MENU-2019

Sunday 02 June 2019 - Friday 07 June 2019

Carnegie Mellon University

Book of Abstracts

Contents

Menu-2019 Plenary / 57

Searching for Exotic Hadrons at GlueX

Author: Sean Dobbs[1]

[1] *FSU*

Corresponding Author: sdobbs@fsu.edu

The search for hybrid mesons and the detailed study of their spectrum is the primary goal of the GlueX Experiment in Hall D at Jefferson Lab, which promises to provide unique insight into gluonic degrees of freedom in QCD and the nature of confinement. The experiment combines an intense photon beam with linear polarization peaking around 9 GeV incident on a liquid hydrogen target with a nearly hermetic spectrometer, allowing for the comprehensive study of charged and neutral particle final states. The first phase of the experiment has recently concluded, yielding a photoproduction data set of unprecedented size and quality. This talk will report on the status of the analysis of this data, including measurements of polarization observables, progress in spectroscopic measurements of light mesons, and the measurement of the photoproduction of J/psi near threshold, which is providing critical insight into the nature of the LHCb charmed pentaquark candidates.

Early Consideration:

No

Graduate Student:

No

Menu-2019 Plenary / 67

Precision studies of pion-nucleon interactions

Author: Martin Hoferichter[1]

[1] *University of Washington*

Corresponding Author: mhofer@uw.edu

We review the determination of the low-energy pion-nucleon scattering amplitude using Roy-Steiner equations. In particular, we focus on the phenomenological determination of the pion-nucleon σ-term, derived in combination with modern precision data on pionic atoms. We will also discuss recent applications to nucleon form factors and the determination of low-energy constants in chiral perturbation theory.

Early Consideration:

No

Graduate Student:

No

Menu-2019 Plenary / 117

Partonic Nucleon Structure in Lepton Scattering

Author: Marco Contalbrigo[1]

[1] *INFN Ferrara*

Corresponding Author: contalbrigo@fe.infn.it

Most of our present understanding of the nucleon structure derives from inclusive deep inelastic scattering (DIS) experiments performed over the past five decades in different kinematic regimes at fixed-target experiments and collider machines. In the recent years, it has been realized that in DIS reactions, single and dihadron semi-inclusive and hard exclusive production, provide a variety of spin and azimuthal angle dependent observables sensitive to the dynamics of quark gluon interactions. New parton distributions and fragmentation functions have been introduced to describe the rich complexity of the hadron structure and move towards a multi-dimensional imaging of the underlying parton correlations. Besides the hard probe scale, these functions explicitly depend on the parton transverse degrees of freedom at the scale of confinement. Studies of the parton distribution functions which encode transverse momentum (TMDs) or transverse position (GPDs) promise to open a unprecedented gateway to the unique dynamics of the strongly interacting force. This work presents a selection of available observations and upcoming measurements planned in DIS experiments to address the mysteries of the nucleon structure from a modern point of view.

Early Consideration:

Graduate Student:

MENU-2019 Plenary / **39**

Dynamical coupled-channels approach to electroweak reactions on nucleon and deuteron

Author: Satoshi Nakamura[1]

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

Corresponding Author: sxnakamura@gmail.com

The Argonne-Osaka dynamical coupled-channels (DCC) approach provides a unified description of various electroweak meson productions on single nucleon and nucleus. The model can be used, for example, to extract properties of nucleon resonances through a comprehensive analysis of reaction data, and to evaluate nuclear effects involved in the reactions, thereby enabling us to obtain information of interest.

In the former part of the presentation, I discuss the DCC model of a single nucleon. The model includes πN, $\pi\pi N$, ηN, $K\Lambda$, and $K\Sigma$ stable channels and also $\pi\Delta$, σN, and ρN unstable channels that are gateway to the $\pi\pi N$ channel. The DCC model is developed through a comprehensive analysis of $\pi N, \gamma N \to \pi N, \eta N, K\Lambda, K\Sigma$ reaction data from the thresholds up to $W = 2.1$ GeV. This model is further extended to finite Q^2 by analyzing pion electroproduction data, and to neutrino-induced reactions using the PCAC relation between the axial currents and πN amplitudes.

In the latter part of the presentation, I discuss applications of the DCC model to electroweak meson productions on the deuteron. We consider impulse mechanism supplemented by final state interactions (FSI) due to NN and meson-nucleon rescatterings. Predictions from this model turn out to be in good agreement with existing data. Using this model, I discuss a novel method to extract ηN scattering length and effective range, and FSI corrections needed to extract γ-neutron reaction observables from γ-deuteron data. Finally, I discuss FSI corrections on the existing neutrino-nucleon data, which are important for neutrino-oscillation experiments, that had been extracted from neutrino-deuteron data.

Early Consideration:

No

Graduate Student:

No

MENU-2019 Plenary / 70

Probing the nucleon spin structure at RHIC using the Electroweak interaction

Author: Ralf Seidl[1]

[1] *RIKEN*

Corresponding Author: rseidl@riken.jp

Only a short time after the discovery of the massive bosons of the elctro-weak interaction, they can be used as tool in the study of the nucleon structure at RHIC energies. In particular the maximal parity violation makes W boson production interesting as W bosons only couple to left-handed quarks and right-handed anti-quarks. The W boson production therefore selects the helicity in longitudinally polarized proton-proton collisions. In addition, the charge of the W determines the dominant quark and anti-quark flavors (up and dbar for W+, d and ubar for W^-). The RHIC experiments PHENIX and STAR have successfully used single spin asymmetries of W decay leptons to access the polarized light sea at a very high scale and without the added uncertainties of fragmentation functions. The results strongly indicate an asymmetric polarized light sea of opposite sign to the unpolarized light sea which rules out simple pion-cloud models.
When fully reconstructing Ws or Zs, the STAR experiment managed to measure single transverse spin asymmetries related to the Sivers effect. First results slightly favor a sign change of the Sivers function with respect to semi-inclusive DIS measurements in accordance with theory predictions.
Last, electro-weak boson production also provides information about the unpolarized nucleon structure, again particularly light sea quarks, at higher fractional energies than what is typically probed at the LHC.
An overview over these RHIC measurements will be presented.

Early Consideration:

No

Graduate Student:

No

Hadron Spectroscopy / 28

Excited Nucleon Spectrum and Structure Studies with CLAS and CLAS12

Author: Daniel Carman[1]

[1] *JLab*

Corresponding Author: carman@jlab.org

The study of the spectrum and structure of excited nucleon states employing the electroproduction of exclusive reactions is an important avenue for exploring the nature of the non-perturbative strong interaction. The CLAS detector in Hall~B has provided the dominant part of the available world data

on all relevant meson electroproduction channels off the nucleon in the resonance region for Q^2 up to 5~GeV^2. Analyses of CLAS data for the exclusive channels πN, ηN, and $\pi\pi N$ on a proton target have provided the only results available on the Q^2 evolution of the helicity amplitudes for the transitions from the initial photon-proton to the final N^* states in the mass range up to W=1.8~GeV. These electrocoupling amplitudes allow for exploration of the internal structure of the produced N^* states. This work has made it clear that consistent results from independent analyses of several exclusive channels with different resonance hadronic decay parameters and non-resonant backgrounds but the same N^* electro-excitation amplitudes, is essential to have confidence in the extracted results. Starting in early 2018, a program to study the spectrum and structure of N^* states in various exclusive electroproduction channels using the new CLAS12 spectrometer commenced. These studies will probe the structure of these states in the mass range up to W=3~GeV and for Q^2 as low as 0.1~GeV^2 and as high as 10-12~GeV^2, thus providing a means to access N^* structure information spanning a broad regime encompassing both low and high energy degrees of freedom. Quasi-real photoproduction studies are also planned to search for additional N^* states, the so-called hybrid baryons, for which the glue serves as an active structural component. In this talk the N^* programs from both CLAS and CLAS12 will be reviewed.

Early Consideration:

No

Graduate Student:

No

Few-Body Systems / 20

Measurements of Polarization-Transfer to Bound Protons at the Mainz Microtron

Author: Sebouh Paul[1]

[1] *Tel Aviv University*

Corresponding Author: sebouh.paul@gmail.com

A comparison between polarization-transfer to a bound proton in quasi-free kinematics by the $A(\vec{e}, e'\vec{p})$ knockout reaction
and that in elastic scattering off a free proton can provide information on the characteristics of the bound proton. In elastic scattering, the ratio of the transverse (P_x)
to longitudinal (P_z) polarization-transfer components is proportional to the electromagnetic form factor ratio G_E/G_M. This provides a direct measurement of the form factor (FF) ratio and eliminates many systematic uncertainties. Similar measurements in quasi-elastic scattering off bound protons have been performed at the Mainz Microtron (MAMI) using ^{2}H and ^{12}C targets, with Q^2 up to 0.65 GeV$^2/c^2$. These measurements are compared to the free-proton scattering, as well to realistic calculations that include nuclear effects such as final state interactions (FSI), in order to search for nuclear-medium modifications of the nucleon. Comparison of the individual components P_x and P_z to the calculated predictions are used to further test the validity of the calculated polarizations.

This talk will explain the setup of the experiment, the methods used to derive P_x, P_z and their ratio, as well as the calculated predictions that they are compared to. It will also present the polarization observables, as well as the ratio of the observables to those of elastic scattering off a free moving proton.

Early Consideration:

No

Graduate Student:

No

Meson-Nucleon Interactions / 33

The pion-nucleon sigma term from pionic atoms

Author: Avraham Gal[None]

Co-author: Eliahu Friedman

Large scale fits to pionic atoms data show that the in-medium pion-nucleon isovector scattering length b1 gets renormalized in pionic atoms by 30-40% away from its free-space value [1], apparently owing to the decrease of the pion decay constant in the nuclear medium in terms of the pion-nucleon sigma term [2]. Accepting the validity of this approach, we extracted this sigma term from a large-scale fit of pionic-atom level shift and width data across the periodic table [3]. Our fitted value sigma=57+/-7 MeV is robust against variation of pion-nucleon interaction terms other than the isovector s-wave term with which sigma is associated. Higher order corrections to the leading order in density involve some cancelations, suggesting thereby only a few percent overall systematic uncertainty. The derived value of sigma agrees with values obtained in several recent studies based on near-threshold pion-nucleon phenomenology [4], but sharply disagrees with values obtained in recent direct lattice QCD calculations [5].

[1] E. Friedman and A. Gal, Phys. Rep. 452 (2007) 89.
[2] W. Weise, Acta Phys. Polon B 31 (2000) 2715.
[3] E. Friedman, A. Gal, submitted to PLB, http://arXiv.org/abs/1901.03130
[4] J. Ruiz de Elvira et al., JPG 45 (2018) 024001.
[5] N. Yamanaka et al. (JLQCD Collaboration), PRD 98 (2018) 054516.

Early Consideration:

No

Graduate Student:

No

Hadron Spectroscopy / 5

Light Nucleon Resonance Revival

Author: Igor Strakovsky[1]

[1] *The George Washington University*

Corresponding Author: igor@gwu.edu

Nucleon state in one unitary octet with Lambda(1330), Sigma(1475),and Xi(1620) is discussed. It seems to be possible that its mass is below the Delta. We derive bounds for the properties of such states. Some of these are new [recent evidences came from COSY for Sigma(1475) and Belle for Xi(1620)], while others improve upon
existing limits. We discuss the nature of N' states, and their unitary partners, assuming that their existence can be verified.

Early Consideration:

No

Graduate Student:

No

Few-Body Systems / 61

The NPDGamma Experiment: Measuring the Hadronic Weak Interaction in Neutron-Proton Capture

Author: Matthew Musgrave[1]

[1] *Massachusetts Institute of Technology*

Corresponding Author: musgrave@mit.edu

Neutrons have proved themselves to be a useful system to study topics in nuclear, particle, and astrophysics with high-precision, low-energy experiments. At the Fundamental Neutron Physics Beamline (FNPB) at the Spallation Neutron Source (SNS), the NPDGamma experiment investigated the hadronic weak interaction via the capture of cold neutrons on protons. Observation of the hadronic weak interaction is challenging because of the relatively small coupling compared to the hadronic strong interaction but is possible by looking for a parity violating observable. The NPDGamma experiment measures the parity-violating asymmetry in gamma-ray emissions after spin-polarized neutron are captured in a liquid para-hydrogen target. The parity-violating gamma-ray asymmetry is sensitive to the $\Delta I = 1$ weak potential and is therefore a measure of the long-range pion component in the meson exchange model of hadronic weak interactions. The experiment, analysis, and final results of the NPDGamma experiment will be presented.

Early Consideration:

No

Graduate Student:

No

Meson-Nucleon Interactions / 30

Simulating pA reactions to study the phi meson in nuclear matter at J-PARC

Author: Philipp Gubler[1]

[1] *JAEA*

Corresponding Author: gubler@post.j-parc.jp

The behavior of the ϕ meson in nuclear matter has attracted renewed interest because of (recent and future) experiments that aim to study its properties in nuclei [1-3]. Theoretically, many works have however been conducted assuming infinite nuclear matter [4-5], which is not realistic from an experimental point of view. To relate theoretical predictions with experimental observables, a thorough understanding of the actual reaction, in which the ϕ meson is produced in a nucleus, is required. For the past E325 experiment at KEK [1] and the future E16 experiment at

J-PARC, this is a pA reaction with initial proton energies between 10 and 30 GeV. To simulate such a reaction, we make use of the PHSD transport code, which is based on a covariant microscopic transport model [6]. In this framework, the phi meson spectral function obtained theoretically as a function of density, can be used as an input, while the output of the simulation can be compared with experimentally observed spectra. In this presentation, I will give an overview of first results obtained in simulations of the reactions probed at the E325 and E16 experiments.

[1] R. Muto et al., Phys. Rev. Lett. 98, 042501 (2007).
[2] A. Polyanskiy et al., Phys. Lett. B 695, 74 (2011).
[3] K. Aoki (J-PARC E16 Collaboration), arXiv:1502.00703 [nucl-ex].
[4] P. Gubler and K. Ohtani, Phys. Rev. D 90, 094002 (2014).
[5] P. Gubler and W. Weise, Phys. Lett. B 751, 396 (2015).
[6] W. Cassing and E. Bratkovskaya, Phys. Rev. C 78, 034919 (2008).

Early Consideration:

No

Graduate Student:

No

Few-Body Systems / 45

Interpolating QCD_2 between the instant and front forms of relativistic dynamics

Author: Bailing Ma[1]

[1] *NCSU*

Corresponding Author: bma4@ncsu.edu

The two dimensional quantum chromodynamics (QCD) in the limit of infinite number of colors, known as the 't Hooft model, was originally formulated in the Light Front Dynamics (LFD). The theory is exactly solvable, while still bearing some resemblance to the 4 dimensional real world QCD in aspects such as confinement and mass gap, as well as the spontaneous breaking of chiral symmetry. Similar work was done in 1978 by Bars and Green in the Instant Form Dynamics (IFD). The quark-antiquark bound state equation was derived and solved in each of the two forms, i.e., 't Hooft equation and Bars-Green equations, respectively, and they give the same discrete meson mass spectrum independent of the quantization form. Introducing an interpolation angle parameter, δ, we try to link the two distinct forms of dynamics, IFD and LFD, by letting the form rotate from the ordinary $\{t, z\}$ axes to the light front $\{x^+, x^-\}$ ones, as δ varies from 0 to $\pi/4$. We have found that the quark condensate is quantization angle independent. This indicates a non-trivial vacuum structure even in light-front form. We also unify the 't Hooft and Bars-Green equations into one formula, and by numerically solving it we confirm the independence of the meson mass spectra on the interpolation angle δ.

Early Consideration:

Graduate Student:

Yes

Hadron Spectroscopy / 38

Spin-Density Matrix Elements for Vector Meson Photoproduction at GlueX

Author: Alexander Austregesilo[1]

[1] *Carnegie Mellon University*

Corresponding Author: aaust@cmu.edu

The GlueX experiment at Jefferson Lab aims to study the light meson spectrum with an emphasis on the search for hybrid mesons. To this end, a linearly-polarized 9 GeV photon beam impinges on a hydrogen target contained within a hermetic detector with near-complete neutral and charged particle coverage. In 2018, the experiment completed its first phase of data taking in its design configuration and the analyzed data already exceeds previous experiments for polarized photoproduction in this energy regime by orders of magnitude. Polarization observables like spin-density matrix elements provide valuable input for the theoretical description of the production mechanism, which will be essential for the interpretation of possible exotic meson signals. We will present results for the photoproduction of vector mesons, focusing on the unprecedented statistical precision of the spin-density matrix elements for the $\rho(770)$ meson.

Early Consideration:

No

Graduate Student:

No

Few-Body Systems / 29

Collectivity in small systems measured with PHENIX at RHIC

Author: Carlos Perez[1]

[1] *Stony Brook University*

Corresponding Author: cperez@cern.ch

The study of anisotropic flow provides strong constrains to the evolution of the medium produced in heavy ion collisions and its event-by-event geometry fluctuations. The strength and predominance of these observables have long been related to collective behaviour in the formed medium. Recent results in small systems both at RHIC and LHC provide strong arguments for the formation of such medium at those scales.

PHENIX has measured the v2 and v3 anisotropic flow coefficients for p+Au, d+Au and He+Au collisions at 200GeV as well as d+Au at various lower energies. We have found a remarkable dependence of the flow amplitude with initial geometry which can be reproduced by hydrodynamic models.

Early Consideration:

No

Graduate Student:

No

Hadron Spectroscopy / 35

Unitarity constraints on three-body effects

Authors: Maxim Mai[1]; Michael Doering[2]

[1] *The George Washington University*

[2] *GWU*

Corresponding Author: maximmai@gwu.edu

Three-body unitarity puts important constraints on the form of the scattering amplitudes required for the clarification of several puzzles in modern meson and baryon spectroscopy - e.g. Roper-puzzle, kinemaitic (triangle-) singularities in excited state of a1(1260), nature of XYZ states.

In my talk, I will demonstrate, how a minimal form of such a relativistic and unitary scattering amplitude can be derived and its recent applications. I will also discuss mathematical aspects and application to physical systems when applying such an amplitude to the finite-volume spectrum obtained from Lattice QCD.

[Eur.Phys.J. A53 (2017) no.9, 177]
[Eur.Phys.J. A53 (2017) no.12, 240]
[Phys.Rev.Lett. 122 (2019) no.6, 062503]

Early Consideration:

No

Graduate Student:

No

Electroweak Probes / 27

Measurement of the proton polarizabilities at MAMI

Author: Edoardo Mornacchi[1]

[1] *University of Mainz*

Corresponding Author: emornacc@uni-mainz.de

Polarizabilities are fundamental properties related to the internal structure and dynamics of the nucleon. They play a crucial role not only in our understanding of the nucleon, but also in other areas such as atomic physics. The A2@MAMI Collaboration has undertaken a comprehensive program of real Compton scattering experiments in order to accurately determine these parameters at the MAinz MIcrotron (MAMI), using the Crystal Ball/TAPS setup. A new high quality data set has been collected both on the differential cross section and on the beam asymmetry Σ_3 below the pion production threshold using a polarized photon beam and an unpolarized liquid hydrogen target. This measurement will allow an extraction of the proton scalar polarizabilities α_{E1} and β_{M1} with a significant improvement to the large uncertainties of the present values. Moreover, the use of linearly and circularly polarized photon beams in conjunction with polarized targets will also allow an extraction of the different proton spin polarizabilities, which at the moment have only been determined in various linear combinations. To study these, the asymmetries Σ_{2x}, Σ_{2z} and Σ_3 were measured above the pion production threshold. This talk will give the current status as well as the present and expected results on all different proton polarizabilities that can be obtained at Mainz.
*On the behalf of A2 Collaboration.

Early Consideration:

No

Graduate Student:

Yes

Hadron Spectroscopy / 42

$Z_c(4430)$, $Z_c(4200)$, $Z_1(4050)$ and $Z_2(4250)$ as triangle singularities

Author: Satoshi Nakamura[1]

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

Corresponding Author: sxnakamura@gmail.com

Recent experimental observations of charged charmonium- and bottomonium-like structures have brought lots of excitements in the field of hadron spectroscopy. If these structures are associated with the existence of the corresponding hadrons, these states includes minimally two quarks and two antiquarks, being objects clearly beyond the conventional quark model picture. Such charged charmonium-like state candidates include $Z_c(4430)$ discovered by the Belle and confirmed by the LHCb in $\bar{B}^0 \to \psi(2S)K^-\pi^+$, $Z_c(4200)$ found in $\bar{B}^0 \to J/\psi K^-\pi^+$ by the Belle, and $Z_1(4050)$ and $Z_2(4250)$ observed in $\bar{B}^0 \to \chi_{c1}K^-\pi^+$ by the Belle. Existing theoretical models, which had not been ruled out by the experiments, all interpreted these candidates as four-quark states, until we recently identified a compelling alternative; this new scenario is what I am going to discuss in my presentation. I discuss that kinematical singularities in triangle loop diagrams induce a resonance-like behavior that can consistently explain the properties (such as spin-parity, mass, width, and Argand plot) of $Z_c(4430)$, $Z_c(4200)$, $Z_1(4050)$ and $Z_2(4250)$ from the experimental analyses. Also, in terms of the triangle singularities, we can naturally understand interesting experimental findings such as the appearance (absence) of $Z_c(4200)(Z_c(4430))$-like contribution in $\Lambda_b^0 \to J/\psi p\pi^-$, and the highly asymmetric shape of the spectrum bump for $Z_1(4050)$; the other theoretical models have not successfully addressed these points. Even though the proposed mechanisms have uncertainty in the absolute strengths which are currently difficult to estimate, otherwise the results are essentially determined by the kinematical effects and thus robust. This contribution is based on two recent papers: arXiv:1901.07385, 1903.08098.

Early Consideration:

No

Graduate Student:

No

Fundamental Symmetries / 72

Searching for light dark matter at accelerators

Author: Mauro Raggi[1]

[1] *Sapienza University Roma*

Corresponding Author: mauro.raggi@lnf.infn.it

Understanding the nature of dark matter is crucial in modern physics.
Among the different possibilities, the idea that dark matter could be con-
ned into a 'dark sector' is attracting growing interest in recent years.
A combination of different standard model anomalies can be solved by
introducing a mediator particle with mass lower than the weak scale, connecting the dark sector to the standard model.
We will focus our attention on the dark photon hypothesis, reviewing the
experimental status and future prospects of dark photon searches, with
particular attention to the PADME experiment at Laboratori Nazionali
di Frascati.

Early Consideration:

No

Graduate Student:

No

Electroweak Probes / 41

Deep exlcusive processes measured in Hall A at Jefferson Lab

Author: Bishnu Karki[1]

[1] *Ohio University*

Corresponding Author: karkibishnunpl@gmail.com

Generalized Parton Distributions (GPDs) provide simultaneously spatial and momentum distribution of quarks and gluons inside the nucleons. GPDs can be accessed experimentally through hard exclusive processes like Deeply Virtual Compton Scattering (DVCS) or Deeply Virtual Meson Production (DVMP). Experiment E12-06-114 completed half of its data taking at the end of 2016 in Hall A at JLab. This experiment has measured the DVCS and exclusive π^0 electroproduction cross-sections at various Q^2 for three Bjorken-x in valence regime. These result will provide stringent test of factorization in hard exclusive processes over a wide range of Q^2 achieved with 12 GeV upgrade. I will show the most recent results on the behalf of our DVCS collaboration.

Early Consideration:

No

Graduate Student:

Yes

Fundamental Symmetries / 68

The Proton Radius (PRad) Experiment at Jefferson Lab

Author: Eugene Pasyuk[1]

[1] *Jefferson Lab*

Corresponding Author: pasyuk@jlab.org

The PRad experiment is aimed to determine proton charge radius from electron-proton elastic scattering. The measurements were performed in the experimental Hall B of Jefferson Lab using a novel non-magnetic spectrometer technique and windowless hydrogen gas flow target. This allowed to measure ep scattering at angles as small as $0.7\,^\circ$ to access unprecedentedly low Q^2 down to 2×10^{-4} (GeV/c)^2. The overview of the experiment and its results will be presented.

Early Consideration:

No

Graduate Student:

No

Hadron Spectroscopy / 85

Quark, gluon and hadron physics in terms of a novel renormalization-group procedure for the QCD Hamiltonian

Author: Maria Gómez-Rocha[1]

Co-authors: Stanislaw Glazek ; Kamil Serafin [2]; Jai More [3]; Enrique Ruiz Arriola [1]

[1] *Universidad de Granada*

[2] *University of Warsaw*

[3] *Indian Institute of Technology*

Corresponding Author: mariagomezrocha@gmail.com

In view of the growing need of theoretical tools that can be used in QCD to understand the dynamics of gluons in hadrons, the renormalization group procedure for effective particles (RGPEP) has been applied to several problems in QCD in order to study its utility. The method, based on the Glazek-Wilson similarity renormalization group for Hamiltonians, uses the concept of effective particles, which differ from the point-like canonical ones by having a finite size s. The size plays the role of renormalization group parameter. However, instead of integrating out high-energy degrees of freedom, our RGPEP procedure is based on a transformation of the front-form QCD Hamiltonian from its canonical form with counterterms to the renormalized, scale-dependent operator that acts in the Fock space of effective quanta of quark and gluon fields, keeping all degrees of freedom intact but accounting for them in a transformed form. The notion of effective size allows one to select the relevant energy scale in a particular problem.

In this talk, I present the general concepts of the method and show recent results for quarkonia and triply-heavy baryons, as they are the simplest possible systems one can consider in theory and compare with data. I display numerical estimates for meson and baryon masses, which match predictions given by lattice QCD and quark models. Furthermore, I present a new application of the method to hadron-hadron interactions, considering the pipi scattering problem as an example and showing how the RGPEP can be used to select the relevant energy scale in the physical process.

As it turns out from the study of heavy-quark bound states, the second-order solutions to the RGPEP equation yield a Coulomb potential in the effective quark-(anti)quark component, which appears to be corrected by a harmonic oscillator term. An effective confining effect appears as a result of assuming that the non-Abelian and non-perturbative dynamics generate an effective gluon mass. The framework accounts for gluonic degrees of freedom explicitly, and therefore it is very convenient for the study of hybrids.

References:

[1] M. Gómez-Rocha, S.D. Glazek, Asymptotic freedom in the front-form Hamiltonian for quantum chromodynamics of gluons
Phys.Rev. D92 (2015) no.6, 065005.

[2] S.D. Głazek, M. Gómez-Rocha, J. More, K. Serafin, Renormalized quark–antiquark Hamiltonian induced by a gluon mass ansatz in heavy-flavor QCD
Published in Phys.Lett. B773 (2017) 172-178.

[3] K. Serafin, M. Gómez-Rocha, J. More, S.D. Głazek,
Approximate Hamiltonian for baryons in heavy-flavor QCD
Eur.Phys.J. C78 (2018) no.11, 964.

[4] M. Gómez-Rocha, E. Ruiz Arriola, Wilsonian approach to pipi scattering
In preparation.

Early Consideration:

Graduate Student:

No

Electroweak Probes / 11

Novel determination of the nucleon form factors and the proton radius with Dispersively Improved Chiral EFT

Authors: Jose Manuel Alarcon[None]; Christian Weiss[None]; Douglas Higinbotham[None]; Zhihong Ye[None]

The form factors of the nucleon are quantities widely used in the forefront of nuclear physics research. Its calculation from first principles is still an open problem that limits our knowledge of the nucleon. In this talk I will show how, using constrains from unitarity, one can find a representation for the spectral functions that allow us to compute much more efficiently the nucleon form factors with chiral effective field theory. This new approach, that we called Dispersively Improved Chiral Effective Field Theory, overcomes the known limitations of previous chiral calculations, and becomes competitive with other ab initio determinations of the nucleon form factors. As a practical application, I will show how this approach allows us to extract reliably the proton radius from current data without the need of any extrapolation to Q^2 = 0.

Early Consideration:

No

Graduate Student:

No

Fundamental Symmetries / 53

PHYSICS BEYOND SM WITH KAONS AT NA62

Author: Patrizia Cenci[1]

[1] *INFN Perugia (IT)*

Corresponding Author: massarotti@na.infn.it

The NA62 experiment at CERN SPS was designed to measure BR(K+ -> pi+ nu nu-bar) with in-flight decays, a novel technique for this channel. NA62 took its first physics data in 2016, reaching the sensitivity to the decay at the Standard Model BR. The experiment collected 10 times more statistics in 2017 and a similar amount of data is expected from the 2018 run.
The result on K+ to pi+ nu nu-bar from the full 2016 data set and the latest extrapolation and background evaluation from the 2017 data set will be presented. Prospects for improvements to be achieved with the full data set will also be discussed.
A large sample of charged kaon decays into final states with multiple charged particles was also collected in 2016-2018. The sensitivity to a number of Lepton Flavour and Lepton Number violating K+ decays provided by this data set is an order of magnitude beyond the current state of the art. The latest results of the search for K+ ⟶ π- l+ l+ (l=mu, e) decays and prospect for the search of K+ ⟶ π- mu+ e+ and K+ ⟶ π+ mu- e+ processes will be reviewed.
Recent results on production searches of Dark Photons in neutral pion decays at NA62 will also be outlined, together with sensitivity results for production and decay searches of Heavy Neutral Leptons, Axion-Like Particles and prospects for future data taking at the NA62 experiment.

Early Consideration:

Graduate Student:

Hadron Spectroscopy / 119

Beam Asymmetries from Light Scalar Meson Photoproduction on the Proton at GlueX

Author: Stuart Fegan[1]

[1] *The George Washington University*

Corresponding Author: stuart_fegan@email.gwu.edu

The GlueX facility, featuring a linearly polarized 9 GeV real photon beam delivered to a large-acceptance detector system, has recently completed its first phase of running, and analysis efforts of this dataset are well underway. It has been suggested that at GlueX energies, quark systems beyond the three quark and quark-antiquark systems of baryons and mesons, such as hybrid mesons, tetraquarks and glueballs, should exist, and studies of these systems could shed new light on how quarks combine under the strong force, particularly the role played by gluons.

GlueX data encompasses final states at energies where photoproduction of light scalar mesons, such as $a_0(980)$ and $f_0(980)$, can provide discriminatory evidence between various models, manifested in experimental observables such as the cross section and beam asymmetry. However, many of these analyses comprise multi-particle final states, which can arise from numerous intermediate resonances formed via different production mechanisms.

The work presented showcases efforts to measure the beam asymmetry of the $a_0(980)$ meson from the reaction $\gamma p \to p\eta\pi$, and discusses the application of longitudinal phase space plots, originally introduced by van Hove fifty years ago, as a means of optimizing event selection. This technique has found traction in several multi-particle final state analyses in GlueX, and provides an effective additional means of separately visualising meson and baryon production events with the same final state.

Early Consideration:

No

Graduate Student:

No

Fundamental Symmetries / 55

Independent determination of Lambda Decay Parameter

Authors: David Ireland[1]; Michael Doering[2]; Maxim Mai[3]; Deborah Roenchen[4]; Johann Haidenbauer[5]; Derek Glazier[1]; Roderick Murray-Smith[1]

[1] *University of Glasgow*

[2] *GWU*

[3] *The George Washington University*

[4] *HISKP, Bonn*

[5] *Forschungszentrum Julich*

Corresponding Author: maximmai@gwu.edu

The asymmetry parameter α_- of the parity-violating weak decay $\Lambda \to p\pi^-$ is a result of interference between s- and p-waves. The BESIII collaboration recently reported a value of α_- as 0.750(9)(4) - which is significantly higher than the current PDG value of 0.642(13).

In the same time, most of the polarization observables (from CLAS measurements) also depend on the value of α_-. We show, that a higher value of the decay parameter is obtained when constraints from spin-algebra (Fierz identities) are implemented into the analysis of the photoproduction data.

Such, independently obtained value is significantly closer to the BESIII value than the quoted PDG value and implies also a closer agreement with vanishing matter/antimatter asymetry ratio $(\alpha_- + \alpha_+)/(\alpha_- - \alpha_+)$.

Early Consideration:

No

Graduate Student:

No

Hadron Spectroscopy / 6

Dispersive analysis of the $\gamma\gamma^* \to \pi\pi, \pi\eta$ processes

Author: Oleksandra Deineka[1]

Co-authors: Igor Danilkin [1]; Marc Vanderhaeghen [1]

[1] *JGU Mainz*

Corresponding Author: deineka@uni-mainz.de

We present a theoretical analysis of $\gamma\gamma^* \to \pi^0\pi^0, \pi^+\pi^-$ and $\gamma\gamma^* \to \pi^0\eta$ processes within the energy range from threshold to 1.4 GeV and the low spacelike virtualities of photons. The Omn\'es representation is adopted in order to account for rescattering effects in both s- and d-partial waves, except for $a_2(1320)$, which is approximated as a Breit-Wigner resonance. For the description of the $a_0(980)$ and $f_0(980)$ resonances, we implement a coupled-channel unitarity. The constructed amplitudes serve as an essential framework to interpret the current experimental two-photon fusion program at BESIII. As a natural continuation of our work we also provide a discussion on the double-virtual processes, since they serve as an important input for the dispersive analyses of the hadronic light-by-light scattering contribution to the muon's anomalous magnetic moment.

[1] I. Danilkin, O. Deineka and M. Vanderhaeghen, Phys.Rev.D 96, no. 11, 114018 (2017)
[2] O. Deineka, I. Danilkin and M. Vanderhaeghen, arXiv:1808.04117 [hep-ph]
[3] I. Danilkin and M. Vanderhaeghen, Phys.Lett.B 789, 366 (2019)

Early Consideration:

Yes

Graduate Student:

Yes

Electroweak Probes / 90

Studies of Partonic Distributions using Kaon SIDIS

Author: Fatiha Benmokhtar[1]

[1] *Duquesne University*

Corresponding Author: benmokhtarf@duq.edu

The E12-09007 experiment in CLAS12 of Hall B at Jefferson lab proposed to measure multiplicities and longitudinal double spin asymmetries for pions (π+,π−, π0) and kaons (K+, K−, K0s) in Semi-Inclusive Deep Inelastic Scattering (SIDIS) from both hydrogen and deuterium. The data will be used to measure the x-dependence of the strange parton distribution function (PDF) and will help constrain the global fits used to obtain the fragmentation functions (FF). In addition this data will allow the extraction of the individual contributions of quarks and anti-quarks to the nucleon spin. The experiment is scheduled in two parts: The first involves unpolarized beam and targets for multiplicity and strange PDF measurements. The second uses both polarized beam and targets for the flavor decomposition. The measurements will cover the x-range from 0.05 to 0.7. Part of the unpolarized measurements was achieved this last winter and data taking will proceed at the end of this year. The polarized part of the experiment will run in a few years.

The experiment requires the use of a Ring Imaging Cherenkov (RICH) for a successful charged kaon identification in the 3 to 8 GeV/c momentum range. One full RICH detector was recently built and is functional; a second one is under construction.

Early Consideration:

Graduate Student:

Menu-2019 Plenary / 62

Parity and Time Reversal Violation in Nuclei

Author: Emanuele Mereghetti[1]

[1] *LANL*

Corresponding Author: emereghetti@lanl.gov

Electric dipole moments (EDMs) are extremely sensitive probes of physics beyond the Standard Model (SM). A vibrant experimental program is in place, with the goal of improving existing bounds on the electron and neutron EDMs by one/two orders of magnitude, while testing new ideas for the measurement of EDMs of light ions, such as the proton and the deuteron, at a comparable level. The success of this program, and its implications for physics beyond the SM, relies on the precise calculation of the EDMs in terms of the couplings of CP-violating operators, induced by BSM physics in the QCD Lagrangian. In light of the non-perturbative nature of both QCD at low energy and of the nuclear interactions, these calculations have proven difficult, and are affected by large theoretical uncertainties. In this talk I will review the progress that has been achieved on different aspects of the calculation of hadronic and nuclear EDMs, the challenges that remain to be faced, and the implications for our understanding of physics beyond the SM.

Early Consideration:

Graduate Student:

Menu-2019 Plenary / 100

Recent results from LHCb

Author: Mike Williams[1]

[1] *MIT*

The LHCb experiment at the LHC has been the world's premier laboratory for studying quark-flavor-changing processes since 2011. Such processes are highly sensitive to contributions from as-yet-unknown particles, e.g. supersymmetric particles, even those that are too massive to produce at the LHC. I will discuss the status of these searches, including some intriguing anomalies. In addition, I will present some recent studies of exotic hadron spectroscopy in heavy-flavor decays. Planned future upgrades and the resulting physics prospects will also be discussed, including our plans to process the full 5 terabytes per second of LHCb data in real time in the next LHC run.

Early Consideration:

No

Graduate Student:

No

Menu-2019 Plenary / 73

A fresh look at the excited baryon spectrum: What have we learned?

Author: Volker Crede[1]

[1] *Florida State University*

Corresponding Author: crede@fsu.edu

One of the most striking phenomenon of 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. Complementary to nucleon structure studies, nucleon excitations provide a unique opportunity to explore the many facets of non-perturbative QCD. The last few years have seen significant progress toward mapping out the nucleon spectrum. The rapidly growing database of high-quality experimental results on exclusive meson photo- and electroproduction off the nucleon from experimental facilities around the world allows us to determine the scattering amplitudes in the underlying reactions and to identify nucleon resonance contributions with minimal model dependence. The excited baryon program at Jefferson Lab now continues in the 12-GeV era with the successful data-taking of the GlueX experiment.

In this talk, I will review the experimental efforts in exploring and understanding the nucleon resonance spectrum at Jefferson Lab using the CEBAF Large Acceptance Spectrometer (CLAS) and at ELSA using the CBELSA/TAPS experimental setup. The discussion will also focus on the prospects for very-strange hyperon spectroscopy at Jefferson Lab.

Early Consideration:

Graduate Student:

Menu-2019 Plenary / 26

Next-generation hadronic physics with the Electron-Ion Collider

Author: Christian Weiss[1]

[1] *Jefferson Lab*

Corresponding Author: weiss@jlab.org

A high-luminosity polarized Electron-Ion Collider (EIC) has been recommended for future construction in the 2015 NSAC Long-Range Plan. This facility will enable a next-generation physics program aimed at exploring the three-dimensional structure of the nucleon in QCD (spin, spatial distributions, orbital motion), the dynamics of quarks and gluons in nuclei (nuclear interactions, quark/gluon densities, gluon saturation), and the emergence of hadrons from energetic color charge (color propagation, fragmentation, hadronization). An overview of the physics program and the present facility designs will be given. Emphasis will be placed on EIC measurements that directly impact on the identified topics of the MENU conference, such as meson-nucleon interactions (e.g. chiral dynamics in partonic structure, peripheral high-energy processes), few-body systems (e.g. high-energy scattering from polarized light nuclei, nuclear breakup), and hadron spectroscopy (e.g. heavy flavor production, quarkonia). The goal will be to make the scientific community at MENU aware of the potential of EIC for hadronic physics and engage it in the further development of the physics program.

Early Consideration:

Graduate Student:

Menu-2019 Plenary / 59

Results from the Qweak Parity Violation Experiment at Jefferson Laboratory and Implications for Future Measurements

Author: Roger Carlini[1]

[1] *Jefferson Laboratory*

Corresponding Author: carlini@cox.net

Experimental programs in the fields of nuclear and particle physics are searching for evidence of physics beyond that explained by current theories. Indirect searches using precise measurements of well predicted Standard Model observables allow highly targeted tests that can reach mass and energy scales beyond those directly accessible by today's high energy accelerators. From our precise measurement (-226 ±9 ppb) of the parity-violating (PV) asymmetry in the scattering of longitudinally polarized electrons on protons, we extract the proton's weak charge and the weak mixing angle sin^2(Theta_W) at low Q^2. Several consistent methods used to extract the proton's weak charge from the data will be discussed. This allows a mass reach for any parity violating semi-leptonic physics beyond the Standard Model at the multi-TeV scale. Implications for several specific models will be presented. The results for the strange and axial form factors obtained from a fit which included additional existing PV electron scattering data will also be presented. In conjunction with existing atomic parity violation results on 133Cs we also extract the vector weak quark couplings C1u and C1d. The latter are combined to obtain the weak charge of the neutron. This talk will also briefly discuss the discover space available to future PV measurements in the context of the combine constraints from existing high precision measurements.

Early Consideration:

No

Graduate Student:

No

Menu-2019 Plenary / 116

Physics overview of the Belle II experiment

Author: Toru Iijima[1]

[1] *KMI, Nagoya University*

Corresponding Author: iijima@hepl.phys.nagoya-u.ac.jp

The Standard Model (SM) of particle physics so far successfully explains almost all particle phenomena, including the recently discovered Higgs boson. However, there are several reasons by which physicists believe that the SM is not the ultimate theory, and that there must be New Physics. Critical tests of fundamental symmetries play important role in search for physics beyond the SM. The SuperKEKB accelerator and Belle II experiment at the KEK laboratory in Japan has started data taking just recently, and tries to find evidence for New Physics with precision measurements of rare processes of heavy flavor particles. In this talk, we present overview of the Belle II physics program with selected topics, such as CP violation in rare B decays, test of lepton universality in B decays, and lepton flavor violation in τ decays. We also present the status and prospects of the project.

Early Consideration:

No

Graduate Student:

No

Hadron Spectroscopy / 79

Single and Double Meson PhotoProduction at JLab

Author: Vincent Mathieu[1]

[1] *Complutense University of Madrid*

Corresponding Author: vmathieu@ucm.es

We'll review the recent developments in pi, eta and vector meson photoproduction at JLab energies. We'll see the theoretical implications of the factorization between the meson dynamics and the target and compare them to the new data obtained by the GlueX detector.
We'll discuss the photoproduction of eta-pi^0 and the sensibility of the observables to the exotic P-wave. We'll present a new observable, the beam asymmetry along the y axis, which allows to easily identify exotic odd waves.
Finally we'll illustrate these considerations with a simple model for the eta-pi^0 photoproduction.

Early Consideration:

Graduate Student:

Few-Body Systems / 32

Problems & Progress in Few-Body Hypernuclei

Author: Avraham Gal[None]

Co-author: Nir Barnea

Progress on several persistent problems in single- and double-Lambda light hypernuclei is briefly reviewed in this talk: (i) Lifetimes of the weakly bound Lambda-3H (Lambda-p-n), and of Lambda-3n (Lambda-n-n) if existing [1]; (ii) Charge Symmetry Breaking in the A=4, isospin I=1/2, Lambda hypernuclei [2]; (iii) Overbinding of Lambda-5He [3], apparently related to the hyperon puzzle in neutron stars; and (iv) Onset of binding in double-Lambda hypernuclei [4].

[1] A. Gal, H. Garcilazo: PLB 791 (2019) 48.
[2] D. Gazda, A. Gal: PRL 116 (2016) 122501, NPA 954 (2016) 161.
[3] L. Contessi, N. Barnea, A. Gal, PRL 121 (2018) 102502.
[4] L. Contessi, M. Schaefer, N. Barnea, A. Gal, in preparation.

Early Consideration:

No

Graduate Student:

No

Future Facilities / 102

Physics with the GlueX DIRC

Author: Justin Stevens[1]

[1] *William & Mary*

Corresponding Author: jrsteven@jlab.org

The GlueX experiment is located in experimental Hall D at Jefferson Lab (JLab) and provides a unique capability to search for hybrid mesons in high-energy photoproduction, utilizing a 9 GeV linearly polarized photon beam. The initial, low-intensity phase of GlueX was recently completed and a high-intensity phase will begin this year which includes an upgraded kaon identification system known as the DIRC (Detection of Internally Reflected Cherekov light) utilizing components from the decommissioned BaBar DIRC. The identification of kaon final states will significantly enhance the GlueX physics program, to aid in inferring the quark flavor content of conventional (and potentially hybrid) mesons. In this talk, an overview of the GlueX DIRC will be presented with a focus on recent commissioning studies and the future measurements made possible by this upgrade.

Early Consideration:

Graduate Student:

Hadron Spectroscopy / 76

The prediction of J/psi Photo-production

Authors: Jiajun Wu[1]; T.-S. Harry Lee[2]; Bing-Song Zou[3]

[1] *University of Chinese Academy of Sciences*

[2] *Argonne National Laboratory*

[3] *Institute of Theoretical Physics, Chinese Academy of Sciences*

Corresponding Author: wujiajun@ucas.ac.cn

A Pomeron-exchange model of the $\gamma p \to J/\psi p$ reaction has been used to make predictions for the on-going experiments at JLab. The parameters of the Pomeron-exchange amplitudes are determined by fitting the total cross section data of $\gamma p \to J/\psi p$ up to very high energy W = 300 GeV. To provide information for the search of nucleon resonances with hidden charm $N^*_{c\bar{c}}$, we then make predictions by including the resonant amplitude of $\gamma p \to N^*_{c\bar{c}} \to J/\psi p$ calculated from all available meson-baryons (MB) coupled-channel model of $N^*_{c\bar{c}}$ with MB = ρN, ωN, $J/\psi N$, $\bar{D}\Lambda_c$, $\bar{D}^*\Lambda_c$, $\bar{D}\Sigma_c$, $\bar{D}^*\Sigma_c$, $\bar{D}\Sigma^*_c$. The $N^*_{c\bar{c}} \to MB$ vertex interactions are determined from the partial width predicted from various theoretical models and SU(4) symmetry. The $\gamma p \to N^*_{c\bar{c}}$ is calculated from the Vector Meson Dominance (VMD) model as $\gamma p \to Vp \to N^*_{c\bar{c}}$ with V = ρ, ω, J/ψ. The model then depends on an off-shell form factor $\lambda^4/(\Lambda^4 + (q^2 - m_V^2)^2)$ which is needed to account for the q^2-dependence of VMD model.
It has been found that with $\Lambda = 0.55$ GeV, the predicted total cross sections are within the range of the very limited data in the energy region near J/ψ production threshold. We then demonstrate that the $N^*_{c\bar{c}}$ can be most easily identified in the differential cross sections at large angles where the contribution from Pomeron-exchange becomes negligible.

Early Consideration:

Yes

Graduate Student:

No

Future Facilities / 65

Current Status of the LEPS2 Experiment and Commissioning of the Solenoid Spectrometer

Author: Sun Young Ryu[1]

[1] *Osaka University*

Corresponding Author: syryu@rcnp.osaka-u.ac.jp

We report recent beam commissioning results of the LEPS2 solenoid spectrometer at SPring-8. The LEPS2 spectrometer is primarily designed for high-statistics experimental confirmation or exclusion of the Θ^+ with a large angular acceptance, and also for unveiling the hadronic structures of the $\Lambda(1405)$ and other exotic baryon systems. A large time-projection chamber (TPC) is a main tracking device for providing almost 4π angular acceptance and 1% momentum resolution. Four drift chambers are placed downstream of the TPC for tracking charged particles at forward angles. Forward and barrel resistive plate chamber (RPC) arrays provide us with trigger and timing information. Cherenkov detector arrays cover the large polar angle region for π/K identification. For the LEPS2 experiments, we have developed a new, network-distributed data acquisition system based on the DAQ middleware. During the beam commissioning and the first physics run, Compton backscattered photon beam was incident on a CH2 target in the energy region from 1.4 GeV to 2.4 GeV. We will report on preliminary results of beam commissioning of the LEPS2 spectrometer with a special emphasis on the performance of the new DAQ system.

Early Consideration:

No

Graduate Student:

No

Few-Body Systems / 37

Four-body Faddeev-type calculation of the $\bar{K}NNN$ system

Author: Nina Shevchenko[1]

[1] *Nuclear Physics Institute of CAS, Rez, Czech Republic*

Corresponding Author: shevchenko@ujf.cas.cz

The attractive nature of $\bar{K}N$ interaction has stimulated theoretical and experimental searches for K^- bound states in different systems. In particular, many theoretical calculations devoted to the lightest possible system $\bar{K}NN$ have been performed using different methods: Faddeev equations with coupled channels, variational methods, and some others. All of them agree that a quasi bound state in the K^-pp system exists but they yield quite diverse binding energies and widths. The experimental situation is unsettled as well: several candidates for the K^-pp state were reported by different experiments, but the measured binding energies and decay widths of such state differ from each other and are far from all theoretical predictions.

Detection of the heavier four-body $\bar{K}NNN$ system could be easier than in the case of $\bar{K}NN$ since direct scattering of K^- on three-body nuclei can be performed. Some theoretical works were devoted to the question of the quasi bound state in the $\bar{K}NNN$ system with different quantum numbers, but more accurate calculations within Faddeev-type equations are needed. The reason is that only these dynamically exact equations written in momentum representation can treat energy dependent $\bar{K}N$ potentials, necessary for the this system, exactly.

We are solving four-body Faddeev equations in AGS form in order to search for the quasi-bound state in the $\bar{K}NNN$ system. We are using our experience with the three-body AGS calculations, and our two-body potentials, constructed for them. Namely, three models of the $\bar{K}N$ interaction are being used: two phenomenological potentials and a chirally motivated one. All three potentials describe

low-energy K^-p scattering and $1s$ level shift of kaonic hydrogen with equally high accuracy. This will allow us to study the dependence of the four-body results on the two-body input.

A reliable calculation of a four-body problem is much harder task than a three body one, that is why we are using some approximations. In contrast to our three body calculations, where the coupling between the $\bar{K}N$ and $\pi\Sigma$ channels was taken into account explicitly, here we are using the exact optical (and due to this energy-dependent) $\bar{K}N$ potentials, corresponding to our antikaon-nucleon potentials with coupled channels. We shown that the one-channel three-body calculation with such potential is a very good approximation to the problem with coupled channels and assume that it is true for the four-body case as well. In addition we are using a separable expansion of the three-body amplitudes, entering the kernels of the four-body equations, in order to reduce the dimension of the system of integral equations. The first peliminay results of the calculations are expected to be ready.

Early Consideration:

Yes

Graduate Student:

No

Future Facilities / 51

The prospect of precise measurement of the neutrino oscillation by JUNO

Author: Yuekun Heng[1]

[1] *Institute of High Energy Physics*

Corresponding Author: hengyk@ihep.ac.cn

The Jiangmen Underground Neutrino Observatory (JUNO) is a multipurpose neutrino experiment in China with a 20-thousand-ton liquid scintillator detector of 3% (at 1 MeV) at 700-meter deep underground. The major goal of JUNO is determining neutrino mass hierarchy by precisely measuring the energy spectrum of reactor electron antineutrinos at a distance of ~53 km from the powerful reactors of the Yangjiang and Taishan Nuclear Power Plants. Also for all 6 neutrino oscillation parameters, JUNO is going to measure the 3 parameters of Δm^2_21, Δm^2_32 and sin^2θ_12 with the precision better than 1% . Considering the precision of sin^2θ_13 can be measured to ~4% by Daya Bay, the unitarity of the neutrino mixing matrix can be probed to 1% level. Besides, JUNO has other scientific possibilities such as supernova neutrinos, geo-neutrinos, solar neutrinos, atmospheric neutrinos, and exotic searches.

Early Consideration:

Yes

Graduate Student:

No

Hadron Spectroscopy / 77

Including tetraquark operators in the low-lying scalar meson sectors in lattice QCD

Authors: Daniel Darvish[1]; Ruairí Brett[1]; Jacob Fallica[2]; Andrew Hanlon[3]; Colin Morningstar[1]

[1] *Carnegie Mellon University*

[2] *University of Kentucky*

[3] *Johannes Gutenberg University of Mainz*

Corresponding Author: ddarvish@andrew.cmu.edu

Lattice QCD allows us to probe the low-lying hadron spectrum in finite-volume using a basis of single- and multi-hadron interpolating operators. Here we examine the effect of including tetraquark operators on the spectrum in the scalar meson sectors containing the $K_0^*(700)/\kappa$ and the $a_0(980)$. We present preliminary results outlining additional states found using tetraquark operators, and the discuss the possible implications of these states.

Early Consideration:

No

Graduate Student:

Yes

Few-Body Systems / 12

Constructing Wave Functions for Few-Body Systems in a Hyperspherical Basis Using Parentage Scheme of Symmetrization

Author: Lia Margolin[1]

[1] *Marymount Manhattan College*

Corresponding Author: lmargolin@mmm.edu

Investigating few-body systems with identical particles in a hyperspherical basis yields the problem of obtaining symmetrized hyperspherical functions from functions with arbitrary quantum numbers. This article solves the problem of hyperspherical basis symmetrization for four-,five- ,and six- body systems using Parentage Scheme of Symmetrization. Parentage coefficients corresponding to the [4], [31], [22], [211], representations of S_4 groups, [5], [311], [221], [2111], [11111] representations of S_5 groups, and [42] and [51] representations of S_6 groups are obtained, and Young operators, acting on N = 4,5,6 body hyperspherical functions symmetrized with respect to (N-1) particles, are derived. The symmetrized N = 4,5,6 body hyperspherical functions are obtained with different values of quantum numbers . The connection between the transformation coefficients for the identical particle systems and the parentage coefficients is demonstrated and the corresponding formulas are introduced.

Early Consideration:

Yes

Graduate Student:

No

Future Facilities / 74

Development of a Polarized 3He++ Ion Source for the EIC

Author: Matthew Musgrave[1]

[1] *Massachusetts Institute of Technology*

Corresponding Author: musgrave@mit.edu

The capability of accelerating a high-intensity polarized ^{3}He ion beam would provide an effective polarized neutron beam for the study of new high-energy QCD studies of nucleon structure. This development is essential for the future Electron Ion Collider, which could use a polarized ^{3}He ion beam to probe the spin structure of the neutron. The proposed polarized ^{3}He ion source is based on the Electron Beam Ion Source (EBIS) currently in operation at Brookhaven National Laboratory. ^{3}He gas would be polarized within the 5 T field of the EBIS solenoid via Metastability Exchange Optical Pumping (MEOP) and then pulsed into the EBIS vacuum and drift tube system where the ^{3}He will be ionized by the 10 Amp electron beam. The goal of the polarized ^{3}He ion source is to achieve 2.5×10^{11} ^{3}He^{++}/pulse at 70% polarization. An upgrade of the EBIS is currently underway. An absolute polarimeter and spin-rotator is being developed to measure the ^{3}He ion polarization at 6 MeV after initial acceleration out of the EBIS. The source is being developed through collaboration between BNL and MIT.

Early Consideration:

No

Graduate Student:

No

Hadron Spectroscopy / 80

Recent results on charmonia- and bottomonia-like particles at Belle

Author: Shohei Nishida[1]

[1] *KEK*

Corresponding Author: r06244003@ntu.edu.tw

The large data sample accumulated by the Belle experiment at KEKB asymmetric energy e^+e^- collider provides opportunities to study charmonia (bottomonia) and charmonium-like (bottomonium-like) exotic particles. In this presentation, we report recent results on these topics from Belle, including searches for $B \to h_c K$, $B \to Y(4260)K$, $B \to X(3872/3915)(\to \chi_{c1}\pi^0)K$ and a new measurement of the $e^+e^- \to \Upsilon(nS)\pi^+\pi^-$ ($n = 1, 2, 3$) cross sections at energies from 10.52 to 11.02 GeV.

Early Consideration:

No

Graduate Student:

No

Few-Body Systems / 3

Generalized Parton Distributions and Transverse Momentum Distribution of Pion

Authors: Harleen Dahiya[None]; Navdeep Kaur[None]

Corresponding Author: dahiyah@nitj.ac.in

Inspired from AdS/QCD light-front wave functions, we calculate the generalized parton distributions (GPDs) of pion. The impact-parameter dependent parton distribution functions (ipdpdf) and the GPDs in longitudinal boost-invariant space are also obtained by taking the Fourier transforms. We also calculate the charge density, gravitational form factor and the unpolarized transverse momentum distribution (TMD) of the pion.

Early Consideration:

Yes

Graduate Student:

No

Hadron Spectroscopy / 13

Threshold Effects in Heavy Quarkonium Spectroscopy

Author: Jacopo Ferretti[1]

Co-author: Elena Santopinto [2]

[1] *Yale University*

[2] *INFN Genova, Italy*

Corresponding Author: jacopo.ferretti@yale.edu

I discuss a coupled-channel model for heavy quarkonium spectroscopy, based on the Unquenched Quark Model Formalism (UQM) with some modifications. The previous model is used to calculate the masses of $\chi_c(2P)$ and $\chi_b(3P)$ states with threshold corrections. Other applications of the coupled-channel model are briefly discussed.

Early Consideration:

No

Graduate Student:

No

Few-Body Systems / 44

From $\bar{K}N$ interactions to $\bar{K}$-nuclear quasi-bound states

Authors: Ales Cieply[1]; Jaroslava Hrtankova[1]; Jiri Mares[1]; Angels Ramos[2]

[1] *Nuclear Physics Institute, Rez, Czechia*

[2] *Barcelona University, Barcelona, Spain*

Corresponding Author: cieply@ujf.cas.cz

The current chirally motivated theoretical approaches to low energy $\bar{K}N$ interactions were reviewed in [1] with a special attention paid to the origin of resonances generated dynamically within the coupled channels models derived from an effective SU(3) chiral Lagrangian. The $\Lambda(1405)$ represents a well known resonance of this kind, interpreted as a molecular $\bar{K}N$ bound state submerged in the $\pi\Sigma$ continuum, and affecting strongly the properties of the $\bar{K}N$ system at low and subthreshold energies.
The dynamics of the $\bar{K}N$ system in nuclear matter was studied in [2] where the effects due to Pauli blocking and hadron self energies in nuclear matter were discussed.

The K^-N scattering amplitudes generated by the chirally motivated approaches and modified to account for Pauli blocking were then used in the construction of a K^--nuclear optical potential. This potential was supplemented by a phenomenological term representing the K^- multinucleon interactions, fitted to kaonic atom data. The optical potentials constructed from the Prague [2] and Kyoto-Munich [3] scattering amplitudes were then applied in calculations of kaonic nuclei [4]. The K^- multinucleon interactions were found to cause radical increase of the K^- widths which exceed considerably the K^- binding energies. Finally, we will report briefly on our recently developed microscopic coupled channels model of the K^-NN absorption using chiral amplitudes [5].

[1] A. Cieply, M. Mai, U.-G. Meissner, J. Smejkal - J. Nucl. Phys. A 954, 17 (2016).
[2] A. Cieply, J. Smejkal - Nucl. Phys. A 881, 115 (2012).
[3] Y. Ikeda, T. Hyodo, W. Weise, Nucl. Phys. A 881, 98 (2012).
[4] J. Hrtankova, J. Mares, Phys. Lett. B 770, 342 (2017); Phys. Rev. C 96, 015205 (2017).
[5] J. Hrtankova, A. Ramos, prepared for publication.

Early Consideration:

No

Graduate Student:

No

Electroweak Probes / 82

Fragmentation related results from Belle

Author: Ralf Seidl[1]

[1] *RIKEN*

Corresponding Author: rseidl@riken.jp

The Belle experiment at the asymmetric e+e- collider KEKB provides a large data set not only for the exploration of flavor physics but also for precision QCD studies. The clean initial state is particularly well suited to investigate the process of high-energetic partons fragmenting into final state hadrons. Various results related to unpolarized and polarized fragmentation functions have been obtained in the previous years. A new measurement studies the creation of transverse momentum with respect to the fragmenting parton in the fragmentation process. Such transverse momentum dependent functions are the main input in learning about the three-dimensional structure of the nucleon using other reactions such as hadron collisions or semi-inclusive DIS. In particular for the future electron-ion collider this information is essential as in e+e- annihilation only the fragmentation process can be singled out. The latest results show that the transverse momentum width of the extracted single hadron cross sections has a nontrivial fractional energy dependence as well as an interesting dependence on hadron type. The latest results on this measurement and previous fragmentation function related results will be presented.

Early Consideration:

No

Graduate Student:

No

Few-Body Systems / 1

Properties of hadrons in medium in the context of Fermi Liquid Model and diquarks.

Authors: Aparajita Bhattacharya[1]; S. Pal[None]; B. Chakrabarti[None]

[1] *Adamas University*

Corresponding Author: aparajita_bh@yahoo.co.in

The Landau Fermi liquid theory is an phenomenological approach to strongly interacting normal Fermi system at small excitation energies. It is a model which suggest a point to point correspondence between low energy excitation of non interacting Fermi gas. The model has been widely used to study the properties of liquid He-3, electron in metal and nuclear matter. It gives an effective description of low energy elementary excitations like the quasi particles in crystal lattice. The model is found to be successful in describing some aspects of QCD, quark and hadronic matter also. In the current work a Fermi liquid model for hadrons has been suggested for the hadrons in medium. The hadrons are supposed to behave like quasi particle as Fermi excitation while in the medium and the effective mass of the hadrons have been estimated using Fermi liquid model. Considering a momentum dependent potential like $V(r,p^2) = V^{'}e^{-\gamma(\frac{p^2}{m})}\upsilon(r)$ inside the medium to describe the interaction, the effective masses of the hadrons are estimated.Compressibility, specific heats, density of states in medium have been studied. We have extracted the values of available well depths which give the idea about the binding energy of the particles in medium. We have also studied the masses of exotic baryons in the framework of diquark formalism. A quasi particle model of diquark has been suggested in an analogy with composite fermion and subsequently used to compute the masses of baryons like λ_b^0, Σ_b^0, Ξ_b^0, Ξ_{cc}^+, Ω_{cc}^+, Ω_{cb}^0,Ω_{ccc}, Ω_{bbb}. Using a density and momenum dependent potential of the form $V_p = \frac{\rho/\rho_0}{1+(\frac{p}{\lambda})^2}$ at p= p_f, the mass of the diquark have been estimated. The results are found to be very interesting and compared with the other theoretical and experimental studies available in literature.

Early Consideration:

Yes

Graduate Student:

No

Hadron Spectroscopy / 99

Recent results on exclusive hadronic cross sections with the BABAR detector

Author: Achim Denig[1]

[1] *JGU Mainz*

Corresponding Author: denig@kph.uni-mainz.de

The measurement of exclusive e^+e^- to hadrons processes is a significant part of the physics program of BABAR detector, aimed to improve the calculation of the hadronic contribution to the muon $g-2$ and to study the intermediate dynamics of the processes. We present the most recent results obtained by using the full data set of about 470 fb^{-1} collected by the BABAR experiment at the PEP-II e^+e^- collider at a center-of-mass energy of about 10.6 GeV. In particular, we report the results on the channels $e^+e^- \rightarrow \pi^+\pi^-\pi^0\pi^0(\pi^0)$, $e^+e^- \rightarrow \pi^+\pi^-\pi^0\pi^0\eta$, and $e^+e^- \rightarrow \pi^+\pi^-\eta$,
which have been studied in a wide mass range, from threshold production up to 4 GeV/c^2.

Early Consideration:

No

Graduate Student:

No

Electroweak Probes / 114

Bootstrap-based fit of proton scalar polarizabilities to real Compton scattering data, using fixed–t subtracted dispersion relations

Authors: Stefano Sconfietti[1]; Barbara Pasquini[1]; Paolo Pedroni[2]

[1] *Universita' degli Studi di Pavia & INFN, Pavia*

[2] *INFN, Pavia*

Corresponding Author: stefano.sconfietti@pv.infn.it

Stefano Sconfietti[1,2], Barbara Pasquini[1,2], and Paolo Pedroni[2]

1: Dipartimento di Fisica, Università degli Studi di Pavia, 27100 Pavia, Italy,
2: Istituto Nazionale di Fisica Nucleare, Sezione di Pavia, 27100 Pavia, Italy

---

I will discuss the results of the the extraction of static scalar polarizabilities from real Compton scattering (RCS) data off the proton, obtained from a bootstrap-based fit combined with the theoretical framework of dispersion relations (DRs) [1]. Nucleon scalar polarizabilities α_{E1} and β_{M1} are structure constants that parametrize the spin-independent response of the nucleon to an external quasi-static electromagnetic field.
In the framework of fixed–t subtracted DRs, the 6 functions that parametrize the RCS amplitude are obtained from dispersive integrals, with an additional subtraction constant for each function. Specific combinations of these constants are related to 6 polarizabilities: four of them are spin-dependent, the remaining two are the electric α_{E1} and magnetic β_{M1} polarizabilities.
In this framework, I performed a fit of α_{E1} and β_{M1} to the data of unpolarized proton RCS differential cross section, using a bootstrap-based technique. The main idea of this technique is the Monte Carlo sampling of replicas from the probability distribution of the original data. The conventional χ^2 fitting strategy is recovered when only statistical errors are included in data analysis, while the inclusion of systematic sources of uncertainties modifies the limit probability distribution of the minimization function [2].
I will discuss the global fitted values of α_{E1} and β_{M1} , their comparison with the previous extractions (obtained in the framework of unsubtracted DRs and chiral perturbation theory), and the statistical features of the bootstrap-based strategy.

---

[1] B. Pasquini, P. Pedroni and S. Sconfietti, arXiv:1903.07952.
[2] P. Pedroni and S. Sconfietti, in preparation.

Early Consideration:

Yes

Graduate Student:

Yes

Hadron Spectroscopy / 8

Studing XYZ states with BESII

Author: Nils Hüsken[None]

Corresponding Author: n_hues02@uni-muenster.d

The BESIII experiment at the Beijing Electron Positron Collider (BEPCII)
collected about 13 fb-1 of data in the energy range 4.0 GeV~ 4.6 GeV
dedicated to the study of potentially exotic states in the charmonium region.
Vector resonances, such as the Y (4260), are studied in lineshape analyses of
various exclusive e+e- ->hadrons cross sections. Some of these reactions,
e.g., e+e–> gamma J/psi and e+e- -> pi pi J/psi among others, also boast
the possibility to explore intermediate X- and Z-like states through their
decays, for example in X(3872) -> pi+pi-J/psi or Zc (3900) -> pi J/psi.
An overview of recent results obtained with BESIII and an outlook on future
perspectives regarding exotic hadron studies will be given.

Early Consideration:

Yes

Graduate Student:

No

Electroweak Probes / 115

Understanding r-process and Nuclear Structure via β-delayed Neutron Emission Studies in the 78Ni Region

Authors: Maninder Singh[None]; Rin Yokoyama[None]; Robert Grzywacz[None]; Andrew Keeler[None]; Tobias King[None]

β-decay studies of nuclei far-off the line of stability and neutron-rich side are crucial in understanding nuclear structure evolution and provide inputs for r-process [Burdbidge et al., 1957] simulations. Half-lives, one- and two-neutron emission probabilities (Pn, 2n), and neutron energy spectra are the most critical observables, helpful in simulating r-process pathway. The region ($26 \le Z \le 34$) around doubly magic 78Ni lies on the r-process pathway and provides a testing ground for the completeness of various physical models.

Focus here is on the experiment performed at RI-beam Factory at RIKEN Nishina Center, Japan to study the region by performing time-of-flight based spectroscopy for the delayed neutrons using detector array called VANDLE [W.A. Peters et al., 2016]. Direct measurement of energy spectra will provide information about the Gamow-Teller strength distributions. It will also directly verify the conclusions from the BRIKEN experiment [R. Yokoyama et al., submitted to Phys. Rev. Lett.] where

evidence for dominating single neutron emission from 2n unbound states was observed in 84-87Ga decays.

Early Consideration:

No

Graduate Student:

Yes

Few-Body Systems / 60

Search for an H-dibaryon near $\Lambda\Lambda$ and $\Xi^- p$ thresholds in (K^-, K^+) reaction

Author: Jung Keun Ahn[1]

[1] *Korea University*

Corresponding Author: ahnjk@korea.ac.kr

Recent Lattice QCD predictions for the mass of H-dibaryon pointing to the mass region near ΛΛ and Ξ−p thresholds encourage experimental searches. A dedicated experiment (J-PARC E42) is designed to measure Λpπ−, ΛΛ and Ξ−p decays from the H-dibaryon in the 12C(K-,K+) reaction at the K1.8 beam line of J-PARC. A new superconducting Hyperon Spectrometer is now under commissioning, consisting of a conduction-cooled superconducting dipole magnet and a time projection chamber (HypTPC). This talk will review our new attempt to find evidence supporting the existence of the H-dibaryon in the wide mass range as well as the current status of the Hyperon Spectrometer.

Early Consideration:

No

Graduate Student:

No

Electroweak Probes / 64

New results on Nucleon/Baryon Timelike Form Factors

Authors: Marco Maggiora[1]; on behalf of the BESIII Collaboration[None]

[1] *Department of Physics, University of Turin and INFN, Turin*

Corresponding Author: marco.maggiora@unito.it

An important tool to study the Nucleon Structure are the Nucleon/Baryon Timelike Form Factors.

Many unexpected features have recently been found by BESIII and other experiments concerning $e^+e^- \to N\bar{N}$ as well as $e^+e^- \to B\bar{B}$, close to their thresholds, like for instance:

- oscillations in the Proton Timelike Effective Form Factor as a function of the energy;

- steep steps in the cross section at threshold followed by a plateau in $e^+e^- \to p\bar{p}$, as well as in $e^+e^- \to \Lambda_c\bar{\Lambda}_c$ and simiiar behaviour in other $e^+e^- \to B\bar{B}$ cross sections.

Data will be shown and possible interpretations discussed.
Concerning the near future, some features of $e^+e^- \to \Lambda_c\bar{\Lambda}_c$ will be reported, that might be related to the recently found XYZ new resonances, if interpreted as four quarks states.
BESIII will collect more data above the maximum energy, achieved at present.

Early Consideration:

No

Graduate Student:

No

Few-Body Systems / 89

Pion Production at the Spallation Neutron Source

Author: Rebecca Rapp[1]

[1] *Carnegie Mellon University*

Corresponding Author: rrapp@andrew.cmu.edu

The Spallation Neutron Source (SNS) at Oak Ridge National Laboratory uses pulsed, 1 GeV protons incident on liquid mercury to produce neutron beams. As a byproduct of its operation, the SNS is a source of $\pi^\pm$ and, ultimately, an intense stopped-pion source of neutrinos. The COHERENT collaboration uses this source to investigate coherent elastic neutrino-nucleus scattering (CEvNS), and we plan to reduce an estimated 10% uncertainty in our flux calculation associated with the lack of data for $\pi^\pm$ production from 1 GeV protons on an Hg target. We present here our Geant4 simulation of pion production at the SNS and our plans to measure the neutrino flux using the precise cross section calculations for neutrino interactions on deuterium (2-3% uncertainty).

Early Consideration:

No

Graduate Student:

Yes

Hadron Spectroscopy / 96

Hybrid meson decay widths

Authors: Alessandro Giachino[1]; Elena Santopinto[2]; Eric Swanson[3]; Hugo García-Tecocoatzi[4]

[1] *INFN*

[2] *INFN Genova, Italy*

[3] *University of Pittsburgh*

[4] *Unam*

Corresponding Author: agiachino@ge.infn.it

We calculated the decay widths of hybrid mesons [1], considered as hadrons that carry both quark-antiquark and gluon degrees of freedom.
In the construction of hybrid wave functions we follow the coupling scheme adopted for gluelump studies [2], in which the energy spectrum of gluelumps, which are the states obtained by considering a gluon field bound a static color octet (given for example by the quark-antiquark pair), were calculated by means of a mean-field approach based on Coulomb Gauge QCD.
In the last decades, experimental evidence for states which cannot be explained within the quark model framework has accumulated, especially in the heavy quark sector (see Particle Data Group 3). For this reason, our decay width predictions should be of great interest for the experimental community.

[1] H. Garcia Tecocoatzi, A. Giachino, E. Santopinto, and E. Swanson, work in progress;
[2] P. Guo and A. P. Szczepaniak, G. Galata', A. Vassallo, and E. Santopinto, Phys. Rev. D 77, 056005;
[3] M. Tanabashi et al. (Particle Data Group), Phys. Rev. D 98, 030001 (2018).

Early Consideration:

No

Graduate Student:

Yes

Menu-2019 Plenary / 108

Parity-Violating Electron Scattering Experiments: Past Decade Results and Next Decade Prospects

Author: Mark Pitt[1]

[1] *Virginia Tech*

Corresponding Author: pitt@vt.edu

The experimental technique of parity-violating electron scattering has been used for over four decades as a tool to study a variety of physics topics. They include sensitive tests of the electroweak Standard Model as probes for new physics, determination of the contribution of the strange quark sea to the nucleon's electromagnetic properties, and measurements of the neutron distributions in nuclei. This talk will review the highlights in this area over the past decade and the expectations for the coming decade.

Early Consideration:

No

Graduate Student:

No

Menu-2019 Plenary / 34

The proton radius puzzle – 9 years later

Author: Jan Christopher Bernauer[1]

[1] *Stony Brook University and RBRC*

Corresponding Author: jan.bernauer@stonybrook.edu

The so-called proton radius puzzle, the roughly 4% difference in the extracted values for the root-mean square charge radius of the proton from electron spectroscopy and scattering on one side, and muon spectroscopy on the other, remains unsolved for nine years now. Recent results from spectroscopy and scattering shed new light on the puzzle, but so far fall short of a satisfactory solution. In the talk, I will discuss the current state of the puzzle and describe upcoming experiments.

Early Consideration:

No

Graduate Student:

No

Menu-2019 Plenary / 111

PANDA, the next-generation facility in technology and strong-interaction physics

Author: Johan Messchendorp[1]

[1] *University of Groningen*

Corresponding Author: j.g.messchendorp@rug.nl

Despite the successes of the Standard Model of particle physics, it remains a challenge to understand the dynamics of the strong interaction among the building blocks of hadronic matter. At small distance scales or at high energies, the underlying theory, QCD, is well tested and understood. Our understanding of the strong interaction deteriorates dramatically at larger distances scales such as the size of the nucleon. This so-called "strong QCD regime" exhibits spectacular effects such as the generation of hadron masses and color confinement. The future experiment PANDA, will address the dynamics of this regime by exploiting the annihilation of antiprotons with protons and nuclei. A versatile detector and data-analysis scheme is presently under development driven by forefront technologies. In this talk, I will give an overview of the physics, detector, and data-processing ambitions of PANDA at the first few phases of the experiment.

Early Consideration:

No

Graduate Student:

No

Menu-2019 Plenary / 95

Hadron Physics with KLOE-2 data at the Phi-factory

Author: Caterina Bloise[1]

[1] *INFN - Frascati National Laboratory (LNF)*

Corresponding Author: caterina.bloise@lnf.infn.it

KLOE-2 has recorded 5.5/fb of e+e- data at 1.02 GeV.
A status report of the experiment plans and current analyses is given, including recent results in the K-short sector which at the Phi-factory is uniquely tagged by K-long identification.
Our attempt to exploit the lepton-tagging technique to identify gamma-gamma processes in the high-luminosity environment of the Phi-factory, the progress on searches in the dark sector, and in the analysis of eta->pi0 gamma gamma decays are presented.

Early Consideration:

Graduate Student:

Menu-2019 Plenary / 75

Low-Energy Precision Physics at MESA

Author: Achim Denig[1]

[1] *JGU Mainz*

Corresponding Author: denig@kph.uni-mainz.de

At Mainz/Germany, the new electron accelerator MESA (Mainz Energy-Recovering Superconducting Accelerator) for a new generation of fixed-target experiments, is currently under construction. In this talk we report on the status and the science case of MAGIX, which will be operated as an internal target experiment during the energy-recovery operation mode of MESA. The detector will consist of two high-resolution spectrometers.
Key experiments to be performed at MAGIX range from the measurement of electromagnetic form factors of the nucleon (proton radius puzzle) and of light nuclei to searches for low-mass particles of the dark sector.
Furthermore, we also discuss the possibilities for a beam dump experiment at MESA, which opens the avenue for competitive searches for light dark matter particles.

Early Consideration:

No

Graduate Student:

No

Menu-2019 Plenary / 25

Heavy-light meson spectroscopy

Author: Feng-Kun Guo[1]

[1] *Institute of Theoretical Physics, CAS*

Corresponding Author: fkguo@itp.ac.cn

In this talk, I will review some aspects of the heavy-light meson spectroscopy, making connections between theoretical calculations to the recent lattice and experimental results.

Early Consideration:

Graduate Student:

Menu-2019 Plenary / 97

Preliminary Results from the JLab MARATHON Tritium DIS Experiment

Author: Hanjie Liu[1]

[1] *Columbia University*

Corresponding Author: hl2923@columbia.edu

Preliminary results from a Jefferson Lab (JLab) experiment on electron deep inelastic scattering (DIS) off the ^3H and ^3He mirror nuclei will be presented. The experiment (MARATHON, "MeAsurement of the F_2^n/F_2^p, d/u RAtios and A=3 EMC Effect in Deep Inelastic Electron Scattering Off the Tritium and Helium MirrOr Nuclei") completed data taking in Spring 2018, using the JLab 11 GeV electron beam and the Hall A spectrometer facility. It has measured the DIS cross section ratios for ^2H, ^3H and ^3He to determine the ratio of the F_2^n/F_2^p structure functions of the neutron and proton with a novel method which is free of theoretical uncertainties presented in previous SLAC measurements, and extract the d/u ratio of the up and down quark probability distributions in the proton. The results are expected to test the predictions of the quark model of the nucleon and perturbative QCD, and to constrain the parameterizations of nucleon's parton distribution functions used in the interpretation of high energy collider data. Another goal of the experiment is to precisely measure the EMC effect of the two A=3 mirror nuclei. The results are considered essential for understanding the EMC effect, which describes the modification of the nucleon structure functions in the nuclear medium.

*On the behalf of MARATHON Collaboration.

Early Consideration:

No

Graduate Student:

Yes

Menu-2019 Plenary / 110

Physics from CLAS 12

Author: Annalisa D'Angelo[1]

[1] *Universita' di Roma Tor Vergata & INFN Roma Tor Vergata*

Corresponding Author: annalisa.dangelo@roma2.infn.it

The CLAS Collaboration has completed the installation of the new CLAS12 Large Acceptance Detector in Hall-B at the Jefferson Laboratory in USA, in view of the operation with electron energies up to 11 GeV.
The experimental program spans over a broad range of od scientific scopes, designed to address fundamental issues in nuclear physics, such as spectroscopy and structure of the excited baryon states, including the search for hybrid hadrons with the glue as an extra constituent component beyond the constituent, 3-D imaging of the ground state nucleons and exploration of the N −>N* form factors in the transition from the regimes of confinement to perturbative QCD.

A first set of data have been taken in spring and fall 2018. This talk will review the initial CLAS12 physics program and highlight the current status of the ongoing physics analyses.

Early Consideration:

No

Graduate Student:

No

Menu-2019 Plenary / 63

$K^{-}pp$ Bound System at J-PARC

Authors: Fuminori Sakuma[1]; for the J-PARC E15 collaboration[None]

[1] *RIKEN*

Corresponding Author: sakkuma@ribf.riken.jp

The possible existence of deeply-bound $\bar{K}$-nuclear bound states
has been widely discussed as a consequence of the strongly attractive
$\bar{K}N$ interaction in I = 0 channels.
The investigation of those exotic states will provide unique information
of the $\bar{K}N$ interaction below the threshold, which is still not
fully understood up to date.
Furthermore, the grate interest of those exotic states is that they
might form high-density nuclear matter where the chiral symmetry is
expected to be restored.

Among the $\bar{K}$-nuclear bound states, the $\bar{K}NN$ system with $I = 1/2$ and $J^P = 0^-$ (symbolically denoted as K^-pp") is of
special interest because it is the lightest $S = -1$ $\bar{K}$ nucleus.
Many theoretical works agree on the existence of the bound state,
however, the binding energies and the decay widths are scattered.
Experimentally, there are several reports on observation of aK^-pp" candidate with the binding energy of around 100 MeV.
On the other hand, several groups concluded that the reactions
can be understood without the inclusion of a bound state.

To clarify whether or not the K^-pp" bound state exists, we
performed an exclusive measurement of the $^3\mathrm{He}(K^-, \Lambda p)n$
reaction at 1.0 GeV/c at J-PARC (J-PARC E15 xperiment).
In the experiment, we observed a distinct peak in the Λp
invariant-mass spectrum well below the mass threshold of $K^- + p + p$,
of which the simplest and natural interpretation is a kaonic-nuclear
bound-stateK^-pp".
The obtained binding energy and the width are $47 \pm 3(\mathrm{stat.})^{+3}_{-6}(\mathrm{syst.})$ MeV/c^2 and $115 \pm 7(\mathrm{stat.})^{+10}_{-20}(\mathrm{syst.})$MeV/$c^2$, respectively.
This result is experimentally solid as against the previously reported
results.
In addition, we observed $\Lambda(1405)pn$ final state in $K^- +$
^{3}He reactions by reconstructing $\pi^{\mp}\Sigma^{\pm}pn$ events,
which is of special importance to understand the production mechanism of
the "K^-pp" state such as theoretically predicted $\Lambda(1405)N \to \bar{K}NN$ doorway process.

We will discuss the possible existence of the K^-pp" state from
both aspects of production and decay:K^-pp" and $\Lambda(1405)p$

production, and Λp non-mesonic and $(\pi\Sigma)^0 p$ mesonic decay, respectively.

Early Consideration:

No

Graduate Student:

No

Menu-2019 Plenary / 112

Meson-Nucleon scattering using lattice QCD

Author: John Bulava[1]

[1] *CP3-Origins, University of Southern Denmark*

Corresponding Author: bulava@cp3.sdu.dk

Lattice QCD calculations of resonant meson-meson scattering amplitudes have improved significantly due to algorithmic and computational advances. However, progress in meson-nucleon scattering has been slower due to difficulties in computing the necessary correlation functions, the exponential signal-to-noise problem, and the finite-volume treatment of scattering with fermions. Nonetheless, first benchmark calculations have now been performed. I will review the status of lattice QCD calculations of meson-nucleon scattering amplitudes and comment on future prospects.

Early Consideration:

No

Graduate Student:

No

Menu-2019 Plenary / 104

Drell-Yan physics program at SeaQuest

Author: Arun Tadepalli[1]

[1] *Rutgers University*

Corresponding Author: tadepalli@physics.rutgers.edu

The Fermilab E906/SeaQuest is an experiment aimed at studying the anti-quark distributions in nucleons and nuclei. The experiment uses a 120 GeV proton beam extracted from the Main Injector at Fermilab to collide with various solid and cryogenic targets to study a variety of physics topics ranging from light quark flavor asymmetry to the EMC effect in the nucleon sea. It takes advantage of the Drell-Yan process to probe the anti-quark structure. In the Drell-Yan process, a quark from one hadron annihilates with an anti-quark from another hadron, producing a virtual photon which eventually decays into a dileptons. The SeaQuest forward spectrometer is optimized for detecting such di-muons. The overall status of the experiment and recent results regarding light quark flavor asymmetry in the nucleon sea, parton energy loss in cold nuclear matter and nuclear dependence of the anti-quarks in heavy nuclei will be presented in this talk.

Early Consideration:

No

Graduate Student:

Yes

Menu-2019 Plenary / 69

Interactions of light nuclei from lattice QCD

Author: William Detmold[1]

[1] *MIT*

Corresponding Author: wdetmold@mit.edu

I will discuss recent work applying lattice QCD to the study of the interactions of light nuclei from lattice QCD. Calculations of nuclear matrix elements relevant for Standard Model processes such as proton-proton fusion, and neutrinoful double beta decay will be overviewed. The potential for lattice QCD input into new physics searches will also be highlighted with emphasis on calculations relevant for dark matter direct-detection and neutrinoless double beta decay. Prospects for future calculations and extensions will also be discussed

Early Consideration:

Graduate Student:

Nucleon Structure / 121

Polarized Structure Functions of Spin-1 Targets

Author: Karl Slifer[1]

[1] *University of New Hampshire*

Corresponding Author: karl.slifer@unh.edu

Several experiments are planned at Jefferson Lab and other facilities which will utilize a solid polarized target to investigate tensor structure functions. This new program will help clarify how the properties of the nucleus arise from the underlying partons, and provide novel information about gluon contributions, quark angular momentum, and the polarization of the quark sea that is not accessible in spin-1/2 targets. There are plans to measure the deuteron tensor structure function b1, which gives access to the tensor-polarized quark and antiquark distribution functions, and the tensor asymmetry Azz in the x > 1 region, in order to explore the nature of short-range correlations in nuclei. This program can also be extended and improved at the planned Electron Ion Collider.

Early Consideration:

No

Graduate Student:

No

Hadron Spectroscopy / 36

Studies of Xi(1620)^0 and Xi(1690)^0 hyperons at Belle

Author: Mizuki Sumihama[1]

[1] *Gifu University / Osaka University RCNP*

Corresponding Author: sumihama@rcnp.osaka-u.ac.jp

The Ξ excited states are not well understood because of less experimental study. In this presentation, we report on the studies of $\Xi(1620)^0$ and $\Xi(1690)^0$ via the $\Xi_c^+ - > \Xi^-\pi^+\pi^+$ decays by using a data sample collected with the Belle detector at the KEKB asymmetric-energy e^+e^- collider. We observe the $\Xi(1620)^0$ and measure its mass and width. We find an evidence of the $\Xi(1690)^0$ in the $\Xi\pi$ decay mode.

Early Consideration:

No

Graduate Student:

No

Future Facilities / 113

The Belle II experiment: status and prospects

Author: Martin Bessner[1]

[1] *University of Hawaii*

Corresponding Author: bessner@hawaii.edu

Belle II at the electron-positron collider SuperKEKB is the successor to the Belle experiment. Its design luminosity is 8*10^35/(cm^2 s), 40 times the record achieved at KEKB/Belle, at the same center of mass energy in the bottomonium region. Over the next years it is expected to accumulate an integrated luminosity of 50/ab, collecting by far the largest sample of B mesons at electron-positron colliders, together with large datasets of bottomonium and lighter particles. After a commissioning run in 2018 the detector started routine data taking in March 2019. In this talk the current status of the detector, current and future running conditions and further prospects for the future will be discussed.

Early Consideration:

No

Graduate Student:

No

Nucleon Structure / 49

Determination of Pion Parton Distributions Using Threshold Resummation

Authors: Patrick Barry[1]; Nobuo Sato[2]; Wally Melnitchouk[3]; Chueng Ji[1]

[1] *North Carolina State University*

[2] *Old Dominion University*

[3] *Jefferson Lab*

Corresponding Author: pcbarry@ncsu.edu

The pion's makeup of quarks, antiquarks, and gluons (or partons) can be described in terms of its parton distribution functions (PDFs). These are functions of the partons' momentum fraction, x, relative to the pion. Recently, we were able to determine the pion's PDF at high- and low-x regions using Drell-Yan (DY) and Leading Neutron (LN) data. In the DY process, two hadrons collide, one donating a quark the other donating an antiquark, producing a dimuon pair. In LN electroproduction, an electron beam is incident on a proton, which splits into a charged pion and a detected neutron. The exchanged virtual photon probes the pion. In this work, we aim to pin down the pion's PDFs at x near 1 using threshold resummation (TR) on DY. At threshold, all energy from the initial hadrons produces the dilepton pair. Just below threshold, soft gluons are emitted and inflate the cross-section. TR sums the contribution of the soft gluons to all orders in perturbative QCD. We present preliminary results of the pion PDFs using TR.

Early Consideration:

No

Graduate Student:

Yes

Hadron Spectroscopy / 46

The $X(1835)$ and $X(p\bar{p})$ puzzle at BESIII

Author: Johannes Bloms[1]

[1] *Westfälische Wilhelms-Universität Münster*

Corresponding Author: j_blom02@uni-muenster.de

The BESIII experiment at the Beijing Electron Positron Collider (BEPCII) has collected the world's largest data sample at the J/ψ resonance including 10 billion events, which offers an unique opportunity to study hadron spectroscopy and search for light exotic states. In 2003, BESII reported the first observation of a $p\bar{p}$ mass threshold enhancement $X(p\bar{p})$ in $J/\psi \to \gamma p\bar{p}$. In addition, a structure was observed in $J/\psi \to \gamma\eta'\pi^+\pi^-$ and $J/\psi \to \gamma K_s K_s \eta$ in 2005 and 2015 called $X(1835)$. Both were determined to have spin-parity $J^P = 0^-$. While the masses of the $X(p\bar{p})$ and $X(1835)$ are in agreement with each other, their widths are significantly different, in fact $\Gamma_{X(p\bar{p})} < 76$ MeV (90% C.L.) and $\Gamma_{X(1835)} = 245$ MeV. Additionally, detailed studies of $J/\psi \to \gamma\eta'\pi^+\pi^-$ show a significant abrupt change in slope of the $X(1835) \to \eta'\pi^+\pi^-$ line shape at the $p\bar{p}$ mass threshold. An overview of recent developments of the mentioned observations as well as approaches to understand the line shape will be presented in this talk.

Early Consideration:

Graduate Student:

Yes

Future Facilities / 86

The DVCS experiment in Hall C at Jefferson Lab with the new NPS detector

Author: Ho San KO[1]

Co-author: Carlos MUNOZ CAMACHO [1]

[1] *Institut de Physique Nucléaire Orsay*

Corresponding Author: hosanko@ipno.in2p3.fr

Deeply Virtual Compton Scattering (DVCS) is the simplest exclusive process to access Generalized Parton Distributions (GPDs). GPDs encode the correlation between the spacial distribution of partons inside the nucleon and their momentum. An upcoming DVCS experiment in Hall C at Jefferson Lab (Virginia, U.S.A.) will provide the highest precision data in a vast Q^2-x_B region accessible by a 11 GeV electron beam. It will further test the leading twist dominance of the observables and get more precise data in lower x_B region needed for the full mapping of GPDs. A Neutral Particle Spectrometer (NPS) is being developed for this experiment. It consists of an electromagnetic calorimeter made of 1080 PbWO4 crystals. We will present the status of the detector R&D and construction, as well as simulation results of its performance.

Early Consideration:

Yes

Graduate Student:

Yes

Hadron Spectroscopy / 94

Meson spectrum in an unquenched quark model

Author: Jialun Ping[1]

[1] *Nanjing Normal University*

Corresponding Author: jlping@njnu.edu.cn

The discovery of XYZ particles is a big challenge for quark model. The model must be extended. By considering the high Fock components, an unquenched quark model is developed. The improved quark-pair creation operator in 3P0 model is invoked to deal with the mixing between quark-antiquark and meson-meson states. Gaussian expansion method is employed to do a high precision calculation of this few-body problem. Applying the unquenched quark model to light meson systems, a reasonable results are obtained. Applying to charmonium states, X(3872) can be reproduced as a mixing states of ccbar (70%) and DD* states.

Early Consideration:

No

Graduate Student:

No

Nucleon Structure / 15

Single-spin asymmetry at subleading level

Author: Hsiang-nan Li[1]

Co-authors: Sanjin Beni [2]; Yoshitaka Hatta [3]; Dong-Jing Yang [4]

[1] *Academia Sinica*

[2] *Kyoto University*

[3] *BNL*

[4] *National Taiwan Normal University*

Corresponding Author: hnli@phys.sinica.edu.tw

We find that a parton-level hard cross section also generates a phase at two loops in semi-inclusive deeply inelastic scattering (SIDIS) off a polarized nucleon, which represents a new source of transverse single-spin asymmetry different from those in the Sivers function and the Collins function. As an extension of the above analysis, we complete the sources of transverse single spin asymmetry at two parton twist three accuracy in SIDIS up to two loops.
One source from the parton distribution function g_T survives in the collinear factorization, whose associated hard scattering kernel starts from two loops. The potential impact on the current understanding of the underlying mechanism for single-spin asymmetry is explained.

Early Consideration:

Yes

Graduate Student:

No

Future Facilities / 91

New Experiments at the CERN M2 beam line within "Physics Beyond Colliders": AMBER/COMPASS++, NA64μ, MuonE

Author: Johannes Bernhard[1]

Co-authors: Dipanwita Banerjee [2]; Markus Brugger [1]; Nikolaos Charitonidis [1]; Serhii Cholak [1]; Gian Luigi D'Allesandro [3]; Lau Gatignon [1]; Alexander Gerbershagen [1]; Eva Montbarbon [1]; Bastien Rae [1]; Marcel Rosenthal [1]; Maarten van Dijk [1]; Benjamin Moritz Veit [4]

[1] *CERN*

[2] *University of Illinois at Urbana-Champaign and CERN*

[3] *Royal Holloway, University of London and CERN*

[4] *CERN and Johannes Gutenberg-Universität Mainz*

Corresponding Author: johannes.bernhard@cern.ch

The "Physics Beyond Colliders (PBC)" study explores fundamental physics opportunities at the CERN accelerator complex complementary to collider experiments. Three new collaborations aim to exploit the M2 beam line in the North Area with existing high-intensity muon and hadron beams, but also aspire to go beyond the current M2 capabilities with a RF-separated, high-intensity hadron beam, under study. The AMBER/COMPASS++ collaboration proposes an ambitious program with a measurement of the proton radius with muon beams, as well as QCD-related studies from pion PDFs / Drell-Yan to cross section measurements for dark sector searches. Assuming feasibility of the RF-separated beam, the spectrum of strange mesons would enter a high precision era while kaon PDFs as well as nucleon TMDs would be accessible via Drell-Yan reactions. The NA64μ collaboration proposes to search for dark sector mediators such as a dark scalar A' or a hypothetical Z_μ using the M2 muon beam and complementing their on-going A' searches with electron beams. The MuonE collaboration intends to assess the hadronic component of the vacuum polarization via elastic μ-e scattering, the dominant uncertainty in the determination of g_μ-2. An overview of the three new experimental programs will be presented together with implications for the M2 beam line and the experimental area EHN2, based on the studies of the PBC "Conventional Beams" Working Group.

Early Consideration:

No

Graduate Student:

No

Hadron Spectroscopy / 120

Exclusive eta and eta' photoproduction and beam asymmetries at GlueX

Author: William McGinley[1]

[1] *Carnegie Mellon University*

Corresponding Author: wmcginle@andrew.cmu.edu

The GlueX experiment is a photopoduction experiment located at Thomas Jefferson National Lab in Newport News, Virginia. GlueX is capable of making beam asymmetry (Σ) measurements using a tagged, linearly-polarized 9 GeV photon beam incident on a hydrogen target. Measurements of the beam asymmetry for the exclusive reactions, $\gamma p \rightarrow \eta p$ and $\gamma p \rightarrow \eta' p$, will provide insight into the meson production mechanisms. GlueX measurements are the first beam asymmetry results for the η and η' in this energy range and are expected to further constrain Regge theory models for photoproduced pseudoscalar mesons. This talk will present preliminary results of the photon beam asymmetries as a function of the Mandelstam variable, t , for multiple η decay modes and the $\eta' \rightarrow \pi^+\pi^-\eta$ decay mode.

Early Consideration:

Graduate Student:

Yes

Nucleon Structure / 17

FFNS QCD analysis of charm and beauty production cross sections data and parton distribution functions

Author: Alireza Vafaee[1]

Co-author: Alireza BaradaranShokouhi

[1] *Iran's National Elites Foundation*

Corresponding Author: shokouhi.phy@gmail.com

To separate the proton structure functions into calculable processes and parton distribution functions (PDFs), there are various schemes such as the Fixed-Flavor Number (FFN) and the General Mass Variable-Flavor Number (GM-VFN) schemes. In this Next-to-Leading Order (NLO) Quantum Chromo Dynamics (QCD) analysis we determine PDFs based on the four different HERA I and II combined, H1-ZEUS combined charm production and H1 and ZEUS beauty production cross sections data sets in FFN scheme (FFNS). This FFNS QCD analysis attempts to exactly separate the role and influence of the strong coupling $\alpha_s(M_Z^2)$ as an important phenomenological parameter from contribution of the heavy-flavor data in determination of PDFs shape, fit-quality and improvement of the uncertainty bands of PDFs. To reach this goal we use two different scenarios. At the first scenario we fix the strong coupling value and determine the PDFs based on the heavy-flavor data only. In the second scenario we determine the same PDFs based on the heavy-flavor data plus the strong coupling as an extra QCD parameter.

Early Consideration:

Yes

Graduate Student:

Future Facilities / 106

Analysis and systematics of KATRIN: from Krypton calibration to Tritium beta decay

Author: Larisa Thorne[1]

[1] *Carnegie Mellon University*

Corresponding Author: lthorne@andrew.cmu.edu

The Karlsruhe Tritium Neutrino (KATRIN) experiment aims to make a precision measurement of the effective neutrino mass by leveraging the kinematics of tritium beta decay, with a sensitivity of 0.2eV (90% C.L.). Recent run campaigns, both in standard mode (using molecular Tritium) and calibration mode (using ^{83m}Kr) operation, have provided a wealth of data. The models which we use to fit these data include information about the decay physics, and is convolved with a response function, which encodes details of the experimental setup into the model. In order to achieve the design sensitivity levels, our understanding of systematics must be under control. To this end, we explore KATRIN systematics and their effects on certain model fit parameters. A summary of preliminary results will be given here, as well as an outlook to both the immediate and extended future.

*Primary support for CMU participation in KATRIN is provided by the U.S. Department of Energy Office of Science, Office of Nuclear Physics, under award number DE-SC0019304

Early Consideration:

No

Graduate Student:

Yes

Hadron Spectroscopy / 47

Light Hadron Spectroscopy at BESIII

Author: Huanhuan Liu[1]

[1] *Institute of High Energy Physics, CAS*

Corresponding Author: hhliu@ihep.ac.cn

The BESIII has collected 1.3 billion J/ψ and 478 million ψ events from 2009 to 2016 (10 billion J/ψ now). The huge sample provides an ideal platform for light hadron spectroscopy research. In this talk, we shall introduce four recent analyses on light hadron spectroscopy at BESIII. They are related to glueball candidates, e.g. $\eta(1405)$, $f_0(1710)$ and $X(1835)$.

Early Consideration:

Yes

Graduate Student:

No

Fundamental Symmetries / 54

The Heavy Photon Search Experiment at JLab

Author: Maurik Holtrop[1]

[1] *University of New Hampshire*

Corresponding Author: maurik@physics.unh.edu

The Heavy Photon Search (HPS) experiment at Jefferson Lab is searching for a new $U(1)$ vector boson ("heavy photon", "dark photon" or A') in the mass range of 20-500 MeV/c^2. An A' in this mass region is natural in hidden sector models of light, thermal dark matter. The A' couples to the ordinary photon through kinetic mixing, which induces its coupling to electric charge. Since heavy photons couple to electrons, they can be produced through a process analogous to bremsstrahlung, subsequently decaying to an e^+e^- pair, which can be observed as a narrow resonance above the dominant QED trident background. For suitably small couplings, heavy photons travel detectable distances before decaying, providing a second signature. HPS accesses unexplored regions in the mass-coupling parameter space.

The experiment uses the CEBAF electron beam located at Jefferson Lab to accelerate electrons which are then incident on a thin tungsten target. The outgoing e^+e^- pair is detected in a compact, large acceptance forward spectrometer consisting of a silicon vertex tracker and lead tungstate electromagnetic calorimeter.

HPS conducted successful engineering runs in the spring of 2015 using a 1.056 GeV, 50 nA beam and in the spring of 2016 using a 2.3 GeV, 200 nA beam, and is readying an upgraded detector for an extended physics run for summer 2019. This talk will present the results of the 2015 run, preliminary results of the 2016 run, and prospects for the 2019 run.

Early Consideration:

No

Graduate Student:

No

Meson-Nucleon Interactions / 101

Pion-pion scattering and the timelike pion form factor from Lattice QCD

Author: Ben Hoerz[None]

Corresponding Author: hoerz@physik.hu-berlin.de

The pion-pion scattering amplitude is required for the calculation of the pion form factor in the time-like region from Lattice QCD. We present results from a recent lattice calculation of both quantities and discuss their impact on the lattice determination of the hadronic vacuum polarization contribution to $(g-2)_\mu$. These results pave the way towards computing the more complicated Delta transition form factors from lattice QCD.

Early Consideration:

No

Graduate Student:

No

Fundamental Symmetries / 56

Hadronic Corrections to Muon Anomalies

Author: Franziska Hagelstein[1]

[1] *AEC, Uni Bern*

Corresponding Author: hagelstein@itp.unibe.ch

In this talk, I will discuss two topics:

1. The Schwinger sum rule as a new data-driven dispersive approach for the evaluation of hadronic corrections to the muon g-2.
2. Proton-polarizability effects in muonic hydrogen using baryon chiral perturbation theory.

Early Consideration:

Graduate Student:

Hadron Spectroscopy / 4

DK interaction as a doorway to manifestily exotic mesons

Author: Lisheng Geng[1]

[1] *Beihang University*

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

In recent years, it is found that many of the newly discovered states cannot easily fit into the naïve quark model. Because some of them are located close to two body thresholds, they have been conjectured as molecular states. We propose that one way to unambitiously test such a picture is going to few body (greater than two) systems while the building blocks are the two body subsystems. The DK/DDK/DDDK systems provide one of the be best playground for testing our proposal.

The Ds0*(2317) is widely accepted as a DK molecule. Its existence indicates that the DK interaction is attractive and strong enough to form a bound state. A natural question is then whether the system will still bind with one or more D mesons added. In a series of recent works, we explored such possibilities and showed that the DDK three-body molecular state exists, with a mass around 4140 MeV and a width of about 10 MeV. Due to the doubly charmed and doubly charged nature, such a state is explicitly exotic. We have also performed a preliminary study of the strong decay of the DDK state and the existence of a DDDK molecule. In this talk, I will report on these studies.

References:
1309.4743
1707.03802
1805.08330
1809.01059

Early Consideration:

Yes

Graduate Student:

Meson-Nucleon Interactions / 88

A first measurement of antikaonic deuterium atoms to study strong interaction

Author: Johann Zmeskal[1]

[1] *Stefan Meyer Institute for Subatomic Physics*

Corresponding Author: johann.zmeskal@oeaw.ac.at

Antikaon hydrogen atoms offer an ideal framework to study strong-interaction processes, allowing to perform experiments at vanishing relative energies between the antikaon and the nucleon, which will give access to the basic low-energy parameters, like the antikaon-nucleon scattering lengths. The antikaon hydrogen reaction is well understood from the recent results obtained from KpX at KEK, DEAR and finally from SIDDHARTA at DAFNE, along with theoretical calculations based on these results.
The importance of antikaon deuterium atom X-ray spectroscopy has been well recognized, no experimental results have yet been obtained due to the difficulty of the X-ray measurement. The kaonic deuterium measurement, is indeed needed to disentangle the isoscalar and isovector complex scattering length, shedding light on the antikaon-neutron interaction, long-awaited by theory.
The planned antikaon deuterium experiment at Laboratori Nazionali di Frascati (Italy) and at the Japan Proton Accelerator Research Complex (J-PARC, Japan) will be described, including first test measurements at J-PARC with the new developed X-ray spectroscopy device.

Early Consideration:

Graduate Student:

Hadron Spectroscopy / 43

Spectroscopy from the lattice: the scalar glueball and K-pi scattering

Author: Ruairí Brett[1]

[1] *Carnegie Mellon University*

Corresponding Author: rbrett@andrew.cmu.edu

Lattice calculations allow us to probe the low-lying, non-perturbative spectrum of QCD using first principles numerical calculations. Here we present the low-lying spectrum in the scalar sector with vacuum quantum numbers, including in fully dynamical QCD for the first time the mixing between glueball, q-qbar, and meson-meson states.

As lattice calculations are necessarily restricted to finite-volume, we want to connect the spectrum of QCD in a cubic volume to infinite-volume resonance parameters. For this, we apply Lüscher's formalism for relating stationary state energies in finite-volume to the infinite-volume scattering matrix to elastic K-pi scattering, where the partial wave mixing induced by the finite-volume is included for $\ell < 3$.

Early Consideration:

No

Graduate Student:

Yes

Meson-Nucleon Interactions / 58

ωN scattering length from ω photoproduction on the proton near the threshold

Author: Takatsugu Ishikawa[1]

[1] *Research Center for Electron Photon Science, Tohoku University*

Corresponding Author: ishikawa@lns.tohoku.ac.jp

The ω meson is one of the important particles to describe the nucleon-nucleon interaction. Nevertheless, scattering between the omega meson and nucleon is not well established. Recently we have performed high precision photoproduction experiment of the ω meson from the proton near the threshold. The total cross sections are determined at incident energies ranging from 1.08 to 1.15 GeV. The 1/2 and 3/2 spin-averaged scattering length $a_{\omega N}$ and effective range $r_{\omega N}$ between the ω meson and nucleon are extracted from the excitation function of the total cross section using a model with final-state ωN interaction based on the Lippman-Schwinger equation. The obtained values suggest strong repulsion. We discuss the excitation function of the total cross section for the $\gamma p \to \omega p$ reaction and the ωN scattering parameters in this talk.

Reference: arXiv:1904.02797 (2019).

Early Consideration:

Yes

Graduate Student:

No

Fundamental Symmetries / 92

Measurement of the Neutron Lifetime with Magnetically-Levitated Ultracold Neutrons

Author: Steven Clayton[1]

[1] *Los Alamos National Laboratory*

Corresponding Author: sclayton@lanl.gov

An unbound neutron decays via the weak interaction into a proton, electron, and antineutrino with a lifetime τ_n of approximately 15 minutes. Within the Standard Model of particle physics, τ_n is precisely related to two other parameters, the nucleon axial form factor g_A and the CKM matrix element V_{ud}. Thus, measurements of two of these parameters determines the third, or precise measurements of all three serves as a test for beyond Standard Model physics. Also, τ_n is an input to models of big bang nucleosynthesis where it impacts primordial abundance of light elements. Most of the recent measurements of τ_n have employed ultracold neutrons (UCN), which are neutrons with extremely small kinetic energy which undergo total external reflection from material surfaces. In these experiments, UCN are confined to a bottle and the number of survivors are counted after prescribed holding periods to determine a characteristic storage time τ_s. The free neutron lifetime τ_n is then found by applying corrections for the finite loss probability when a UCN bounces from the material wall. The difference between τ_s and τ_n has been typically much larger than the final quoted uncertainty in τ_n, demanding very good understanding of the extrapolation to effectively infinite storage volume. To overcome systematic uncertainties of material bottle experiments, the "UCNtau" experiment uses an array of permanent magnets to repel UCN from the bottle surface, avoiding material interactions altogether. The recent result from the UCNtau experiment, with overall uncertainty matching that of the previous most-precise experiment, will be discussed in this talk, along with prospects for further improvement to the τ_n measurement.

Early Consideration:

No

Graduate Student:

No

Hadron Spectroscopy / 16

Measurement of the Photon Beam Asymmetry Σ for $\gamma + p \rightarrow K^+\Sigma^0$ at E_γ = 8.5 GeV in GlueX

Authors: Nilanga Wickramaarachchi[1]; Moskov Amaryan[1]

[1] *Old Dominion University*

Corresponding Author: nwick001@odu.edu

We present measurements of the photon beam asymmetry Σ for the reaction $\gamma p \rightarrow K^+\Sigma^0$(1193) using the GlueX experiment in Jefferson Lab's Hall D. Data were collected using a linearly polarized photon beam with energy range 8.2-8.8 GeV incident on a liquid hydrogen target. Asymmetries are measured as functions of Mandelstam variables t and u. These are the first exclusive measurements of the photon beam asymmetry Σ in this reaction at high energies. In the t-channel, results show that the reaction is dominated by the natural-parity exchange of presumably the $K^*(892)$ meson, as predicted by theoretical models. Results obtained for the u-channel are consistent with an intermediate baryon exchange mechanism predicted by theoretical models.

Early Consideration:

No

Graduate Student:

Yes

Meson-Nucleon Interactions / **2**

Multiple-particle interaction in 1 + 1 dimensional lattice model

Author: Peng Guo[1]

Co-author: Tyler Morris [1]

[1] *California State University Bakersfield*

Corresponding Author: tmorris5@csub.edu

Finite volume multiple-particle interaction is studied in a two-dimensional complex ϕ^4 lattice model. The existence of analytical solutions to the ϕ^4 model in two-dimensional space and time makes it a perfect model for the numerical study of finite volume effects of multi-particle interaction. The spectra from multiple particles are extracted from the Monte Carlo simulation on various lattices in several moving frames. The S-matrix of multi-particle scattering in ϕ^4 theory is completely determined by two fundamental parameters: single particle mass and the coupling strength of two-to-two particle interaction. These two parameters are fixed by studying single-particle and two-particle spectra. Due to the absence of the diffraction effect in the ϕ^4 model, three-particle quantization conditions are given in a simple analytical form. The three-particle spectra from simulation show remarkable agreement with the prediction of exact solutions.

Early Consideration:

No

Graduate Student:

No

Fundamental Symmetries / **98**

Search for octupole-deformed nuclei for enhancement of sensitivity to atomic EDM in Ramsey-type measurements.

Author: Umesh Silwal[1]

Co-authors: Prajwal Mohanmurthy [2]; Durga P. Siwakoti [1]; Jeff A. Winger [1]

[1] *Mississippi State University*

[2] *LNS, Massachusetts Institute of Technology*

Corresponding Author: us35@msstate.edu

Observed baryon asymmetry of the universe (BAU) cannot be explained by the known sources of charge-parity (CP)-violation in the Standard Model (SM). A non-zero permanent electric-dipole-moment (EDM) of fundamental particles, nuclei or atoms, violates CP. Measuring an EDM definitively allows us to gain a handle on additional sources of CP-violation required to explain the observed BAU. EDM of an atom with a octupole and quadrupole deformed nucleus which are characterized by the terms β3 and β2, respectively, is enhanced. Therefore, the search for such atoms has become important. We have performed a global survey from the list of octupole deformed nuclei predicted in different calculations including Density Functional Theory (DFT), Skyrme, and Hartree-Fock (HF) plus Bardeen-Cooper-Schieffer (BCS). Our search of long-lived, spin-half ground state nuclei with β3,2 >0.1 results in a handful of viable candidate nuclei for future atomic EDM experiments based out of the Facility for Rare Isotope Beams (FRIB). We will present inconsistencies between the theory calculations and measurements, along with highlighting the lack of measurement for certain suspect deformed nuclei. Furthermore, the EDM enhancement in each of these nuclei will be tabulated.

Early Consideration:

No

Graduate Student:

Yes

Meson-Nucleon Interactions / 109

Photoproduction of Baryon-anti-Baryon Pairs at GlueX.

Authors: Hao Li[1]; Reinhard Schumacher[1]

[1] *Carnegie Mellon University*

Corresponding Author: hl2@andrew.cmu.edu

Baryon-anti-baryon photoproduction has not been extensively studied at Jefferson Lab energies. At the GlueX Experiment, we observe $\bar{p}p$ and, for the first time, $\overline{\Lambda}\Lambda$ photoproduction (with $\Lambda \to \pi^- p, \overline{\Lambda} \to \pi^+ \overline{p}$) from threshold up to $E_\gamma = 11.4$ GeV. Preliminary spectra from data accumulated during the GlueX Phase-I period will be presented. Angular distributions of the photoproduced hyperons indicate that more than one production mechanism exists in the reaction channel $\gamma p \to p\Lambda\bar{\Lambda}$. A tree-level Monte Carlo model with four mechanisms, tested through comparison between simulation and experimental data, will also be presented. The further goal of the study is to investigate the angular momentum structure of strangeness production through the study of spin correlations between the Λ hyperons. Using linearly polarized photons peaking near 9.0 GeV, observables such as the beam spin asymmetry can be studied. The status of beam spin asymmetry spectra for this channel will be discussed.

Early Consideration:

Yes

Graduate Student:

Yes

Hadron Spectroscopy / 81

Recent results on hyperons and charmed baryons at Belle

Author: Shohei Nishida[1]

[1] *KEK*

Corresponding Author: sumihama@rcnp.osaka-u.ac.jp

The large data sample accumulated by the Belle experiment at KEKB asymmetric energy e^+e^- collider provides opportunities
to study hyperons and charmed baryons.
In this presentation, we report recent measurements on these topics from Belle,
including absolute branching fractions of Ξ_c and an observation of new excited Ω^-.

Early Consideration:

No

Graduate Student:

No

Electroweak Probes / 118

Quark Wigner distributions of kaon using light-cone quark model

Authors: Satvir Kaur[1]; Harleen Dahiya[None]

[1] *Dr. B. R. Ambedkar National Institute of Technology, Jalandhar*

Corresponding Author: dahiyah@nitj.ac.in

We study the quark and anti-quark Wigner distributions of kaon in light-cone quark model. Wigner distributions are evaluated by using overlap representation of light-cone wavefunctions. Specifically, we investigate the Wigner distributions of unpolarized and longitudinally-polarized quark and anti-quark in unpolarized kaon in impact-parameter space and momentum space.

Early Consideration:

No

Graduate Student:

No

Meson-Nucleon Interactions / 83

The "K^-pp" system investigated with a fully coupled-channel Complex Scaling Method

Author: Akinobu Dote[1]

Co-authors: Takashi Inoue [2]; Takayuki Myo [3]

[1] *KEK theory center*

[2] *Nihon University, College of Bioresource Sciences*

[3] *Osaka Institute of Technology*

Corresponding Author: dote@post.kek.jp

The K^-pp is the most essential system of kaonic nuclei, which are expected to be a doorway to dense matter due to the strong $\bar{K}N$ attraction [1]. To clarify the nature of K^-pp, theorists have investigated this three-body system with various approaches for a long time [2]. Those theoretical studies have indicated that the K^-pp should be a resonant state of a meson-baryon-baryon coupled-channel system. Thus, we have developed a coupled-channel complex scaling method (ccCSM), because it can deal with both resonance and coupled-channel aspects of the K^-pp correctly and it can provide us with the wave function to reveal the nature of K^-pp in detail. A few years ago, we accomplished fully coupled-channel CSM calculations (Full ccCSM), in which all meson-baryon-baryon channels coupling to the K^-pp state, $\bar{K}NN$, $\pi\Sigma N$, and $\pi\Lambda N$, are explicitly treated.
Based on our studies with Full ccCSM using a phenomenological $\bar{K}N$ potential [3] and a chiral-theory based one [4], we will report the nature of the K^-pp resonance and discuss on the comparison with experimental results, in particular, the latest result of J-PARC E15 experiment [5]. Furthermore, we will show some results of a semi-relativistic version of our calculation, which is undergoing. Such a treatment should be better for pions which appear in the decay of K^-pp, and it is expected to give influence to the decay width in our calculation.
[1] Y. Akaishi and T. Yamazaki, Phys. Rev. C 65, 044005 (2002).
[2] A. Gal, E. V. Hungerford and D. J. Millener, Rev. Mod. Phys. 88, 035004 (2016).
[3] A. Dote, T. Inoue and T. Myo, Phys. Rev. C 95, 062201(R) (2017).
[4] A. Dote, T. Inoue and T. Myo, Phys. Lett. B784, 405 (2018).
[5] S. Ajimura et al. (J-PARC E15 collaboration), Phys. Lett. B789, 620 (2019).

Early Consideration:

No

Graduate Student:

No

Hadron Spectroscopy / 84

Photoproduction of Ξ Baryons at GlueX

Author: Ashley Ernst[1]

[1] *Florida State University*

Corresponding Author: ace15f@my.fsu.edu

Understanding the nature of the baryon spectrum will provide useful insight of quantum chromodynamics in the non-perturbative regime. Significant progress has been made in the N^* regime, but little is known about doubly-strange hyperons. Most knowledge of the Cascade baryons stems from Kaon-nucleon experiments from the 1960s and 1970s or the more recent CLAS experiment at Jefferson Lab. This research studies these doubly-strange baryons via photoproduction using the GlueX experiment at Jefferson Lab. The Cascade octet ground state Ξ^- can be studied by exclusive t-channel process in the reaction $\gamma p \to KY^* \to K^+(\Xi^- K^+)$ with the subsequent decay of the Ξ^- into $\Lambda\pi^-$. The model suggests the intermediate hyperon Y^* is broad and possibly consists of overlapping states. To better understand the production mechanism, the cross section for Ξ^- is studied and extends the energies of the recently published cross section from CLAS g12. GlueX utilizes a linearly polarized photon beam which allows access to a quasi-two-body beam asymmetry ($\gamma p \to KY^*_\Xi$). The quasi-two-body beam asymmetry provides information about the t-channel exchange producing the intermediate hyperon. With GlueX Phase-I data taking concluded, preliminary results of the Cascade baryon spectrum are presented.

Early Consideration:

No

Graduate Student:

Yes

Electroweak Probes / 107

A percent-level determination of the nucleon axial coupling from Quantum Chromodynamics.

Author: Henry Monge Camacho[1]

Co-author: André Walker-Loud [2]

[1] *UNC at Chapel Hill*

[2] *Lawrence Berkeley National Laboratory*

Corresponding Author: hjmonge@ad.unc.edu

The nucleon axial charge g_A, measures the strength of the coupling of the axial current of the standard model to the nucleon, controlling the rate of beta decay, for example. A determination of g_A directly from QCD is complicated by the non-perturbative nature of QCD, but is important for benchmarking the application of lattice QCD to problems in nuclear physics, and for aiding in precision tests of the standard model. I will present the first per-cent-level determination of g_A using lattice QCD, which was made possible through the use of an unconventional computing strategy inspired by the Feynman-Hellmann Theorem. I will summarize the robustness of our result to all systematic variations that arise in the lattice QCD calculation. Our published result is $g_A^{QCD} = 1.2711(13)$.

Early Consideration:

No

Graduate Student:

No

Hadron Spectroscopy / 50

$K^+\Lambda$ Photo- and Electroproduction off Proton

Authors: Dalibor Skoupil[None]; Petr Bydzovsky[1]

[1] *Nuclear Physics Institute, Czech Academy of Sciences, Rez/Prague, Czech Republic*

Corresponding Author: d.skoupil@seznam.cz

New models for photo- and electroproduction of kaons on the proton were constructed [1,2,3] utilizing new experimental data from LEPS, GRAAL, and particularly CLAS collaborations. Higher spin nucleon (spin-3/2 and spin-5/2) and hyperon (spin-3/2) resonances were included using the consistent formalism and were found to play an important role in the description of data. In these analyses, we paid close attention to model predictions of the cross section at small kaon angles which are vital for accurate calculations of the hypernucleus-production cross section.

In order to account for the unitarity corrections at the tree level, we have introduced energy-dependent widths of nucleon resonances, which affect the choice of hadron form factors and the values of their cutoff parameters extracted in the fitting procedure.

On the road to electroproduction, we have implemented a new shape of electromagnetic form factors [4]. We have found out that for a reliable description of $K^+\Lambda$ electroproduction at small Q^2 it is necessary to take into account also a longitudinal coupling of virtual photons to nucleon resonances.

For the investigation of kaon photoproduction off the proton target, we have exploited also the hybrid Regge-plus-resonance (RPR) model [3] which provides an acceptable description of data in and above the resonance region. A novel feature of our version of the RPR model consists in applying a different scheme for the gauge-invariance restoration [5], which results in a need for a contact current. We reveal that the choice of the gauge-invariance restoration method may play a significant role for cross-section predictions at forward angles where data are scarce.

The sets of chosen nucleon resonances in our recent models are mutually quite well consistent and they also greatly overlap with the set selected in the Ghent analysis [6].

[1] D. Skoupil, P. Bydžovský, Phys. Rev. C 93, 025204 (2016).

[2] D. Skoupil, P. Bydžovský, Phys. Rev. C 97, 025202 (2018).

[3] P. Bydžovský, D.~Skoupil, arXiv:1903.02292.

[4] E. L. Lomon, Phys. Rev. C 66, 045501 (2002).

[5] H. Haberzettl et al., Phys. Rev. C 92, 055503 (2015).

[6] L. De Cruz et al., Phys. Rev. Lett. 108, 182002 (2012).

Early Consideration:

No

Graduate Student:

No

Electroweak Probes / 105

Improving our understanding of the axial structure of the nucleon with lattice QCD: a march towards relevancy

Author: André Walker-Loud[1]

[1] *Lawrence Berkeley National Laboratory*

Corresponding Author: walkloud@lbl.gov

Following on our recent per-cent-level determination of g_A, I will describe our efforts to reduce the theoretical uncertainty from 1% to 0.2%, a level at which we will have a 4-sigma discriminating prediction of the neutron lifetime, to match the level of precision of the current experimental discrepancy. I will describe the challenges that must be overcome and our progress to doing so using the new pre-exascale super computers. I will also describe our new calculations of the axial form factor. Providing a standard model prediction for this form factor will improve the prospects of the neutrino beam experiments identifying sources of new physics, including the CP-violating phase of the neutrino mixing matrix (PMNS matrix).

Early Consideration:

Graduate Student:

Meson-Nucleon Interactions / 78

Global analysis of the Delta(1232) contribution in the pion photo-production off nucleons

Authors: Gustavo Guerrero-Navarro[1]; M. J. Vicente Vacas[1]

Co-authors: Astrid N. Hiller Blin [2]; De-Liang Yao [3]

[1] *IFIC-UV*

[2] *Institut fuer Kernphysik, J.G. Universität, Mainz*

[3] *Institute of Modern Physics, Chinese Academy of Sciences*

Corresponding Author: gustavo.guerrero@ific.uv.es

We study the effects of the Δ(1232) resonance as an effective degree of freedom in a global analysis of the pion photo-production off nucleons. Cross sections and polarization observables have been calculated for charged and neutral pion channels in relativistic chiral perturbation theory up to third order in the δ counting. We compare our model with a large database containing the available experimental data. This allows us to strongly constrain some little known low-energy constants and even see the effect of those that are still unknown. We find that the Δ(1232) inclusion leads to an improved convergence of the chiral series. Finally, we compare our results with the low-energy constants previously determined in related calculations such as nucleon EM form factors, axial charged current and the EM Δ(1232) decay.
Our aim is to use these values for low-energy constants as inputs for further calculations involving electromagnetic and weak interactions for hadron processes in order to have a more complete and accurate description at the low energy regime of the hadronic physics.

Early Consideration:

No

Graduate Student:

Yes

Menu-2019 Plenary / 10

Newly completed JLab experiment (E12-17-003): Determine the unknown Λn interaction by investigating the possible Λnn resonance

Author: Liguang Tang[1]

[1] *Hampton University/JLab*

Corresponding Author: tangl@jlab.org

The newly completed JLab experiment E12-17-003 aimed to search for a possible Λnn resonance using the $^3H(e,e'K^+)$(Λnn) reaction. If such a state does exist, the experiment will measure its binding (or excitation) energy and natural width. These measurements will provide extremely important and experimentally determined information, for the first time, that can be used to investigate the unknown Λn interaction.

Direct ΛN scattering data is extremely important and needed based on the newly confirmed Charge-Symmetry-Breaking (CSB) at a level of 270keV from the binding energy difference observed between ground states of ^4He and ^4H. Especially, the Λn data does not exist at all, thus the properties of Λn interaction has been assumed to be identical to that of Λp interaction. The resonance of Λnn

system can provide a unique and only experimental data that can be used to determine the unknown properties of Λn interaction.

The presentation will give an overview of the physics motivation of the JLab experiment, the experimental technique, and the most updated analysis results which although may still be preliminary.

Early Consideration:

No

Graduate Student:

No

Menu-2019 Plenary / 52

Spin structure of heavy-quark hybrids

Author: Jaume Tarrus Castella[1]

[1] *IFAE (Universitat Autonoma de Barcelona)*

Corresponding Author: jaumetarrus@gmail.com

A unique feature of QCD is the possibility for gluonic degrees of freedom to participate in the construction of hadrons in an analogous manner to valence quarks. The unambiguous identification of such states has been thus far not possible. Heavy hybrids are particularly promising because in the heavy-quark sector systematic tools can be used that are not available in the light-quark sector. In this talk we review recent developements in nonrelativistic EFTs to describe heavy hybrids and in particular recent results on the spin structure up to $1/m^2$-terms in the heavy-quark-mass expansion. We determine the nonperturbative contributions to the matching coefficients of the EFT by fitting our results to lattice-QCD determinations of the charmonium hybrid spectrum and extrapolate the results to the bottomonium hybrid sector where lattice-QCD determinations are still challenging.

Early Consideration:

No

Graduate Student:

No

Menu-2019 Plenary / 31

Search for Electric Dipole Moment of Charged Particles in Storage Rings

Author: Paolo Lenisa[1]

[1] *University of Ferrara and INFN*

Corresponding Author: lenisa@fe.infn.it

The Electric Dipole Moment (EDM) of elementary particles, including hadrons, is considered as one of the most powerful tools to study CP-violation beyond the Standard Model. Such CP-violating mechanisms are searched for to explain the dominance of matter over anti-matter in our universe.
Up to now EDM experiments concentrated on neutral systems, namely neutron, atoms and molecules. Storage rings offer the possibility to measure EDMs of charged particles by observing the influence of the EDM on the spin motion.
A step-wise approach starting with a proof-of-principle experiment at the existing storage ring Cooler Synchrotron COSY at Forschungszentrum Jülich, followed by an electrostatic prototype ring allowing for a simultaneous operation of counter circulating beams in order to cancel systematic effects, to the design of a dedicated 500 m circumference storage ring will be presented.

Early Consideration:

No

Graduate Student:

No

Menu-2019 Plenary / 24

Nucleon-to-resonance form factors at large photon virtualities

Author: Jorge Segovia[1]

[1] *Pablo de Olavide University*

Corresponding Author: jsegovia@upo.es

Nonperturbative quantum chromodynamics poses significant challenges. Primary amongst them is a need to chart the behaviour of QCD's running coupling and masses into the domain of infrared momenta. Contemporary theory is incapable of solving this problem alone but a collaboration with experiment holds a promise for progress. This effort can benefit substantially by exposing the structure of nucleon excited states and measuring the associated transition form factors at large momentum transfers. Large momenta are needed in order to pierce the meson-cloud that, often to a significant extent, screens the dressed-quark core of all baryons; and it is via the Q^2-evolution of form factors that one gains access to the running of QCD's coupling and masses from the infrared into the ultraviolet.

We present a unified QCD-based description of elastic and transition form factors involving the nucleon and its resonances. We compare predictions made using a framework built upon a Faddeev equation kernel and interaction vertices that possess QCD-like momentum dependence with results obtained using a confining, symmetry-preserving treatment of a vector $\otimes$ vector contact-interaction in a widely-used leading-order (rainbow-ladder) truncation of QCD's Dyson-Schwinger equations. This comparison explains that the contact-interaction framework produces hard form factors, curtails some quark orbital angular momentum correlations within a baryon, and suppresses two-loop diagrams in the elastic and transition electromagnetic currents. Such defects are rectified in our QCD-based approach and, by contrasting the results obtained for the same observables in both theoretical schemes, shows those objects which are most sensitive to the momentum dependence of elementary quantities in QCD.

Early Consideration:

Graduate Student:

Menu-2019 Plenary / 87

Conference Summary

Author: Eric Swanson[1]

[1] *University of Pittsburgh*

Corresponding Author: swansone@pitt.edu

This talk will give an overview of the highlights of the MENU-2019 Conference.

Early Consideration:

No

Graduate Student:

No

93

The role of X(4140) and X(4160) in the reactions of B+ to Jpsi phi K and e+e- to Jpsi phi gamma

Authors: En Wang[1]; Ju-Jun Xie[None]; Lisheng Geng[2]

[1] *Zhengzhou University*
[2] *Beihang University*

Corresponding Author: wangen@zzu.edu.cn

.

Early Consideration:

No

Graduate Student:

No

Future Facilities / **22**

Searching for light dark matter at accelerators

Author: Mauro Raggi[1]

[1] *Sapienza University Roma*

Corresponding Author: mauro.raggi@lnf.infn.it

Understanding the nature of dark matter is crucial in modern physics.
Among the different possibilities, the idea that dark matter could be con-
ned into a 'dark sector' is attracting growing interest in recent years.
A combination of different standard model anomalies can be solved by
introducing a mediator particle with mass lower than the weak scale, connecting the dark sector to the standard model.

We will focus our attention on the dark photon hypothesis, reviewing the experimental status and future prospects of dark photon searches, with particular attention to the PADME experiment at Laboratori Nazionali di Frascati.

Early Consideration:

No

Graduate Student:

No

14

A review of recent progress in the dibaryon sector

Author: Mikhail Bashkanov[1]

[1] *University of York*

Corresponding Author: mikhail.bashkanov@york.ac.uk

The field of multiquark states has been catalyzed in recent years by new experimental and theoretical advances relating to four, five and six quark systems. Significant recent progress has been made in the 6q sector (referred to as the dibaryons or hexaquarks). The existence of dibaryons based on six non-strange quarks has been postulated from theoretical studies based on SU(6) symmetry, with the earliest work by Dyson and Xoung in the 1960's. Recent results based on perturbative quark based models and the developing lattice-QCD calculations are leading to a significant improvement in our understanding of di-baryonic physics.

On the experimental side significant information has been obtained from hadronic beams (CELSIUS, COSY, GSI). The dibaryon sextet has been investigated via a number of final states, with information on the isotensor dibaryon and setting limits on isospin I=3 state obtained only last year.

Electromagnetic probes have the potential to provide new information and a deeper insight into dibaryonic physics. The latest results from the ELPH and MAMI facilities confirm the feasibility of dibaryon production in photo-induced reactions. The clean and controlled environment of electromagnetic beams may enable the size and internal structure of di-baryonic states to be elucidated. Such programmes may also enable important constraints on N-N* interaction dynamics – extending our knowledge of the nucleon-nucleon interaction beyond the ground state interactions.

The potential role of di-baryonic states in astrophysics has given recent added impetus to the programme. Recent theoretical works have indicated that the lightest dibaryons may have a significant impact on neutron star properties, influencing the equation of state, cooling mechanisms and maximum mass limits.

This talk will give an overview of all the recent scientific advances in the dibaryon sector along with some plans for the future direction of the programme.

Early Consideration:

No

Graduate Student:

No

23

Role of the N(1535) in the Lambda_c->K0bar eta p decay

Author: Ju-Jun Xie[None]

Co-author: Li-Sheng Geng

The nonleptonic weak decay of Lambda_c->K0bar eta p is analyzed from the viewpoint of probing the N(1535) resonance, which has a big decay branching ratio to eta N. Up to an arbitrary normalization, the invariant mass distribution of eta p is calculated with both the chiral unitary approach and an effective Lagrangian model. Within the chiral unitary approach, the N(1535) resonance is dynamically generated from the final-state interaction of mesons and baryons in the strangeness zero sector. For the effective Lagrangian model, we take a Breit-Wigner formula to describe the distribution of the N(1535) resonance. It is found that the behavior of the N(1535) resonance in the Lambda_c−>K0bar N(1535)>K0bar eta p decay within the two approaches is different. The proposed Lambda_c decay mechanism can provide valuable information on the properties of the N(1535) and can in principle be tested by facilities such as BEPC II and SuperKEKB.

Early Consideration:

Yes

Graduate Student: