the LHC.

Parallel Session:

Hadron Spectroscopy

Nucleon Structure in DIS / **28**

SoLID: Nucleon 3D Structure at the Luminosity Frontier

Author: Chao Peng[1]

[1] *Argonne National Laboratory*

Corresponding Author: cpeng@anl.gov

Solenoidal Large Intensity Detector (SoLID) is a large acceptance, high luminosity device proposed for exploiting the full potential of the Jefferson Lab (JLab) 12 GeV energy upgrade. The scientific program of SoLID includes six approved experiments: three Semi-Inclusive Deep Inelastic Scattering (SIDIS), two Parity-Violating Deep Inelastic Scattering (PVDIS), and one J/ψ production. As a large acceptance detector capable of operating in an extremely high luminosity environment (10^{37-39}/cm^2/s), SoLID provides a unique opportunity to achieve various scientific goals, including but not limited to the precision 4D mapping of the nucleon structure, probing physics beyond the Standard Model, and investigating the gluonic structure of the proton. After years of work by the SoLID collaboration, a robust, low risk and flexible design concept, which is capable of accomplishing this broad and vibrant physics program, was determined. Many key components of the detector were also demonstrated functional in the extremely high luminosity environment through the DOE-funded and JLab-supported pre-R\&D activities. This talk will give an overview of SoLID and its scientific program.

Parallel Session:

Nucleon Structure in DIS

Facilities / **114**

The MUonE Project

Author: Carlo Michel Carloni Calame[1]

[1] *INFN, Pavia (IT)*

Corresponding Author: carlo.carloni.calame@pv.infn.it

The long standing discrepancy between the measured value of the muon anomalous magnetic moment (a_μ) and its theoretical prediction in the Standard Model has reached the 5 sigma level after the last Fermilab measurement. This has kept the evaluation of the leading hadronic contribution to a_μ (a_μ^{HLO}) under constant scrutiny, because it dominates the theoretical uncertainty. The canonical evaluation exploits dispersion relations and the optical theorem and uses $e^+e^- \rightarrow hadrons$ cross sections time-like data. Lately, the scenario became extremely puzzling after the publication of CMD-3 hadronic cross-section data and because first-principle QCD lattice calculations of a_μ^{HLO} bring a_μ closer to its experimental value.

In this context, the MUonE Project aims at an independent and novel evaluation of a_μ^{HLO} by measuring the hadronic correction to the running of the QED coupling constant in the space-like region by scattering 160 GeV muons (available at the CERN M2 beam line) on electrons in a fixed target.

The talk will review the key concepts and ideas behind the MUonE experiment and will report about the on-going experimental and theoretical efforts to reach the challenging 10^{-5} ppm accuracy required by the experiment. Furthermore, an overview of the recent Test Run at CERN will be presented and the future plans for MUonE will be discussed.

Parallel Session:

Future Facilities and Directions

Hadron spectroscopy / 45

Study of the spectra and decay widths of heavy single baryons

Author: Hugo Garcia Tecocoatzi[1]

[1] *INFN Genova*

Corresponding Author: hgarcia@ge.infn.it

We present a study of the spectra and strong decay widths of heavy baryons. The masses of single heavy baryons up to the D-wave are calculated within a constituent quark model, employing both the three-quark and quark-diquark schemes. We calculated the decay widths of the ground and excited single heavy baryons into the charmed baryon-(vector/pseudoscalar) meson pairs and the (octet/ decuplet) baryon-(pseudoscalar/vector) charmed meson pairs. Moreover, we discuss why the presence or absence of the ρ-mode excitations in the experimental spectrum is the key to distinguishing between the quark-diquark and three-quark behaviors, as was originally pointed out in [1].
Our quantum number assignments and predictions for mass spectra and strong-decay widths are in agreement with the available data. Hence, our findings provide valuable guidance for future measurements in experiments conducted at LHC, Belle, and Belle II.

[1] E.~Santopinto, A.~Giachino, J.~Ferretti, H.~Garc{\'i}a-Tecocoatzi, M.A. Bedolla, R.~Bijker, E.~Ortiz-Pacheco, The European Physical Journal C 79(12), 1012 (2019).

Parallel Session:

Hadron Spectroscopy

Nucleon Structure in DIS / **46**

Study of the nucleon structure using hadron beam at J-PARC

Author: Natsuki Tomida[1]

[1] *Kyoto University*

Corresponding Authors: tomida.natsuki.5z@kyoto-u.ac.jp, natsuki@rcnp.osaka-u.ac.jp

Precise measurement of Generalized Parton Distribution function (GPDs) is a key task to understand the 3-dimensional nucleon structure. There have been attempts to measure GPDs via lepton induced deep inelastic scattering (DIS) reactions. On the other hand, measurements with hadron induced reactions have not been carried out yet. Hadron induced reactions are complementary to the DIS reactions. We are going to carry out the first GPDs measurement using a hadron beam at J-PARC.
Recently, 30 GeV high momentum proton beam became available at the J-PARC Hadron Experimental Facility. In addition, high intensity negative and positive $\pi/K/p$ beam up to 20 GeV/c will be available after the upgrade of the beamline (π20 beamine).
We plan to measure GPDs at the high momentum beamline via $p + p \to p + + B$ and $\pi^- + p \to \mu^+ + \mu^- + n$ (exclusive Drell-Yan) reactions for the first time. J-PARC's high intensity middle momentum beam is suited to measure those reactions. We are now constructing a multi purpose spectrometer. We report the details of the preparation status of the experiments.

Parallel Session:

Nucleon Structure in DIS

Hadron spectroscopy / **59**

Recent results on charmed baryons from Belle (remote)

Author: Suxian Li[1]

[1] *Fudan University*

Corresponding Author: 20110200007@fudan.edu.cn

Charmed baryon spectroscopy can provide unique insights into QCD at low energies. The large data sample accumulated by the Belle experiment at the KEKB asymmetric-energy e^{+}e^{-} collider enables new opportunities to study charmed baryons. We present recent measurements of charmed baryons at Belle, including studies of Omega_c -> Xi pi, Xi K and Omega K, Lambda_c -> p Ks Ks and p Ks eta, Lambda_c -> Sigma eta('), and recent results on the properties of Lambda_c(2625)+.

Parallel Session:

Hadron Spectroscopy

Facilities / **96**

The DarkMESA Experiment

Author: Maik Biroth[None]

Corresponding Author: mbiroth@uni-mainz.de

The dark matter (DM) abundance in the universe is well described by thermal relics on a sub-GeV mass scale. Various models predict a rich phenomenology of portals for the coupling to SM particles. The DarkMESA beam dump experiment will search for light DM particles behind the P2 experiment at the future MESA electron accelerator. An unprecedented amount of electrons-on-target will favor the radiative production of dark photons, which are expected to decay predominantly into DM pairs if kinematically possible. DarkMESA will provide a scalable and sophisticated concept to detected these DM particles.
This talk will report on the current state of development, future plans, and the estimated exclusion limits.

Parallel Session:

Future Facilities and Directions

Hadron spectroscopy / **85**

Two-pole structures as a universal phenomenon dictated by coupled-channel chiral dynamics (remote)

Author: Li-Sheng Geng[1]

[1] *Beihang University*

Corresponding Author: lisheng.geng@buaa.edu.cn

In the past two decades, one of the most puzzling phenomena discovered in hadron physics is that a nominal hadronic state can actually correspond to two poles on the complex energy plane. This phenomenon was first noticed for the Λ(1405), then for K1(1270), and to a lesser extent for D∗0(2300). In this talk, I show explicitly how the two-pole structures emerge from the underlying universal chiral dynamics describing the coupled-channel interactions between heavy matter particles and pseudo Nambu-Goldstone bosons. In particular, the fact that two poles appear between the two dominant coupled channels can be attributed to the particular form of the leading order chiral potentials of the Weinberg-Tomozawa form. Their lineshapes overlap with each other because the degeneracy of the two coupled channels is only broken by explicit chiral symmetry breaking of higher order. We predict that for light-quark~(pion) masses heavier than their physical values (e.g., about 200 MeV in the Λ(1405) case studied), the lower pole becomes a virtual state, which can be easily verified by future lattice QCD simulations. Furthermore, we anticipate similar two-pole structures in other systems, such as the isopin 1/2 K¯Σc−πΞ′c coupled channel, which await for experimental discoveries.

Parallel Session:

Hadron Spectroscopy

Nucleon Structure in DIS / **67**

Constraining the Two-Nucleon Force in Chiral EFT from Three-Nucleon Data

Authors: Evgeny Epelbaum[1]; Sven Heihoff[2]

[1] *Ruhr University Bochum*

[2] *TP II, Ruhr University Bochum*

Corresponding Author: sven.heihoff@rub.de

In previous works, the two-nucleon potential has been successfully determined to a high-precision level in the framework of chiral effective field theory. Nonetheless, there are still some free parameters of this potential, which cannot be extracted from two-nucleon data. The goal of the work presented in this talk is to adjust these parameters using three-nucleon data. Because of the high computational cost of three-nucleon scattering calculations, the scattering amplitude will be obtained using an emulator. The performance of this emulator will be investigated and discussed. This study does not only contribute to a better understanding of three-nucleon scattering data but may also improve ab-initio calculations of few- and many-body systems.

Parallel Session:

Few-Body Systems

Facilities / **76**

A new high-intensity facility at the CERN North Area

Author: Johannes Bernhard[1]

Co-authors: Anna Baratto Roldan [1]; Claudia Ahdida [1]; Dipanwita Banerjee [1]; Francesco Velotti [1]; Helmut Vincke [1]; Laurie J. Nevay [1]; Luigi Salvatore Esposito [1]; Luke Aidan Dyks [1]; Maarten van Dijk [1]; Marco Calviani [1]; Markus Brugger [1]; Matthew Fraser [1]; Rebecca Louise Ramjiawan [1]; Thomas Zickler [1]; Yacine Kadi [1]

[1] *CERN*

Corresponding Author: johannes.bernhard@cern.ch

With their roots in the Physics Beyond Colliders (PBC) Study Group at CERN, several ideas for exploiting the full scientific potential at the Super Proton Synchrotron (SPS) Fixed-Target complex have been brought forward. Amongst them, several proposals wish to utilise the full intensity potential that the accelerator can provide. The ECN3 cavern in the CERN North Area was identified as a candidate location for a future high-intensity experimental facility that will be able to host a selection of the proposed experiments. We report about the findings of the ECN3 Beam Delivery Task Force, which has been mandated to assess the feasibility of transporting the slowly extracted 400 GeV/c beam to ECN3. This includes an assessment of necessary infrastructure upgrades, ensuring compatibility with the North Area Consolidation project that aims to renovate the partly over 40-year-old complex.
One proposal aims at converting ECN3 to a beam dump facility that would host the Search for Hidden Particles experiment (SHiP), aiming at searches for weakly interacting long-lived particles such as heavy neutral leptons, dark photons, dark scalars, and axion-like particles, at the MeV to GeV scale. Another proposal, HIKE (High Intensity Kaon Experiments), aims at an upgrade of the existing charged Kaon beam line K12 that currently serves the NA62 experiment. The beam line upgrade for charged (Phase 1) and neutral kaons (Phase 2) has been studied in the PBC Conventional Beams Working Group together with a conceptual design for integrating an off-axis beam-dump experiment, SHADOWS (Search for Hidden And Dark Objects With the SPS), which would be compatible with parallel operation with HIKE in beam-dump mode.

Parallel Session:

Future Facilities and Directions

Poster Session / **93**

Small Angle Initial State Radiation Analysis of the Pion Form Factor at BESIII

Author: Yasemin Schelhaas[1]

Co-authors: Achim Denig ; Riccardo Aliberti

[1] *JGU Mainz*

Corresponding Author: yaschelh@uni-mainz.de

The anomalous magnetic moment of the muon $a_\mu = (g_\mu - 2)/2$ is one of the most precisely measured quantities in modern physics. However, there is a sizable discrepancy between the Standard Model (SM) prediction of the Muon $g-2$ Theory Initiative and the experimental average of the latest direct measurements at BNL and FNAL. This discrepancy is known as the Muon $g-2$ puzzle. For the SM prediction the main uncertainty arises from hadronic contributions and can be improved systematically using measurements of hadronic cross sections at e^+e^- colliders. One of the most important processes is $e^+e^- \to \pi^+\pi^-$. Using a data set of $1.9\,\text{fb}^{-1}$ (in the near future $20\,\text{fb}^{-1}$) at a center of mass energy of $3.77\,\text{GeV}$, the $\pi^+\pi^-$ cross section is measured at the BESIII experiment located at the BEPCII collider in Beijing, exploiting the initial state radiation technique at small angles. The analysis aims to determine the pion form factor at masses above $0.8\,\text{GeV}$, which is also interesting for hadron spectroscopy. The poster will discuss the current status of this work.

Parallel Session:

Poster Session

Poster Session / **92**

Feasibility Studies for an Inclusive R-Measurement using ISR with BESIII

Author: Thomas Lenz[1]

Co-authors: Achim Denig ; Riccardo Aliberti

[1] *JGU Mainz*

Corresponding Author: lenz@uni-mainz.de

The hadronic vacuum polarization is an important contribution to the running QED coupling constant at the Z pole, $\alpha_{\text{QED}}(M_Z^2)$, and the anomalous magnetic moment of the muon $a_\mu = (g_\mu - 2)/2$. Both quantities allow for precision tests of the Standard Model (SM). Their theoretical uncertainties are dominated by hadronic contributions. Experimental inputs, like the hadronic R value, are used in dispersive approaches to calculate these quantities.

The large data sets collected at the BESIII experiment at the e^+e^- collider BEPCII in Beijing, China, offer an excellent environment for initial state radiation (ISR) measurements. This poster discusses the feasibility of using the ISR technique to measure R_{had} inclusively in a continuous spectrum compared to the established scan technique. This is crucial given the standing $5.1\,\sigma$ discrepancy between the experimental world average of a_μ and the SM prediction of the Muon $g-2$ Theory Initiative and allows for an independent perspective on the existing tensions within hadronic cross section measurements in e^+e^- and between dispersive and Lattice QCD evaluations.

Parallel Session:

Poster Session

Poster Session / **19**

Light Meson Decays

Author: Beijiang Liu[1]

[1] *Institute of High Energy Physics*

Corresponding Author: n_inde01@wwu.de

The 10 billion J/\psi decays collected with the BESIII experiment offer a unique opportunity to investigate the decays of \eta and \eta^\prime mesons produced in the radiative and hadronic J/\psi \to \gamma \eta^{(\prime)}, \phi \eta^{(\prime)} transitions. Using this clean production mechanism, the BESIII experiment is making important contributions to
precision studies of the strong and electromagnetic interactions in \eta^{(\prime)} decays. A selection of recent highlights will be presented.

Parallel Session:

Hadron Spectroscopy

Poster Session / **115**

Second-order pion-nucleus potential for scattering and photo production

Author: Viacheslav Tsaran[1]

[1] *JGU Mainz*

Corresponding Author: vitsaran@uni-mainz.de

Coherent pion photoproduction on nuclei is an efficient tool for studying nucleon density and determining neutron skin thickness. However, a reliable description of pion scattering and other medium effects is needed for these purposes. We build a universal model describing both pion scattering and photoproduction on spin-zero nuclei within the same framework. We develop second-order momentum space scattering and photoproduction potentials based on the Delta(1232) effective self-energy modification and nucleon two-body correlation functions. The model's parameters are determined by fitting pion-carbon scattering data and are shown to be universal. We demonstrate the importance of the charge and spin exchange corrections for nuclear pion photoproduction.

Parallel Session:

Poster Session

Poster Session / **89**

Decays of 1^{-+} Charmoniumlike Hybrid

Author: Chunjiang Shi[1]

Co-authors: Ying Chen [1]; Ming Gong [1]; Xiangyu Jiang [1]; Zhaofeng Liu [1]; Wei Sun [1]

[1] *Institute of High Energy Physics, Chinese Academy of Sciences, Beijing 100049, P.R. China*

Corresponding Author: shichunjiang@ihep.ac.cn

By extracting the transition amplitudes, we give the first lattice QCD prediction of the two-body decay partial widths of the 1^{-+} charmoniumlike hybrid η_{c1}. Given the calculated mass value $m_{\eta_{c1}} = 4.329(36)$ GeV, the η_{c1} decay is dominated by the open charm modes $D_1\bar{D}$, $D^*\bar{D}$ and $D^*\bar{D}^*$ with partial widths of $258(133)$ MeV, $88(18)$ MeV and $150(118)$ MeV, respectively. The coupling of η_{c1} to χ_{c1} plus a flavor singlet pseudoscalar is not small, but $\chi_{c1}\eta$ decay is suppressed by the small $\eta - \eta'$ mixing angle. The partial width of $\eta_{c1} \to \eta_c\eta'$ is estimated to be around 1 MeV. We suggest experiments to search for η_{c1} in the P-wave $D^*\bar{D}$ and $D^*\bar{D}^*$ systems. Especially, the polarization of $D^*\bar{D}^*$ can be used to distinguish the 1^{-+} product (total spin $S = 1$) from 1^{--} products ($S = 0$).

Parallel Session:

Hadron Spectroscopy

Poster Session / **66**

Measurement of K*(892) production in the ^{12}C(K$^-$, p) reaction at 1.8 GeV/c

Author: Sungwook Choi[1]

Co-author: JungKuen Ahn [1]

[1] *Korea University*

Corresponding Author: csw1472@korea.ac.kr

K*(892) production from nuclei provides a crucial test ground for exploring possible in-medium modification of K*(892) properties. Recently, we collected high-statistics datasets for ^{12}C(K$^-$,p) reactions at 1.8 GeV/c. We performed this measurement simultaneously in the J-PARC E42 run for the H-dibaryon search. The HypTPC helps reconstruct the K*(892)-> $K^0_s\pi^-$ decay, while a forward spectrometer tags a proton in the angular range $0^\circ < \theta_{K^-p} < 20^\circ$. This talk will present preliminary results on the differential cross-section measurement for ^{12}C(K$^-$, p)K*(892)X and p(K$^-$,p)K*(892) at 1.8 GeV/c. Furthermore, the measurement of decay particles from the kaonic-bound region will be also discussed, which can be a good probe for kaonic-bound nuclei.

Parallel Session:

Hadron Spectroscopy

Poster Session / **65**

Hyperon production and interaction studies in proton-proton scattering with HADES

Author: Jenny Taylor[1]

[1] *GSI*

Corresponding Author: j.regina@gsi.de

Hyperon-hyperon and hyperon-nucleon interaction potentials are important to study in order to understand the strangeness content of neutron star cores. Strangeness is energetically favorable to

be created in such dense matter since it lowers the Fermi pressure but the resulting maximum allowed mass is lower than observed masses. This could be explained by including strongly repulsive hyperon - nucleon interactions for the potentials. Hence, measurements of these interactions are needed. The structure of hyperon resonances is also important to study. This can be done by measurements of electromagnetic decays since they provide access to for example electromagnetic transition form factors.

HADES (High-Acceptance Di-Electron Spectrometer) at GSI collected high-statistics proton-proton data in 2022 at 4.5 GeV beam kinetic energy. The $\Lambda - \Lambda$ reaction is currently being studied in this data along with production of Σ states where the Dalitz decay of hyperons could be observed for the first time. In addition, the reaction pp $\rightarrow$ p K^+ K^+ Ξ^- [π^- Λ [p π^-]] is ideal for studying double strange hyperon –nucleon interactions close to threshold. However, it is challenging to analyze due to the many final state particles and complex decay chain. This talk will address the hyperon physics cases and discuss the ongoing analyses.

Parallel Session:

Hadron Spectroscopy

Poster Session / **91**

Search for Light Dark Matter with the DarkMESA Experiment

Author: Saskia Plura[1]

Co-authors: Achim Denig ; Luca Doria [2]; Mirco Christmann

[1] *JGU Mainz*

[2] *Johannes Gutenberg University Mainz*

Corresponding Author: saplura@uni-mainz.de

The search for Dark Matter is an integral part of New Physics searches, however, Dark Matter has yet to be observed directly. Theoretical models provide a large parameter space for Dark Matter and allow for different properties of the particles. Models incorporating so-called portal interactions, where Dark Matter interacts with Standard Model particles through a mediator particle, are of special interest. Examples for these are Dark Photon and Axion models, which can be studied at low energy accelerator facilities.
The DarkMESA experiment is a beam dump experiment located at the upcoming accelerator MESA at the JGU Mainz. The accelerator provides an electron beam of 155 MeV and 150 μA in extracted beam mode, which, along with the high-power beam dump of the P2 experiment, provides an ideal environment for Light Dark Matter searches.
To accurately predict the expected reach and the impact of the detector design of the DarkMESA experiment on it with respect to different Dark Matter models, most notably Dark Photon and Axion mediated models, a GEANT4 simulation is used. Here, the current status of the simulations is discussed.

Parallel Session:

Poster Session

Poster Session / **90**

Study of Neutral-Pion Pair Production in Two-Photon Scattering at BESIII

Author: Max Lellmann[1]

Co-authors: Achim Denig ; Christoph Redmer

[1] *JGU Mainz*

Corresponding Author: lellmann@uni-mainz.de

The anomalous magnetic moment of the muon, $a_\mu = (g-2)_\mu/2$, is one of the most precisely measured observables of the Standard Model. However, its value shows a sizeable discrepancy to the Standard Model prediction. It is still under discussion whether this discrepancy is a hint for New Physics or a proof for the limited understanding of strong interaction at low energies. To get a better understanding of this discrepancy, one needs to reduce the uncertainty of both, the Standard Model prediction and the direct measurement.

Information on the production of pion pairs in two-photon fusion processes plays an important role in the dispersive calculation of the hadronic light-by-light scattering contribution to a_μ, which is one of the two large contributions to the Standard Model predictions uncertainty. The BESIII experiment, located at the institute of high energy physics in Beijing/China, offers a perfect testbed for the investigation of two-photon processes at small momentum transfers. The process $e^+e^- \to e^+e^-\pi^0\pi^0$ is measured at the BESIII experiment at centre-of-mass energies between 3.68 and 4.7 GeV with a total integrated luminosity of more than 20 fb^{-1}, with more data being available in future. This presentation will discuss the current status of the analysis.

Parallel Session:

Poster Session

Poster Session / **87**

Investigation of $\gamma^* \gamma^* \to \eta'$ at the BESIII Experiment

Author: Maurice Anderson[None]

Corresponding Author: manderso@students.uni-mainz.de

The $g-2$ puzzle describes a sizable discrepancy between the experimental measurements of the muon's magnetic moment and the theoretical Standard Model prediction. In order to determine whether this observed deviation is a significant discovery of possible physics beyond the Standard Model, the uncertainty of the theoretical prediction must be reduced. The primary source of systematic error stems from the hadronic quantum fluctuations affecting the muon, specifically the hadronic vacuum polarization (HVP) and the hadronic light-by-light (HLbL) scattering contributions. The HLbL term is dominated by the exchange of pseudoscalar mesons.

In this poster presentation, the production of pseudoscalar η' mesons via two virtual spacelike photons will be studied ($\gamma^*\gamma^* \to \eta'$). Double-tagged measurements are conducted at the BESIII experiment in Beijing, China, in which both virtual photons possess nonzero momentum transfers (Q^2). The transition form factor (TFF) needed for the calculation of the HLbL contribution is determined for $Q_1^2, Q_2^2 < 2$ GeV^2. Finally, the BESIII TFF results are compared with the Vector Meson Dominance Model and the previous double-tagged measurement of the BABAR collaboration.

Parallel Session:

Poster Session

Poster Session / **15**

Recent measurements of charmonium decays

Author: Xiaoxuan Ding[None]

Corresponding Author: dingxx@stu.pku.edu.cn

I shall present a few recent measurements of charmonium decays at BESIII in this talk. It will include i) based on 448M psi(3686) events collected with theBESIII detector, the decay psi(3686) -> phi Ks0 Ks0 is observed for the first time. And the branching fraction is measured with considering the interference between psi(3686) and continuum production; ii) using an electron positron collision data sample of 2.7B psi(3686) events collected by the BESIII detector, the process chi_cJ -> Omega- anti-Omega+ (J=0,1,2) has been observed for the first time, and the significance is 5.6, 6.4, 18 sigma, respectively. The corresponding branching fractions will be reported too; iii) the Born cross-section of the process e+ e- -> eta J/psi at aCMS energy 3.773 GeV is measured by using data samples collected at BESIII. The decay psi(3770) -> eta J/psi is observed for the first time with a statistical significance of 7.4 sigma. The branching fraction of psi(3770) -> eta J/psi is determined by considering the interference between psi(3770) and continuum, as well as the highly excited vector states.

Parallel Session:

Poster Session

Poster Session / **18**

Hyperon Physics

Author: Beijiang Liu[1]

[1] *Institute of High Energy Physics*

Corresponding Author: shenhongfei@ihep.ac.cn

With the large datasets on □+□−-annihilation at the □/□ and □(3686) resonances collected at the BESIII experiment, multi-dimensional analyses making use of polarization and entanglement can shed new light on the production and decay properties hyperon-antihyperon pairs. In a series of recent studies performed at BESIII, significant transverse polarization of the (anti)hyperons has been observed in □/□ or □(3686) to $\Lambda\bar{\Lambda}$, $\Sigma\bar{\Sigma}$, $\Xi\bar{\Xi}$, and $\Omega-\bar{\Omega}+$ and the spin of Ω− has been determined model independently for the first time. The decay parameters for the most common hadronic weak decay modes were measured, and due to the non-zero polarization, the parameters of hyperon and antihyperon decays could be determined independently of each other for the first time. Comparing the hyperon and antihyperon decay parameters yields precise tests of direct, Δ□ = 1 CP-violation that complement studies performed in the kaon sector.

Parallel Session:

Fundamental Symmetries / New Physics Searches

Poster Session / **104**

Determination of the polarization observables T,P and H in the reaction $\gamma p \rightarrow p\pi^0$

Author: Sebastian Ciupka[1]

[1] *HISKP, Bonn*

Corresponding Author: ciupka@hiskp.uni-bonn.de

It is experimentally and theoretically challenging to determine the exact number of exited nucleon states and their properties, since the short lifetime of these exited states leads to strongly overlapping resonances. Using a polarized beam, a polarized target or using the polarization of the recoil nucleon helps to measure single or double polarization observables, that are needed for an unambiguous partial wave analysis solution.
The CBELSA/TAPS experiment in Bonn provides a polarized photon beam as well as a longitudinally or transversely polarized target, allowing for the determination of single and double polarization observables. The Crystal Barrel (CB) calorimeter, together with the MiniTAPS calorimeter in forward direction, give the opportunity for close to 4π coverage for the measurements.
This talk will present preliminary results of the determination of the polarization observables T, P and H, for energies between 600MeV and 3200MeV, using data collected after the recent upgrade of the CB calorimeters readout electronics and these results are compared to previous data and model predictions.

Parallel Session:

Hadron Spectroscopy

Poster Session / **112**

X17 discovery potential from $\gamma d \to e^+e^-pn$ with neutron tagging

Author: Cornelis J.G. Mommers[None]

Co-author: Marc Vanderhaeghen

Corresponding Author: cmommers@uni-mainz.de

We propose a novel direct search experiment for X17 using the photon-deuteron reaction $\gamma d \to e^+e^-pn$. X17 is a hypothetical particle conjectured by the ATOMKI collaboration to explain anomalous signals around 17 MeV in excited ^{8}Be, ^{4}He and ^{12}C nuclear decays via internal pair creation. It has been subject to a global experimental and theoretical research program. The proposed direct search in $\gamma d \to e^+e^-pn$ can verify the existence of X17 through the production on a quasi-free neutron, and determine its quantum numbers separate from ongoing and planned nuclear-decay experiments. This is especially timely in view of the theoretical tension between results from the ^{12}C and ^{8}Be measurements. Using the plane-wave impulse approximation, we quantify the expected signal and background for pseudoscalar, vector and axial-vector X17 scenarios. We optimize the kinematics for the quasi-free neutron region with the upcoming MAGIX experiment at MESA in mind and show that for all three scenarios the X17 signal is clearly visible above the QED background.

Parallel Session:

Poster Session

Poster Session / **135**

Proton Structure Corrections to Hyperfine Splitting in Muonic Hydrogen

Author: Vladyslava Sharkovska[1]

[1] *Paul Scherrer Institute*

Corresponding Author: vladyslava.sharkovska@psi.ch

In this poster presentation, I will discuss the two-photon exchange (TPE) as a crucial higher-order contribution to lepton-proton scattering and the theory of light muonic atoms. In particular, I will focus on the proton polarizability contribution as the dominant uncertainty in the theory prediction of the Lamb shift and the hyperfine splitting (HFS) in muonic hydrogen (μH). It is important to provide the best possible theoretical estimate for the TPE correction to guide the upcoming high-precision measurements of the μH ground-state HFS.

Parallel Session:

Poster Session

Poster Session / **77**

AI for Data Analysis and Preservation-A(i)DAPT program

Author: Tommaso Vittorini[1]

[1] *Università di Genova*

Corresponding Author: tommaso.vittorini@ge.infn.it

A(i)DAPT is a program which aims to utilize AI techniques, in particular generative modeling, to support Nuclear and High Energy Physics experiments. Its purpose is to extract physics directly from data in the most complete manner possible. Generative models such GANs and Normalizing Flows are employed to capture the full correlations between particles in the final state of nuclear reactions. This many-fold program will allow us to to achieve various goals including accurately fitting data in a multidimensional space and unfolding detector effects to minimize their impact on the relevant physics. Moreover, it will enable us to store a large amount of realistic-like data in an extremely compact format and to extract reaction amplitudes in an alternative way. We aim at incorporating universality of scattering amplitudes, training networks with different kinematics of the same final state or different final states to recover the underlying physics. As of today, we' ve conducted a positive closure test on inclusive electron scattering, demonstrating that generative models are able to reproduce 2 $-\pi$ photoproduction data. We also showed that GANs are a viable tool to unfold detector smearing, ensuring the preservation of initial correlations.

Parallel Session:

Poster Session

Poster Session / **134**

Pion polarizabilities from a dispersive analysis of the $\gamma\gamma \to \pi\pi$ process

Author: Viktoriia Ermolina[1]

Co-authors: Igor Danilkin ; Marc Vanderhaeghen

[1] *Johannes Gutenberg University Mainz*

Corresponding Author: vermolin@uni-mainz.de

We present results for the charged and neutral pion polarizabilities, obtained through a dispersive analysis of the photon-photon fusion process. This analysis is motivated by the current and future measurements at COMPASS and JLab (Hall D). While the predictions based on the unsubtracted dispersion relation, considering only the pion-pole left-hand cut, provide a relatively good qualitative description of the total cross-section data and the charged pion dipole polarizability, the neutron pion dipole polarizability turned out to be substantially different from the two-loop ChPT result. To account for the influence of heavier left-hand cuts, primarily governed by omega exchange, it becomes necessary to introduce subtraction constants. In the present work, we determine these constants by enforcing an Adler zero for the $\gamma\gamma \to \pi^0\pi^0$ amplitude and by fitting the available cross-section data.

Parallel Session:

Poster Session

Poster Session / **133**

Improved constraints for axion-like particles from 3-photon events at e^+e^- colliders

Authors: Aleksandr Pustyntsev[1]; Marc Vanderhaeghen[None]

[1] *Johannes Gutenberg University of Mainz*

Corresponding Author: apustynt@uni-mainz.de

Axions and axion-like particles (ALPs) are one of the most widely discussed extensions of the Standard Model when it comes to the strong CP problem and dark matter candidates. Current experiments are focused on the indirect searches of invisible pseudoscalars in a wide parameter range. In this paper we investigate limits on ALP mass, and its couplings to photons and leptons from 3-photon annihilation at e^+e^- colliders. We provide detailed calculations and apply them to the particular kinematics of the Belle II experiment, covering the ALP mass range from few hundred MeV to around 10 GeV. Our results, which improve upon previous analyses by also including the ALP coupling to electrons, show that such future analyses will allow to significantly extend the ALP search range and impose much more stringent restrictions on their couplings.

Parallel Session:

Poster Session

Poster Session / **137**

The hadronic vacuum polarization contribution to $(g-2)_\mu$ from coordinate-space methods

Author: Julian Parrino[1]

[1] *Johannes Gutenberg-Universität*

Corresponding Author: juparrin@uni-mainz.de

Lattice QCD (LQCD) has proven to be an important tool in understanding the tension between the experimental value for the anomalous magnetic moment of the muon and its standard model prediction. The lattice gives an unique insight to the hadronic sector, which contributes the largest amount to the uncertainty of the theoretical prediction. The common method for evaluating the hadronic vacuum polarization (HVP) contribution in LQCD is the so called time-momentum representation (TMR). In a recent work we showed, that using a Lorentz-covariant coordinate-space (CCS) formulation the resulting contribution to the $(g-2)_\mu$ window observable a_μ^W agrees very well at an unphysical pion mass of ~350 MeV. On the one hand this serves as a check of the preceding lattice calculations using the TMR method, on the other hand it provides another tool for the HVP calculation with additional freedom in adjusting the kernel. The same CCS kernel can also be utilized to calculate isospin breaking corrections to the HVP contribution. We present a framework similar to the Mainz calculation of the hadronic light-by-light (Hlbl) contribution to evaluate the HVP at NLO treating QED in infinite volume and QCD on the lattice. Using this method we obtain first results for the UV-finite QED correction to the disconnected contribution to a_μ^{HVP}

Parallel Session:

Poster Session

Poster Session / **138**

Scale Separation in Exotic Atoms

Author: Sotiris Pitelis[1]

[1] *Johannes Gutenberg-Universität Mainz*

Corresponding Author: spitelis@uni-mainz.de

Spectroscopy experiments at the precision frontier allow us to study low-energy nuclear structure, test bound-state QED, refine fundamental constants, and potentially find New Physics. As the experimental uncertainties are continuously improved, theory predictions need to follow suit.
The finite-size corrections to the spectra of hydrogen-like atoms are often expanded in terms of the moments of the nuclear charge distribution, e.g. the charge and Friar radii. Contributions to the form factors that involve scales lighter than the inverse Bohr radius of the system can break this expansion.
In this poster, we illustrate the breaking and explain how spectroscopy experiments can probe physics beyond the Standard Model.

Parallel Session:

Poster Session

Plenary talk / **126**

FAIR

Author: Paolo Giubellino[None]

The construction of FAIR is proceeding rapidly. The tunnel for the SIS 100 accelerator is complete, and the realization of the experimental halls advances. The installation of the technical infrastructure is in full swing. The components of the accelerators of the future facility are in production and are arriving progressively on the campus of the GSI Helmholtzzentrum for Heavy-Ion Research in Darmstadt, Germany. The installation of magnets in the tunnels will start in early 2024. The experimental collaborations are actively preparing for the first experiments, adapting their program to the progressive, stepwise realization of the facility. While the full science potential of FAIR can

only be harvested once the new suite of accelerators and storage rings is completed and operational, some of the detectors and instrumentation are already available and are used for a precursor science program called FAIR Phase-0, exploiting also the significantly upgraded GSI accelerator chain. The program has started in the summer of 2019 and continues with a few months of beam time per year. The progress of the FAIR realization and the prospects of science at FAIR will be presented.

Parallel Session:

Plenary talk / **110**

Latest results from KLOE/KLOE-2

Author: Paolo Gauzzi[1]

[1] *Sapienza University and INFN Rome*

Corresponding Author: paolo.gauzzi@roma1.infn.it

KLOE and KLOE-2 collected the largest dataset (about 8 fb^{-1}) at an electron-positron collider operating at the peak of the $\phi(1020)$ resonance, corresponding to the production of about 24 billions of ϕ mesons, namely 8 billion pairs of neutral K mesons and 300 millions of η mesons. A wide hadron physics program, investigating fundamental symmetries, rare meson decays, and dark forces is carried on by the KLOE-2 Collaboration.
The entanglement in the neutral kaon pairs produced at the DAΦNE ϕ-factory is a unique tool to test discrete symmetries. The final result of the first direct test of CPT and T in neutral kaon transitions is presented.
The $\eta \to \pi^0\gamma\gamma$ decay is a test bench for various models and effective theories, like VMD (Vector Meson Dominance) or ChPT (Chiral Perturbation Theory. KLOE-2 performed a new precise measurement of the branching ratio, by using its highly pure η sample produced in $\phi \to \eta\gamma$ process.
KLOE-2 is currently probing a complementary model to the U boson or "dark photon", where the dark force mediator is a hypothetical leptophobic B-boson that could show up in the $\phi \to \eta B \to \eta\pi^0\gamma$ channel. The preliminary upper limit on the coupling constant of such a particle to ordinary matter will be shown.
The KLOE-2 High Energy Tagger detectors allow the possibility to investigate the single π^0 production in $\gamma\gamma$ collisions by tagging the scattered electrons from $e^+e^- \to e^+e^-\gamma^*\gamma^* \to e^+e^-\pi^0$ in coincidence with the π^0 in the barrel calorimeter. A preliminary measurement of the $\gamma^*\gamma^* \to \pi^0$ counting obtained by using single tagged events will be reported.

Parallel Session:

Invited Plenary Talk

Plenary talk / **106**

The Proton Radius Puzzle

Author: Michael Kohl[1]

[1] *Hampton University*

Corresponding Author: kohlm@jlab.org

The Proton Radius Puzzle has been famously known as the discrepancy of the proton charge radius between measurements using the novel method of muonic hydrogen spectroscopy and the conventional methods of regular hydrogen spectroscopy and electron scattering. Suggested explanations

have ranged from hidden experiment systematics through unaccounted effects in conventional theory to New Physics beyond the Standard Model. Defined as the slope of the electric form factor, the proton charge radius manifests itself in altered energy levels observed in atomic hydrogen transitions, or in the angular distribution of elastic lepton scattering at low momentum transfer. In all methods, precisely calculable QED effects are taken into account. A variety of new experimental efforts have been devised over the past decade with the goal to resolve the puzzle, some of which have already obtained results, while others are ongoing. So far, the majority of new data have trended toward a smaller radius as suggested by muonic hydrogen, however a satisfactory understanding of the puzzle has not yet been achieved. An overview of the present status of the field will be provided.

Acknowledgment:
The presenter is presently supported by NSF PHY-2113436 and DOE DE-SC0013941.

Parallel Session:

Invited Plenary Talk

Plenary talk / **108**

Hadron Spectroscopy studies at JPAC

Author: Alessandro Pilloni[1]

[1] *Messina U. and INFN Catania*

Corresponding Author: alessandro.pilloni@unime.it

I will give an overview of the recent activities of the Joint Physics Analysis Center and the plans for the future.

Parallel Session:

Invited Plenary Talk

Plenary talk / **127**

Upgrade Plans at JLab

Author: Marco Battaglieri[1]

[1] *INFN-GE*

Corresponding Author: battaglieri@ge.infn.it

Plenary talk / **128**

Dark Sector Searches

Author: Marco Battaglieri[1]

[1] *INFN-GE*

Corresponding Author: battaglieri@ge.infn.it

Plenary talk / 100

New measurement of the muon anomalous magnetic moment by the Muon g-2 experiment at Fermilab

Author: Anna Driutti[1]

[1] *University and INFN Pisa*

Corresponding Author: anna.driutti@unipi.it

The goal of the Muon g-2 experiment at Fermilab is to measure the muon anomalous magnetic moment to unprecedented precision of 140 parts per billion. In August 2023, the collaboration published the second measurement based on the data acquired during the second (Run-2) and third (Run-3) year of running. The new result is the most precise measurement of the muon magnetic anomaly and it confirms both the previous measurement based on the Run-1 data, published in 2021 and the final result from the precedent Muon g-2 experiment at BNL, published in 2001. This talk will present the new measurement detailing the experimental and analysis improvements with respect to the first result and the plans for the next years.

Parallel Session:

Invited Plenary Talk

Plenary talk / 103

How precisely can we predict the muon g-2 in the standard model?

Author: Marc Knecht[1]

[1] *CNRS/CPT Marseille*

Corresponding Author: knecht@cpt.univ-mrs.fr

The status of the standard model prediction for the muon g-2 at a level of precision comparable to its latest experimental measurement is reviewed and discussed

Parallel Session:

Invited Plenary Talk

Plenary talk / 86

The MESA physics programme

Author: Sören Schlimme[1]

[1] *JGU Mainz*

Corresponding Author: schlimme@uni-mainz.de

The Mainz Energy-Recovering Superconducting Accelerator, MESA, is currently under construction at the Institute of Nuclear Physics in Mainz.
Three experiments will be run there, allowing for a comprehensive physics programme to be conducted.
An external beamline will supply spin-polarized electrons to the P2 experiment, enabling the performance of sensitive tests of the Standard Model through parity-violating electron scattering. The primary objective of the P2 experiment is to achieve a precision measurement of the weak mixing angle. The DarkMESA beam dump experiment, situated behind P2, will run in parallel to P2 and is dedicated to the search for light dark matter particles. The focus of the talk, however, will be the versatile MAGIX experiment which will use MESA's innovative energy recovery technique, which enables the generation of extremely high beam intensities. The setup is equipped with a cryogenic gas jet target and high-resolution magnetic spectrometers. The science focus is on high-precision electron scattering experiments including dark sector searches, the study of hadron structure and few-body systems, and investigations of reactions relevant to nuclear astrophysics.

Parallel Session:

Invited Plenary Talk

Plenary talk / **95**

Parity-Violating Electron Scattering: Recent Results and Future Plans

Author: Krishna Kumar[1]

[1] *University of Massachusetts, Amherst*

Corresponding Author: kkumar@physics.umass.edu

We will report on the latest measurements of the parity-violating asymmetry in the scattering of longitudinally polarized electrons off various nuclear targets. After a brief historical introduction, the implications of the PREX and CREX experiments will be discussed. We then report on the status of the development of new experiments and conclude with a brief discussion of measurements of such asymmetries at the future EIC.

Parallel Session:

Invited Plenary Talk

Plenary talk / **113**

The Jefferson Lab Positron Physics Program

Author: Eric Voutier[1]

[1] *CNRS/IN2P3/IJCLab - UPS*

Corresponding Author: voutier@ijclab.in2p3.fr

The perspective of high duty-cycle and high intensity polarized and unpolarized positron beams, in complement to the existing CEBAF (Continuous Electron Beam Accelerator Facility) 12 GeV electron beams, has been nurtured since the very first 6 GeV upgrade of the CEBAF accelerator. Along the years, experimental results about the electromagnetic form factors and the generalized parton distributions of the nucleon pointed towards the importance of positron beams for the experimental determination of these fundamental quantities of the nucleon structure. Further ideas emerged about testing the predictions of the standard model, exploring the dark matter sector, or investigating electroweak processes. A long term and comprehensive research effort has developed both in the physics [1] and the technics [2] areas to assess the potential of an experimental program and to address the technological issues of high duty cycle positron beams. The Jefferson Lab Program Advisory Committee recognized the high scientific value of such a program. The development of positron beam capabilities at Jefferson Lab (JLab) is now identified as the first step of the future CEBAF upgrade.

This presentation will review the current status of the JLab positron beam and physics programs.

[1] (JLab Positron Working Group) A. Accardi et al. Eur. Phys. J. A 57 (2021) 261.
[2] (Ce+BAF Working Group) J. Grames et al. JACoW IPAC (2023)

Parallel Session:

Invited Plenary Talk

Nucleon Structure in DIS / **111**

Perspectives of SIDIS measurements

Author: Anselm Vossen[1]

[1] *Duke University/JLab*

Corresponding Author: anselm.vossen@duke.edu

An active and diverse program in Semi-Inclusive Deep-Inelastic Scattering is currently underway at facilities around the world. This talk will highlight recent results and future opportunities at current and planned experiments.

Parallel Session:

Nucleon Structure in DIS

Symmetries and New Physics / **109**

Probe Fundamental Symmetry and BSM Physics Via the Primakoff Effect

Author: Liping Gan[1]

[1] *University of North Carolina Wilmington*

Corresponding Author: ganl@uncw.edu

The fundamental QCD symmetries at low energies and the new physics Beyond the Standard Model (BSM) are two frontiers in the contemporary physics. The Primakoff effect, a process of high-energy

photo- or electro-production of mesons in the Coulomb field of a target offers a powerful experimental tool to explore both fundamental issues. A comprehensive Primakoff experimental program has been developed at Jefferson Laboratory (JLab) to perform precision measurements of the two-photon decay widths and the transition form factors of π0, η and η⊠ and to search for dark scalars or pseudoscalars via the Primakoff effect. A measurement of the π0 radiative decay width was carried out at JLab 6 GeV and the published result achieved a precision of 1.5%. The data collection for the η radiative decay width measurement at JLab 12 GeV was recently completed. The future JLab 22 GeV upgrade will offer a new opportunity to perform the Primakoff experiments off an atomic-electron target with experimental sensitivities not previously achievable. The status of this program and its physics impact will be presented.

Parallel Session:

Fundamental Symmetries / New Physics Searches

Hadron spectroscopy / **97**

On exotic hadron spectroscopy and unitarized EFTs

Author: Raquel Molina Peralta[1]

Co-authors: Eulogio Oset Báguena [2]; Fernando Gil Domínguez [2]; Tanja Branz

[1] *Raquel.Molina@ific.uv.es*

[2] *IFIC-UV*

Corresponding Author: raquel.molina@ific.uv.es

In recent years, a plethora of exotic states have been observed in the experimental facilities. Some of these states, of tetraquark and pentaquark types, were predicted previously in approaches based on Effective Field Theories, unitarity of the S-matrix, and chiral and heavy quark spin symmetries. In this talk, I will review some of the predictions made in the local hidden gauge approach on exotic states. One way to test the predictions of these approaches is to compare with results from LQCD simulations, which are done for unphysical pion masses. This is also useful for understanding the predictions from LQCD simulations from an experimental point of view. Thus, I will talk about how the properties of exotics can be extracted from the analysis of LQCD simulations by studying the quark mass dependence of exotic resonances, in particular, of the $D_{s0}(2317)$ and $D_{s1}(2460)$ resonances. Scattering parameters and properties of these resonances are extracted from a global analysis of LQCD data.

Parallel Session:

Hadron Spectroscopy

Nucleon Structure in DIS / **42**

Global extraction of proton and pion Transverse Momentum Distributions

Authors: Alessandro Bacchetta[1]; Andrea Signori[2]; Chiara Bissolotti[3]; Giuseppe Bozzi[4]; Lorenzo Rossi[5]; Marco Radici[6]; Matteo Cerutti[1]; Simone Venturini[1]; Valerio Bertone[7]

[1] *University of Pavia & INFN*

[2] *University of Torino*

[3] *Argonne National Lab*

[4] *University of Cagliari*

[5] *INFN & University of Pavia*

[6] *INFN*

[7] *C.E.A. Paris-Saclay)*

Corresponding Author: lorenzo.rossi@pv.infn.it

In this talk we present the latest results about the extraction of Transverse-Momentum-Dependent (TMD) distributions. We discuss the extraction of unpolarized quark TMD Parton Distribution Functions (TMD PDFs) in the proton and in the pion, as well as TMD Fragmentation Functions (TMD FFs), from global fits of Drell-Yan and Semi-Inclusive Deep-Inelastic Scattering (SIDIS) data sets made by the MAP collaboration and the comparisons with extractions by other groups.

Parallel Session:

Nucleon Structure in DIS

Symmetries and New Physics / **3**

Study of the X17 anomaly with the PADME experiment

Corresponding Author: danilo.domenici@lnf.infn.it

Studying Internal Pair Creation produced in the de-excitation of some light nuclei, the ATOMKI collaboration spotted an anomaly in the opening angle of the outgoing e+e− pair. This anomaly seems not related to any nuclear physics effects but due to the creation and subsequent decay of a new particle of mass approximately 17 MeV (X17). The existence of such state, if confirmed, will represent a real breakthrough in the search for physics beyond the Standard Model.
The Positron Annihilation into Dark Matter Experiment (PADME) ongoing at the Laboratori Nazionali di Frascati of INFN, has been conceived to search for dark sector particles by studying positron annihilations on the electrons of a fixed target. Thanks to the possibility to change the positron beam energy, PADME has the unique opportunity to rule out or to confirm the existence of the X17. In fact, if real, the new particle has to be produced resonantly via the annihilation process e+ e− ⟶ X and then identified via its decay via e+ e−.
The talk will present an overview of the PADME setup and of the dedicated data taking at ~280 MeV beam energy performed in Autumn 2022 to produce the X17 at resonance.

Parallel Session:

Fundamental Symmetries / New Physics Searches

Hadron spectroscopy / **14**

Charmonium-like states at BESIII

Author: Frederik Weidner[None]

Corresponding Author: f.weidner@wwu.de

In this talk, several searches for charmonium-like states will be presented. They are i) using data samples at CMS energies from threshold to 4.95 GeV collected with the BESIII detector, the cross-sections of process e+e−⟶D+*sD*−s are measured, and three structures with masses around 4.19,

4.41, and 4.79 GeV are found; ii) using a data sample corresponding to 2.93/fb collected at a CMS energy of 3.773 GeV with the BESIII detector, a scalar partner of the X(3872), denoted as X(3700) is searched, via ψ(3770)⟶γηη′ and γπ+π−J/ψ processes. No significant signals are observed, and the upper limits are provided; iii) the Born cross-sections of the process e+e−⟶D*0D−π+ at CMS from 4.189 to 4.951 GeV, using 17.9/fb data collected at BESIII, are measured for the first time. Three enhancements around 4.20, 4.47 and 4.67 GeV are visible, and they are assigned to psi(4230), psi(4500), and psi(4660), respectively.

Parallel Session:

Hadron Spectroscopy

Nucleon Structure in DIS / **13**

Fragmentation function studies at BESIII

Author: Beijiang Liu[1]

[1] *Institute of High Energy Physics*

Corresponding Authors: liuwm@mail.ustc.edu.cn, zhangyateng@zzu.edu.cn

Fragmentation Function (FF) plays a crucial role in describing the hadronization process. We report the
measurements of normalized differential cross sections of inclusive pi0 and Ks production as a function of hadron
momentum at six energy points with q^2 transfer from 5 to 13 GeV^2 at BESIII. The results with a relative hadron
energy coverage from 0.1 to 0.9 significantly deviate from several theoretical calculations based on existing
fragmentation functions.

Parallel Session:

Nucleon Structure in DIS

Symmetries and New Physics / **20**

Dark photon and Axion-like particle search at BESIII

Author: Beijiang Liu[1]

[1] *Institute of High Energy Physics*

Corresponding Author: dingxx@stu.pku.edu.cn

he BESIII experiment is a symmetric e+e- collider operating at c.m. energy from 2.0 to 4.95 GeV. With the world's largest data set of J/psi (10 Billion), psi(2S) (2.6 Billion), and about 25 fb-1 scan data from 3.77 to 4.95 GeV, we are able to search various dark sectors produced in e+e- annihilation and meson decay processes. In this talk, we report the search for dark photon candidate in e+e- ->gamma A' with invisible decay. The invisible decay of a light Higgs boson A0 in J/psi->gamma A0, dark sectors in Lambda/Lambda_c invisible decay processes are also searched. Axion-like particles (ALPs) are pseudo-Goldstone bosons arising from some spontaneously broken global symmetry, addressing the strong CP or hierarchy problems. The BESIII experiment has collected 10 Billion J/psi and 2.6 Billion psi(2S) events, which is the largest J/psi & psi(2S) data set in the world. With these data, the

BESIII experiment searches for an Axion-like particle with mass in o(GeV) scale in J/psi-> gamma a, with a->gamma gamma.

Parallel Session:

Fundamental Symmetries / New Physics Searches

Hadron spectroscopy / **9**

Light hybrid mesons and light glueballs

Author: Francesco Giacosa[1]

[1] *Institute of Physics, Jan Kochanowski University, Kielce, poland*

Corresponding Author: fgiacosa@ujk.edu.pl

We revisit the present status of the lightest nonet of hybrid mesons with quantum numbers J^{PC} = 1^{-+}, that includes the resonance \Pi_1(1600) as well as the recently discovered \eta_1(1855). In the framework of an hadronic approach, predictions for not-yet measured decay rates of the two resonances listed above as well as for the not yet found members of the nonet (an isoscalar with a mass of about 1.6 GeV and a kaonic isodoublet with a mass of about 1.75 GeV) are presented. The production of the isoscalar members in the decay of the j/\psi charmonium are also discussed. Next, we present the status and progress concerning of the three lightest glueball states: scalar, tensor, and pseudoscalar. Here, new experimental and theoretical results allow to investigate various glueball candidates.

Parallel Session:

Hadron Spectroscopy

Symmetries and New Physics / **54**

Results and prospects from the NA62 experiment at CERN

Author: Angela Romano[1]

[1] *University of Birmingham*

Corresponding Author: mauro.piccini@pg.infn.it

An overview of the latest results from the NA62 experiment at CERN and future prospects will be presented.
The NA62 experiment collected the world's largest dataset of charged kaon decays in 2016-2018, leading to the first measurement of the branching ratio of the ultra-rare $K^+ \to \pi^+\nu\bar{\nu}$ decay, based on 20 candidates. This provides evidence for the very rare $K^+ \to \pi^+\nu\bar{\nu}$ decay, observed with a significance of 3.4σ. This measurement is also used to set limits on BR($K^+ \to \pi^+X$), where X is a scalar or pseudo-scalar particle. The analysis of the full 2016-2018 data sample and future NA62 plans and prospects are reviewed.

Rare kaon decays are among the most sensitive probes of both heavy and light new physics beyond the Standard Model description thanks to high precision of the Standard Model predictions, availability of very large datasets, and the relatively simple decay topologies. The NA62 experiment at CERN is a multi-purpose high-intensity kaon decay experiment, and carries out a broad rare-decay

and hidden-sector physics programme. Recent NA62 results on searches for violation of lepton flavour and lepton number in kaon decays, and searches for production of hidden-sector mediators in kaon decays, are presented. Future prospects of these searches are discussed. Searches for visible decays of exotic mediators from data taken in beam-dump" mode with the NA62 experiment are also reported. The NA62 experiment can be run as abeam-dump experiment" by removing the kaon production target and moving the upstream collimators into a "closed" position. More than 10^{17} protons on target have been collected in this way during a week-long data-taking campaign by the NA62 experiment. We report on new results from analysis of this data, with a particular emphasis on Dark Photon and Axion-like particle Models.

The future availability of high-intensity kaon beams at the CERN SPS North Area gives rise to unique possibilities for sensitive tests of the Standard Model in the kaon sector. An overview of the physics goals, detector requirements, and project status for the next generation of kaon physics experiments at CERN will be also presented.

Parallel Session:

Fundamental Symmetries / New Physics Searches

Nucleon Structure in DIS / **48**

COMPASS results on pion and kaon multiplicities from SIDIS on proton target.

Author: Marcin Stolarski[1]

[1] *LIP-Lisboa*

Corresponding Author: mstolars@cern.ch

New COMPASS preliminary results on pion and kaon multiplicities from SIDIS on proton target will be presented. These proton results provide
a complementary data set to the deuteron results published in 2016.
One of the improvements over previous COMPASS analyses is an improved treatment of Radiative Corrections using DJANGOH MC. Comparing to the previously used method relative differences up to 10% are observed
at the level of multiplicities. Despite these changes the preliminary
COMPASS kaon results are still incompatible with HERMES ones.
The presented results will provide an important input for global fragmentation functions fits.

Parallel Session:

Nucleon Structure in DIS

Hadron spectroscopy / **35**

Search for Hybrid Mesons at GlueX

Author: William Imoehl[1]

[1] *Carnegie Mellon University*

Corresponding Author: wimoehl@jlab.org

Recent lattice QCD calculations predict the existence of hybrid mesons, which are mesons with gluonic degrees of freedom. By mapping out the hybrid meson spectrum, we can gain insight into how the gluon contributes to the properties of bound states in QCD. The $\pi_1(1600)$ is a candidate for the lightest hybrid meson. This state has exotic quantum numbers of $J^{PC} = 1^{-+}$, which are forbidden for conventional mesons. The GlueX experiment has collected high statistics photoproduction data, which we are using to search for the $\pi_1(1600)$. This talk will summarize the search strategy for the $\pi_1(1600)$ at GlueX, including the most recent results in the $\omega\pi\pi$, $\eta\pi$, and $\eta'\pi$ final states.

Parallel Session:

Hadron Spectroscopy

Nucleon Structure in DIS / **70**

Dynamics of three-nucleon systems at 100 MeV

Author: Izabela Skwira-Chalot[1]

Co-authors: Adam Kozela [2]; Elżbieta Stephan [3]; Nasser Kalantar-Nayestanaki [4]; Stanislaw Kistryn [5]

[1] *Faculty of Physics University of Warsaw*

[2] *Institute of Nuclear Physics,Polish Academy of Sciences*

[3] *Institute of Physics, University of Silesia*

[4] *ESRIG, University of Groningen*

[5] *Jagiellonian University*

Corresponding Author: skwira@fuw.edu.pl

The dynamics of the three-nucleon system can be very extensively tested by means of the deuteron-proton breakup reaction. Experimental studies of the dp system expose various dynamical ingredients, like three-nucleon force (3NF) and Coulomb force, which play an important role in correct description of observables (e.g. cross section). The cross sections as well as polarized observables (e.g. vector and tensor analyzing powers [1]) are interesting for testing theoretical calculations based on various approaches [2 - 5] to model the interaction in three-nucleon systems. Moreover, studies of the dp breakup reaction at low energy are very crucial for testing The Chiral Perturbation Theory [6] and our experimental results will be compared with theoretical calculations that were done in this regime [7].
The presentation will concentrate on testing the 3NF and the Coulomb force effects for the differential cross section of the 1H(d, pp)n reaction at beam energy of 100 MeV. The experiment was performed at KVI in Groningen, with the use of the BINA detector [1,8].

[1] E. Stephan, et al., Eur. Phys. J. A 49 (2013) 36.
[2] H. Witała, et al., Phys. Rev. Lett. 81 (1998) 1183.
[3] A. Deltuva, et al., Phys. Rev. C 68 (2003) 024005.
[4] S.A. Coon, et al., Few-Body Syst. 30 (2001) 131.
[5] A. Deltuva, et al., Phys. Rev. C 80 (2009) 064002.
[6] E. Epelbaum, et al., Eur. Phys. J. A 19 (2004) 125; ibid. A 19 (2004) 405.
[7] R. Skibiński, et al., private communication
[8] N. Kalantar-Nayestanaki et al., Rep. Progr. Phys. 75 (2012) 016301.

Parallel Session:

Few-Body Systems

Symmetries and New Physics / **75**

Status and Update on Results of the NA64 experiment at CERN

Author: Johannes Bernhard[1]

[1] *CERN*

Corresponding Author: johannes.bernhard@cern.ch

on behalf of the NA64 collaboration

The NA64 experiment at CERN searches for dark matter produced in both visible and invisible decays of sub-GeV vector mediators, such as the dark photon A'. During the years 2016 –2022, A' production from electrons impinging on a target Z via the reaction $e^- Z \rightarrow e^- Z A'$ and subsequent decays $A' \rightarrow \chi\chi$, χ being a dark matter particle, and $A' \rightarrow e^+e^-$ was studied with the help of an active beam-dump experiment using the CERN H4 100 GeV/c tertiary electron beam. The invisible mode data set comprises about 10^{12} electrons on target with which NA64 probes for the first time the well-motivated region of parameter space of benchmark thermal scalar and fermionic dark matter models. The new analysis includes furthermore resonant annihilation of secondary positrons stemming from showers in the target, which boost the signal yield in the high mass region. We present the latest findings together with an update on future plans with muon beams, aiming to search for a light Z' vector boson coupled to the second and third lepton generations through the $L_\mu - L_\tau$ current in the reaction $\mu N \rightarrow \mu N Z'$, for which first data has been already taken.

Parallel Session:

Fundamental Symmetries / New Physics Searches

Hadron spectroscopy / **17**

Light Hadron Spectroscopy

Author: Beijiang Liu[1]

[1] *Institute of High Energy Physics*

Corresponding Author: chentong@ihep.ac.cn

Using the world's largest samples of J/\psi and \psi(3686) events produced in e^+e^- annihilation, BESIII is uniquely positioned to study light hadrons in radiative and hadronic charmonium decays. In particular, exotic hadron candidates including multiquark states, hybrid mesons and glueballs can be studied in high detail. Recent highlights from the light hadron spectroscopy program, including the observation of an iso-scalar spin-exotic 1^{-+} state \eta_1(1855) in J/\psi\to \gamma \eta \eta^\prime, and the observation of X(2600) in J/\psi\to\gamma \pi^+\pi^-\eta^\prime will be presented.

Parallel Session:

Hadron Spectroscopy

Nucleon Structure in DIS / **2**

Antisymmetrization of The Wave Functions Consisting of Spin-Isospin and Hyperspherical Parts

Author: Lia Leon Margolin[1]

[1] *Marymount Manhattan College*

Corresponding Author: lmargolin@mmm.edu

In order to investigate Few-Particle Hypernuclei within the framework of the Hyperspherical Function Method, it is necessary to obtain full wave functions that are anti-symmetric under particle interchange. These wave functions must include not only hyperspherical, but also spin-isospin parts. According to the Parentage Scheme of Symmetrization, N-particle hyperspherical functions (N=3,4,5,6 ⋯) symmetrized with respect to (N-1)-particles, can be obtained from the N- particle hyperspherical functions with arbitrary quantum numbers by the use of the transformation coefficients related with the permutations of the last two particles.
This article explains how to obtain fully antisymmetrized wave functions consisting of spin-isospin and hyperspherical parts. It is demonstrated that there are sixteen possible combinations in (3+1) configuration and 12 possible combinations in (2+2) configuration when spin and isospin functions are represented by [4], [31], and [22] representations of the four-particle permutation group S_4. A complete set of the fully antisymmetrized four-particle wave functions is obtained. It is demonstrated that proposed mathematical formalism can be easily generalized to obtain fully antisymmetrized wave functions for the systems consisting of five and more particles.

Nucleon Structure in DIS / **44**

Electromagnetic and gravitational local spatial densities for hadrons

Author: Iuliia Panteleeva[1]

[1] *Ruhr-University Bochum*

Corresponding Author: juliia.panteleeva@ruhr-uni-bochum.de

The issue of a proper definition of the spatial distributions of matrix elements of local operators has attracted much attention in the last few years. In the talk, the novel definition of electromagnetic and gravitational local spatial densities of hadrons will be discussed. We will start from the matrix elements parametrised in terms of the form factors and connect them with the corresponding spatial densities using the sharp localisation approach. We will show how the traditional densities in the Breit frame appear and how they differ from densities in the sharp localisation approach. In the end, we will discuss the interpretation of densities, the structure of hadrons and their fundamental properties.

Parallel Session:

Nucleon Structure in DIS

Few-body Systems / **51**

Electromagnetic form factors and charge radii of light nuclei from chiral effective field theory

Authors: Arseniy Filin[1]; Vadim Baru[1]; Evgeny Epelbaum[1]; Christopher Körber[1]; Hermann Krebs[1]; Daniel Möller[1]; Andreas Nogga[2]; Patrick Reinert[1]

[1] *Ruhr-Universität Bochum*

[2] *Forschungszentrum Jülich*

Corresponding Author: arseniy.filin@ruhr-uni-bochum.de

The electromagnetic form factors play a crucial role in characterizing the charge and magnetization distribution inside a nucleus. They are essential for determining nuclear charge radii and the differential cross section of electron-nucleus scattering, and providing important corrections to Lamb shifts in ordinary and muonic atoms. Achieving a precise and accurate theoretical description of these form factors requires a thorough understanding of two- and three-body forces, two-body electromagnetic currents, and various relativistic effects.

In this talk we present a high-accuracy calculation of the charge form factors for A=2,3,4 nuclei using the latest two- and three-nucleon forces and charge density operators derived up through the fifth order in the chiral effective field theory. We predict the structure radii of the deuteron, alpha-particle, and the isoscalar combination of ^{3}H and ^{3}He, and conduct a comprehensive analysis of uncertainties from different sources.
By combining the predicted structure radii of ^{2}H and ^{4}He with spectroscopic measurements of the deuteron-proton charge radius difference and ^{4}He charge radius, we extract the neutron and proton charge radii.

Parallel Session:

Few-Body Systems

Hadron spectroscopy / **52**

Results on polarization observables in two pion photoproduction at CLAS

Author: Alessandra Filippi[1]

[1] *INFN Torino*

Corresponding Author: filippi@to.infn.it

The nature and identification of N*and* ☒ excitations and the search for missing baryonic resonances are still open issues in the present hadron spectroscopy scenario.
In photon-induced interactions some couplings with the nucleons could be enhanced, as well as the chance of observing signatures of these poorly known resonances. However, the integrated information available from unpolarized ☒p cross sections measurements does not provide enough details for spectroscopic purposes, due to the large width of most of the baryonic intermediate states and their overlap in the same mass spectrum region.
An alternative approach stands in the study of polarization variables, which are theoretically related to partial wave amplitudes and therefore can provide additional information on the amplitude interference. These studies can be more effectively pursued exploiting data that feature both a polarized beam and a polarized target. The polarization variables, in fact, are experimentally related to asymmetries in the cross sections, measured in different configurations of beam helicity and target polarization.
These experimental conditions could be met in the g14 experiment, run at CLAS (Jefferson Lab, USA) in the years 2011-2012: a circularly polarized photon beam, with momentum in the 0.6-2.3 GeV/c range, interacted on a HD longitudinally polarized target. In this talk, results on beam-helicity and target-spin asymmetries in the photoproduction of $\pi^+\pi^-$ pairs with these data will be presented. Indeed, the two pion channel represents the dominant contribution to the total cross section, therefore it favors, especially in the second resonant region, the observation of intermediate states whose decay leads to an exclusive final state with two pions and a nucleon.
The results obtained so far will be shown and compared to earlier results by CLAS and other experiments.

Parallel Session:

Hadron Spectroscopy

Nucleon Structure in DIS / **53**

Exclusive π0 muoproduction at COMPASS

Authors: Karolina Lavickova[1]; Marketa Peskova[2]

Co-author: Nicole d'Hose [3]

[1] *Czech Technical University*

[2] *Charles University, Prague*

[3] *CEA Universite Paris-Saclay, IRFU/DPhN*

Corresponding Author: marketa.peskova@cern.ch

Hard Exclusive Meson Production (HEMP) and Deeply Virtual Compton Scattering (DVCS) are very promising reactions to access Generalized Parton Distributions (GPDs). Such exclusive measurements were performed at COMPASS in 2016 and 2017 at the M2 beamline of the CERN SPS using the 160 GeV muon beam scattering off a 2.5 m long liquid hydrogen target surrounded by a barrel-shaped time-of-flight system to detect the recoiling target proton. The scattered muons and the produced real photons were detected by the COMPASS spectrometer, which was supplemented by an additional electromagnetic calorimeter for the detection of large-angle photons.
Exclusive π^0 production is the main source of background for the DVCS measurement, while it provides complementary information for the parametrization of GPDs. We will report on preliminary results of the exclusive π^0 production cross section and its dependence on the squared four-momentum transfer and on the azimuthal angle between the scattering plane and the π^0 production plane. The COMPASS data will provide further input to constrain GPDs, in particular chiral-odd ("transversity") GPDs.

Parallel Session:

Nucleon Structure in DIS

Few-body Systems / **73**

Exploring the residual strong interaction among thee hadrons at the LHC

Author: Raffaele Del Grande[1]

[1] *Technical University of Munich*

Corresponding Author: raffaele.del-grande@tum.de

The femtoscopy method has been recently used in high-energy collisions at the LHC to study the residual strong interaction for several hadron pairs.
In pp and p-Pb collisions, particles are emitted at relative distances of the order of 1 fm. At such distances, the produced hadrons are sensitive to the effect of their mutual strong interaction, resulting in a correlation signal in the measured particle momentum distributions. Correlation functions have been employed to test for the first time lattice QCD calculations and also to challenge the effective field theory results with unprecedented precision. In the last years, the method has been extended to study three-body systems. In this contribution, the correlation functions of p-d pairs and p-p-p triplets, measured by the ALICE Collaboration, will be shown. The measurements have been interpreted with the help of full fledged three-body calculations, demonstrating that three-baryon systems can be precisely studied at the LHC and that correlations of hadrons with light nuclei can be exploited as innovative methods to investigate many-body nuclear forces.

Parallel Session:

Few-Body Systems

Hadron spectroscopy / **57**

The BGOOD experiment at ELSA - exotic structures in the light quark sector?

Author: Thomas Jude[1]

[1] *Bonn University*

Corresponding Author: jude@physik.uni-bonn.de

The discoveries of the pentaquark states and XYZ mesons in the charmed quark sector initiated a new epoch in hadron physics, where exotic multi-quark states beyond the conventional valence three quark and quark-antiquark systems has been unambiguously observed. Similar structure may be evidenced in the light, uds sector in meson photoproduction, where access to a low momentum exchange and forward meson production region is crucial to study this phenomena. The BGOOD photoproduction experiment is uniquely designed to explore this kinematic region, being comprised of a central calorimeter complemented by a magnetic spectrometer in forward directions.

Highlighted results indicate a peak-like structure in the $\gamma n \rightarrow K^0\Sigma^0$ cross section at a centre-of-mass energy of 2 GeV consistent with a meson-baryon interaction model which predicted the charmed P_C states. The same $K^*\Sigma$ molecular nature of this proposed $N^*(2030)$ is also supported in a measurement of $\gamma p \rightarrow K^+\Lambda(1405) \rightarrow K^+\pi^0\Sigma^0$, where it is predicted to drive a triangle singularity mechanism.

In the non-strange sector, coherent meson photoproduction off the deuteron enables access to proposed dibaryon states, including the recently discovered $d^*(2380)$. Data will be presented which support experimental claims of higher mass isoscalar and isovector dibaryons.

Supported by DFG projects 388979758/405882627 and the European Union's Horizon 2020 programme, grant 824093.

Parallel Session:

Hadron Spectroscopy

Nucleon Structure in DIS / **58**

The study of the N-Delta Transition GPDs via Exclusive pi- Delta++ Electroproduction

Author: Kyungseon JOO[1]

[1] *University of Connecticut*

Corresponding Author: kyungseon.joo@uconn.edu

Generalized Parton Distributions (GPDs) are a well-established tool for exploring the 3D structure of the nucleon and mechanical properties such as the distributions of energy/momentum and forces in the system. While extensive studies have been performed for the ground-state nucleon, little is known about the 3D structure of resonances. The nucleon-to-resonance (N->N*) transition GPDs*

provides a unique tool for exploring the 3D structure and mechanical properties of nucleon resonances. They can be measured in exclusive processes with N -> N transitions. First data on these reactions are becoming available from experiments with CLAS12 in Hall B at Jefferson Lab. The talk will present first beam spin asymmetry measurements for the hard exclusive π-Δ++ production and compare them to results from the hard exclusive π+ and π0 productions and will discuss the outlook on future experimental studies of transition GPDs.

Parallel Session:

Nucleon Structure in DIS

Few-body Systems / **27**

Cross sections for the star configurations of the d(160 MeV)+p->p+p+n breakup reaction

Author: Andrzej Wilczek[1]

[1] *University of Silesia in Katowice*

Corresponding Author: awilczek@uni-mainz.de

The name ‘stars’ describes the specific configurations of the reactions with three particles in the output channel, where the momenta of the reaction products are of the equal norm and thus form an equilateral triangle in the centre-of-momentum frame. If the triangle is perpendicular to the beam momentum, the configuration is called the Space Star (SST). The measurements focused on the stars have become increasingly popular after the discovery of the Space Star Anomaly (SSA) in 1989, defined as a long-lasting discrepancy between the differential cross-sections measured for SST in deuteron-nucleon breakup at 13 MeV and the corresponding theoretical predictions [1]. The effect was measured by some other groups, and it was found to diminish with increasing energy [2]. Up till now, no reliable explanation has been found.

The problem could be explored more thoroughly by expanding the available data to higher energies. To date, there have not been any systematic studies of the star configurations at energies on the order of 100 MeV. The data on deuteron-proton breakup measured with the BINA experimental setup are well-suited for such analysis. In the first stage, the data collected at the deuteron beam energy of 160 MeV were analysed. Although the Space Star configuration is out of the detector acceptance for deuteron on proton breakup, the star configurations were measured for inclination angles below 90° (so-called Forward-Plane Star and the intermediate configurations). The cross-sections for the production of the stars were measured. The data are compared with the recent theoretical calculations, including three-nucleon force and Coulomb interactions.

[1] J. Strate et al. Nucl. Phys. A 501, 51 (1989)
[2] H.R. Setze et al. Phys. Lett. B 388, 229 (1996)

Parallel Session:

Few-Body Systems

Hadron spectroscopy / **7**

Photoproduction of K*Sigma in an effective Lagrangian approach

Author: Fei Huang[1]

[1] *School of Nuclear Science and Technology, University of Chinese Academy of Sciences*

Corresponding Author: huangfei@ucas.ac.cn

We analyze all the available data on differential cross sections, total cross sections, and K^* spin density matrix elements for $K^{*+}\Sigma^0$ and $K^{*0}\Sigma^+$ photoproduction off proton in an effective Lagrangian approach. The data are well reproduced, and the contributions from the s-channel nucleon resonance and t-channel κ meson exchange diagrams are discussed.

Parallel Session:

Hadron Spectroscopy

Nucleon Structure in DIS / **84**

Gravitational form factors of the delta resonance in chiral EFT

Authors: Herzallah Alharazin[1]; Evgeny Epelbaum[2]; Jambul Gegelia[3]; Ulf-G. Meißner[4]; Bao-Dong Sun[5]

[1] *Ruhr-Universität Bochum*

[2] *Ruhr University Bochum*

[3] *Ruhr-Universität-Bochum*

[4] *Bonn University*

[5] *Ruhr Universität Bochum*

Corresponding Author: baodong.sun@ruhr-uni-bochum.de

In this talk, I will present our recent result on the leading one-loop corrections to the gravitational form factors of the delta resonance in the framework of chiral effective field theory. Various contributions to the energy–momentum tensor and the renormalization of the low-energy constants are worked out.

Parallel Session:

Nucleon Structure in DIS

Few-body Systems / **32**

Baryon-Antibaryon Photoproduction off the Proton Using GlueX at Jefferson Lab

Author: Reinhard Schumacher[1]

Co-author: Hao Li [1]

[1] *Carnegie Mellon University*

Corresponding Author: schumacher@cmu.edu

The GlueX Collaboration at Jefferson Lab has used linearly polarized photons to observe $p\overline{p}$ and, for the first time, $\Lambda\overline{\Lambda}$ and $p\overline{\Lambda}$ photoproduction from thresholds up to $E_\gamma = 11.6$ GeV. The goal is to examine and compare the reaction mechanisms for both strange and non-strange quark-pair production. A phenomenological model that includes t-channel Regge exchange and double Regge exchange was developed to match all kinematic distributions in various angles and correlated longitudinal momenta. A dominant forward peak in the polar angle of the baryon-antibaryon pairs in t-channel production is seen. In addition, wide-angle anti-baryon distributions asymmetric from those of the baryons are found, necessitating a production mechanism that acts differently on baryons and anti-baryons. In the hyperon channels, there is clear kinematic separation between the photoproduction of the $\Lambda\overline{\Lambda}$ and $p\overline{\Lambda}$ systems, showing the presence of different production mechanisms. We report the total cross sections of the reactions, the differential cross sections with respect to various momentum transfers, the beam spin asymmetry of the $p\overline{p}$ system, and the invariant mass spectra of the produced systems.

Parallel Session:

Few-Body Systems

Hadron spectroscopy / **50**

Probing the meson photoproduction mechanism through spin-density matrix elements at GlueX

Author: Farah Afzal[1]

[1] *University of Bonn*

Corresponding Author: afzal@hiskp.uni-bonn.de

The light meson spectrum is explored with the GlueX experiment at Jefferson Lab using a real photon beam with energies of up to 12 GeV that is incident on a liquid hydrogen target. At these high energies, the dominant meson photoproduction mechanism in forward direction is the exchange of Reggeons. Understanding the production mechanism is essential for ongoing searches of exotic hybrid mesons in the meson spectrum. An important experimental tool in studying the production mechanism is the measurement of polarization observables including beam asymmetries and Spin-Density Matrix Elements (SDMEs) with a linearly polarized photon beam. The GlueX detector setup is well equipped to detect neutral as well as charged particles over a large angular range. This talk presents an overview of the SDMEs measured at GlueX with an emphasis on high precision measurements of the photoproduction reaction $\gamma p \to \pi^- \Delta^{++}$.

Parallel Session:

Hadron Spectroscopy

Hadron spectroscopy / **49**

Exploring Light Meson Resonances in Two-Pion Photoproduction: A Regge Formalism Analysis

Authors: Adam Szczepaniak[None]; Lukasz Bibrzycki[None]; Nadine Hammoud[None]; Nadine Hammoud[1]; Robert Perry[None]; Vincent Mathieu[None]

[1] *Institute of Nuclear Physics-PAS*

Corresponding Author: nadine.hammoud@ifj.edu.pl

In the domain of hadron spectroscopy, the investigation of meson resonances plays a pivotal role. This study focuses on the significance of two-pion photoproduction as a prominent avenue for studying meson resonances in the $\pi\pi$ system. By employing the Regge formalism, our model incorporates the background contribution from the well-known "Deck Mechanism" and emphasizes the significant $\rho(770)$ resonance, representing the P-wave contribution arising from pomeron and f_2 exchanges. Extending the model, we account for additional physics by encompassing scalar mesons, namely σ and $f_0(980)$, contributing to the S-wave behavior, while also considering non-resonant P and S components. After fitting the model to a subset of moments, we proceed to compare our predictions for the angular moments with experimental data obtained from CLAS. Our analysis reveals a noticeable breakdown of the approximate s-channel helicity conservation (SCHC) at higher four momentum transfers, adding new insights into the intricate dynamics of meson resonances. Furthermore, we extract the t-dependence of the Regge amplitude residue function for the subdominant exchanges, shedding light on their contribution to the overall dynamics.

Parallel Session:

Hadron Spectroscopy

Nucleon Structure in DIS / **31**

Progress on GPD phenomenology (remote)

Author: Herve Dutrieux[1]

[1] *College of William and Mary*

Corresponding Author: hldutrieux@wm.edu

GPD phenomenology experiences an acceleration with a lot of recent results: exploration of new exclusive processes with enhanced sensitivity to GPDs, more sophisticated treatments of experimental uncertainty, kinematic and higher-twist corrections, and the first results from lattice QCD with non-local matrix elements. I will outline the challenges posed by GPD extraction and strategies to make the most out of this diverse and increasing pool of data.

Parallel Session:

Nucleon Structure in DIS

Few-body Systems / **34**

Combined analysis of K^-p reactions and $\pi\Sigma$ photoproduction data

Author: Aleš Cieplý[1]

Co-author: Peter C. Bruns

[1] *Nuclear Physics Institute, Rez*

Corresponding Author: cieply@ujf.cas.cz

The measurements of $\pi\Sigma$ mass distributions in the $\gamma p \to K^+\pi\Sigma$ photoproduction reaction [1] probe the energy region of the $\Lambda(1405)$ resonance, just below the $\bar{K}N$ threshold, and provide new

challenges for the theoretical models of $\pi\Sigma - \bar{K}N$ coupled channels interactions. Adopting the photoproduction model presented in [2, 3] and the chirally motivated Prague model for $\bar{K}N$ interactions [4] we performed a first time attempt on a combined fit of the K^-p low-energy data and the $\pi\Sigma$ photoproduction mass spectra, without fixing the meson-baryon rescattering amplitudes [5]. The achieved description of the photoproduction mass distributions represents a significant improvement when compared with the parameter free predictions made in [3] but remains inferior to a more comprehensive model presented in [6] that employs much larger set of adjustable parameters, some of them purely phenomenological. Although our photoproduction model remains simple and is still lacking in some respects, in particular when predicting the mass spectra of the charged $\pi\Sigma$ states, it still provides additional constraints on the positions of the $\Lambda(1405)$ poles.

[1] K. Moriya et al. (CLAS Collaboration), Phys. Rev. C 88 (2013) 045201.
[2] P.C. Bruns, arXiv:2012.11298 [nucl-th].
[3] P.C. Bruns, A. Cieplý, M. Mai, Phys. Rev. D 106 (2022) 074017.
[4] P.C. Bruns, A. Cieplý, Nucl. Phys. A 1019 (2022) 122378.
[5] A. Cieplý, P.C. Bruns, arXiv:2305.06205 [nucl-th].
[6] S.X. Nakamura and D. Jido, PTEP 2014 (2014), 023D01; arXiv:1310.5768 [nucl-th].

Parallel Session:

Few-Body Systems

Few-body Systems / **30**

Exploring Neutron stars EoS with coherent π0 π0 photoproduction at A2@MAMI

Author: Mihai Mocanu[1]

[1] *University of York*

Corresponding Author: mihai.mocanu.10@aberdeen.ac.uk

Recent measurement of coherent π^0 photoproduction on Pb lead to a most accurate determination of the neutron skin, constraining nuclear matter Equation of State (EoS) at around $\rho \sim 1\rho_0$. A natural next step is elucidating the nuclear EoS at higher densities to tune our understanding of the most violent process in the Universe - neutron star mergers. It was demonstrated that at densities above $\sim 3\rho_0$, dibaryonic degrees of freedom come into play [1]. The work presented in this talk aims to improve our knowledge of dibaryon behavior in dense nuclear matter by measuring coherent $\pi^0\pi^0$ photoproduction of Ca-40/48 nuclei. The experiment was performed at the A2@MAMI facility in Mainz (Germany). The goal of the analysis is to identify the first genuine hexaquark, the $d^*(2380)$, through photoproduction on nuclei. We are expecting to determine the medium modifications of the $d^*(2380)$ in nuclear matter and constrain its couplings [2]. These new results will further improve our understanding of the neutron stars equation of state and allow precise determination of the maximum neutron star mass, as well as provide key ingredients for the calculation of the neutron star merger dynamics. Also, the interplay between the hexaquark, quark-gluon, and hyperon degrees of freedom in the EoS of dense nuclear matter will be discussed. The effective coupling constants obtained in this experiment can further constrain the possibility of hexaquark condensate dark matter [3].

[1] I. Vidana, M. Bashkanov, D.P. Watts, A. Pastore, Phys. Lett. B 781, 112-116 (2018)
[2] A. Mantziris, A. Pastore, I. Vidana, D.P. Watts, M. Bashkanov, A.M. Romero, Astronomy & Astrophysics A40, ISSN 0004-6361 (2020)
[3] M. Bashkanov, D.P. Watts 2020, J. Phys. G: Nucl. Part. Phys. 47 03LT01 (2020)

Parallel Session:

Hadron Spectroscopy

Public Evening Lecture (in German) — Öffentlicher Abendvortrag / 132

Medizinische Anwendungen von Teilchenbeschleunigern

Plenary talk / 98

Exploring the hadron structure with GPDs and TMDs

Author: Barbara Pasquini[1]

[1] *University of Pavia and INFN-Pavia, Italy*

Corresponding Author: barbara.pasquini@unipv.it

I will discuss recent progress in the theoretical investigation of the partonic structure of the nucleon in terms of generalized parton distributions (GPDs) and transverse momentum dependent parton distributions (TMDs).
In particular, I will highlight the information encoded in these function on the spin and multidimensional partonic structure of the nucleon, discussing our present understanding from available experimental data.

Parallel Session:

Invited Plenary Talk

Plenary talk / 88

Evidence of intrinsic charm quarks in the proton

Authors: Alessandro Candido[None]; Felix Hekhorn[None]; Giacomo Magni[None]; Juan Cruz-Martinez[None]; Juan Rojo[None]; Kirill Kudashkin[None]; Richard D. Ball[None]; Stefano Forte[None]; Tommaso Giani[None]

Corresponding Author: niccolo.laurenti@mi.infn.it

Quantum Chromodynamics describes the proton as a bound state of quarks and gluons. However, it is unclear whether the heavy quarks, i.e. quarks whose mass is larger than the proton mass, take part to the non perturbative dynamics of the proton. They are the so-called intrinsic heavy quarks. It has been discussed for a long time that the charm quark, that is the lightest heavy quark and its mass sits slightly above the proton mass, could have a non negligible intrinsic component. However, so far all the efforts to establish the presence of an intrinsic charm remained inconclusive. Here, disentangling the non perturbative component from charm-anticharm pairs arising from high-energy radiation, we provide evidence of intrinsic charm in the proton by exploiting a high-precision determination of the quark-gluon content of the proton based on machine learning and a large experimental dataset. We confirm these findings by comparing to very recent data on Z-boson production with charm jets from the LHCb experiment.

Parallel Session:

Invited Plenary Talk

Plenary talk / **102**

Exotics in EFT

Author: Feng-Kun Guo[1]

[1] *Institute of Theoretical Physics, CAS*

Corresponding Author: fkguo@itp.ac.cn

This talk will be focused on near-threshold exotic hadrons in the hidden-charm and double-charm sectors. For such systems, the separation of scales allows one to construct EFT as a framework to analyze both experimental and lattice QCD data. Insights into the structure of exotic states can be obtained.

Parallel Session:

Invited Plenary Talk

Plenary talk / **107**

Electron-Ion Collider - A Giant CT Scanner for Nucleons and Nuclei

Author: Jianwei Qiu[1]

[1] *Jefferson Lab*

Corresponding Author: jqiu@jlab.org

The proton and neutron, known as nucleons, are the fundamental building blocks of all atomic nuclei that make up essentially all the visible matter in the universe. In Quantum Chromodynamics, nucleons have complex internal structures and emerge as strongly interacting and relativistic bound states of quarks and gluons, the dynamics of which are only beginning to be revealed in modern experiments. Both theory and experimental technology have now reached a point where we are capable of exploring the inner structure of nucleons and nuclei at sub-femtometer distance, leading to the newly emerging science of nuclear femtography. In this talk, I will demonstrate that Electron-Ion Collider (EIC), which the US Department of Energy recently approved for construction at Brookhaven National Lab, will be an excellent new facility for exploring the science of nuclear femtography. I will highlight new developments in theory to precisely match the observed nucleons to quarks and gluons within them, allowing the EIC to be a powerful tomographic scanner and/or microscope able to precisely image the inner structure of nucleon and nuclei with a sub-femtometer resolution. The precise knowledge of confined quark/gluon structure of nucleons/nuclei will help us address the most compelling unanswered questions about the elementary building blocks of our visible world, and are capable of taking us to the new frontier of the Standard Model.

Parallel Session:

Invited Plenary Talk

Plenary talk / **129**

EIC

Author: Silvia Dalla Torre[1]

[1] *INFN - Trieste*

Corresponding Author: silvia.dallatorre@ts.infn.it

Plenary talk / **69**

Inference of the neutron star matter equation of state: impact of new data

Author: Len Brandes[1]

Co-authors: Norbert Kaiser [1]; Wolfram Weise [1]

[1] *Technical University of Munich*

Corresponding Author: len.brandes@tum.de

Information on the phase structure of strongly interacting matter at high baryon densities can be gained from observations of neutron stars and their detailed analysis. Bayesian inference methods are used to set constraints on the speed of sound in the interior of neutron stars, based on recent multimessenger data in combination with low-density constraints based on chiral effective field theory and perturbative QCD constraints at asymptotically high densities. The impact of the recent new heavy ($2.35 M_\odot$) black widow pulsar PSR J0952-0607 and of the unusually light supernova remnant HESS J1731-347 is inspected. A systematic Bayes factor assessment quantifies the evidence (or non-evidence) for small sound speeds ($c_s^2 \leq 0.1$), a prerequisite for a first-order phase transition, within the range of densities realised in the core of neutron stars. One of the consequences of including PSR J0952-0607 in the data base is a further stiffening of the equation-of-state, resulting for a 2.1 solar-mass neutron star in a reduced central density of less than five times the equilibrium density of normal nuclear matter. The evidence against small sound speeds in neutron star cores is further strengthened. Within the inferred posterior credible bands, only a weak first-order phase transition with a coexistence density interval $\Delta n/n$
$lesssim 0.2$ would be compatible with the observed data.

This work has been supported in part by DFG (Project-ID 196253076 - TRR 110) and NSFC as well as the DFG Excellence Cluster ORIGINS.

Parallel Session:

Invited Plenary Talk

Plenary talk / **101**

TBA

Parallel Session:

Invited Plenary Talk

Low Energy Nucleon Structure / **24**

Low-energy constants in the chiral Lagrangian with baryon octet and decuplet fields from Lattice QCD data on CLS ensembles

Author: Matthias F.M. Lutz[1]

Co-authors: Yonggoo Heo ; Xiao-Yu Guo

[1] *GSI*

Corresponding Author: m.lutz@gsi.de

We perform an analysis of Lattice QCD data on baryon octet and decuplet masses based on the chiral SU(3) Lagrangian. Low-energy constants (LEC) are adjusted to describe baryon masses from a large set of CLS ensembles, where finite-box and discretization effects are considered. The set is successfully compared against previous Lattice QCD data from ensembles generated with distinct QCD actions by the ETMC, QCDSF-UKQCD and HSC groups. Discretization effects are modelled by the use of action and lattice-scale dependent leading orders LEC, where uniform values are imposed in the limit of vanishing lattice scales. From the CLS data set we extract a pion-nucleon sigma term, $\sigma_{\pi N} = 58.7(1.2)$ MeV, compatible with its empirical value.

Parallel Session:

Low-Energy Nucleon Structure