

PWA8/ATHOS3 Book of Abstracts

April 13-17, 2015

Monday April 13

Michael Pennington

Monday 9:30am

Jefferson Lab

Why are we still doing hadron spectroscopy?

Answer because we still don't understand how strong coupling QCD really builds hadrons. Spectroscopy is teaching us this.

Curtis Meyer

Monday 10:00am

Carnegie Mellon University

Amplitude Analysis Plans for GlueX

A discussion of the current status of the GlueX experiment as well as a timeline to first physics results will be presented. Current plans within the collaboration for amplitude analysis will be presented.

Stephan Paul

Monday 11:00am

Technische Universität München

Meson Spectroscopy with COMPASS

Volker Burkert

Monday 11:30am

Jefferson Lab

Pion electroproduction and nucleon resonance transition form factors

I will present motivation and current status of experiments on exclusive single pion electroproduction in the nucleon resonance region. These data have been used over the past decade to determine precise electromagnetic transition form factors and helicity amplitudes for a number of lower mass states covering the $\Delta(1232)$ and the mass range of the three states that are part of the 2nd nucleon resonance region. I will discuss the results and what we have learned about the resonance structure from these data. I will also present new results on some higher mass states that belong to the 3rd resonance region. Finally, I will give a brief outlook on cross section data and polarization asymmetries from JLab that will be released in 2015/2016, and on the prospects of studying nucleon resonances at the JLab 12 GeV CEBAF using the upgraded CLAS12 detector.

Craig Roberts
Argonne National Lab

Monday 12:00pm

Unified explanation of the nucleon, Delta and Roper resonances in continuum QCD

Dressed-quark and gluon masses run to large values in the infrared. This is a fundamental feature of strong-coupling QCD and has a measurable impact on hadron properties. That impact is expressed with particular force in the properties of nucleon resonances and nucleon to resonance transition form factors. This will be illustrated via a unified analysis of the nucleon, the Delta and Roper resonances, and the associated nucleon-to-resonance transition form factors.

Bernd Krusche
University of Basel

Monday 1:30pm

Photoproduction of pions and eta-mesons off the neutron

Photoproduction of mesons has developed into a prime tool for the study of the excitation spectrum of the nucleon. The last years have seen a huge effort worldwide to study not only their cross sections but also different types of polarization observables of many $\gamma p \rightarrow xN$ (x some specified meson or pairs of mesons) so that solid data bases for tightly constrained coupled channel partial wave analyses were obtained. So far not even the primary data analysis of the abundant and precise results from e.g. the CLAS experiment at Jlab, the ELSA accelerator in Bonn, and the MAMI accelerator in Mainz is finished and the extraction of the partial waves will still need much more efforts.

A full classification of the nucleon resonances includes also the isospin structure of their electromagnetic excitations which requires measurements off the neutron (ideally, also of coherent photoproduction from light nuclei). Photoproduction of mesons off nucleons bound in light nuclei, in particular in the deuteron, is the only practical method to investigate the electromagnetic excitation spectrum of the neutron. The data base for such reactions is so far much more scarce than for reactions off the proton.

The measurements require a coincident detection of the recoil neutrons, the elimination of the effects from nuclear Fermi motion, and corrections for final state interaction (FSI) effects. The CLAS experiment at Jlab with its magnetic spectrometry is well suited for final states with charged particles and at most one neutral particle which can be reconstructed with missing mass methods. It is therefore well suited for reactions like $\gamma n \rightarrow p\pi^-$, but cannot much contribute to the production off neutral mesons off the neutron. However, among those are many very interesting final states (e.g. $n\pi^0$, $n\eta$, $n\eta'$, $n\omega$, $n\pi^0\pi^0$, $n\pi^0\eta$,...). These reaction can be much better studied with the almost 4π covering electromagnetic calorimeters used at the ELSA accelerator in Bonn (Crystal Barrel/TAPS at ELSA) and the MAMI accelerator in Mainz (Crystal Ball/TAPS), which are optimized for the detection of photons and neutrons. Both experiments have a very active program on this topic and much progress has been made during the last few years. The effects from nuclear Fermi motion can be removed by a full kinematic reconstruction of the final states, FSI effects can be estimated to some extend by the comparison of the results for measurements off free protons and quasi-free protons bound in the deuteron. First interesting results for total and differential cross sections have been recently published for the final states mentioned above. For the $N\pi^0\pi^0$ and $N\pi^0\pi^\pm$ final states also beam-helicity asymmetries (circularly polarized beam, unpolarized target) are available. Data for other (single and double) polarization observables (e.g. T,E,F, circularly polarized beam, longitudinally or transversely polarized targets) for $n\pi^0$, $n\eta$, $n\pi^0\pi^0$... are currently under analysis and measurements of further polarization observables (also with linearly photon beams) are planned for the near future.

The recently published data on the $n\pi^0$ and $n\eta$ final states demonstrate clearly the importance of measurements with neutron targets. In case of single pion production cross section data for all other isospin channels ($p\pi^0$, $p\pi^-$, $n\pi^+$) were already available and since only three independent isospin amplitudes are involved this should be sufficient to fix the isospin structure completely. Nevertheless, different partial wave analyses predicted much different results for the $n\pi^0$ state and actually none of them agreed with the new $\gamma n \rightarrow n\pi^0$ data, which had significant impact on the isospin decomposition.

The data for η production off the neutron revealed a prominent, narrow (less than 50 MeV wide) structure in the excitation function around incident photon energies of 1 GeV (statistical significance beyond any doubts), which does not exist for the proton. Many different scenarios have been discussed for it. The recently published data on precise angular distributions and preliminary results for the helicity dependence ($\sigma_{1/2}$ and $\sigma_{3/2}$) measured with circularly polarized beam and longitudinally polarized target seem to indicate that the structure is related to the S_{11} partial wave.

Eugene Pasyuk

Monday 2:00pm

Jefferson Lab

η and η' Photoproduction Experiments on Protons

Much effort is dedicated to understanding nucleon structure through the study of its excitation spectrum. The challenge is the complexity of this spectrum composed of many overlapping states with a broad range of couplings to different decay modes. Of particular interest are reactions which allow to isolate certain states and consequently simplify the disentangling. η and η' photoproduction is an example of such reactions. They are both isospin singlets and therefore serve as isospin filter. They can be directly coupled to N^* but not to Δ resonances. An overview of the experiments and experimental data for these reactions are presented.

Hiroyuki Sako

Monday 2:30pm

Japan Atomic Energy Agency

Baryon spectroscopy with $(\pi, 2\pi)$ reactions at J-PARC E45

We have proposed an experiment E45 to study baryon excited states in $(\pi, 2\pi)$ reactions at J-PARC. Recent theoretical developments show the three-body reactions have significant contributions to production of baryon resonances with high mass. However, only 240k bubble chamber events were measured in 1970's. We aim at increasing the statistics by two orders utilizing with high rate pion beams of 10^6 Hz and large acceptance spectrometer with a TPC. The TPC has been designed to accept 10^6 Hz beam and the target is embedded in the TPC to maximize the acceptance. We show experimental design, simulation studies, and the status of detector development for the E45 experiment.

Eberhard Klempt

Monday 3:30pm

University of Bonn

What do we learn from the inclusion of photoproduction data into the multichannel excited baryon analysis?

How should we interpret the high-mass excitations of the nucleon? In the talk, new results from photoproduction will be discussed which shed light on the following issues:

The level ordering of negative and positive-parity resonances.

Is chiral symmetry restored in excited hadrons?

The *missing resonances* have been a prime motivation for studying photoproduction of mesons off nucleons. Several debated resonances have been found in photoproduction. We find evidence for the three-body nature of baryon resonances from their decays. Which resonances need to be found but are still missing?

Is baryogenesis, the hypothesis that excited hadrons should be interpreted as molecular states with low-mass hadrons as constituents, a convincing concept?

What can we learn from complete experiments?

Mark Manley

Monday 4:00pm

Kent State University

PWA of ηp and $K^+\Lambda$ Photoproduction

Single-energy partial-wave analyses of the reactions $\gamma p \rightarrow \eta p$ and $\gamma p \rightarrow K^+\Lambda$ are currently being performed at Kent State University. The single-energy partial waves are constrained by multi-channel energy-dependent fits that include amplitudes for πN elastic scattering, $\gamma N \rightarrow \pi N$, $\pi N \rightarrow \eta N$, $\pi N \rightarrow K\Lambda$, and quasi-two-body amplitudes for $\pi N \rightarrow \pi\pi N$. In this talk, preliminary results of the single-energy fits of various observables will be shown as well as Argand diagrams for the dominant partial waves. Resonance parameters will also be discussed for selected cases.

Alfred Švarc

Monday 4:30pm

Ruder Bošković Institute

Partial Wave and N^ Analysis with Analyticity*

In principle there are four ways to perform the partial wave analysis (PWA) in baryon sector: energy dependent single channel analysis (EDSC), energy dependent coupled channel analysis (EDCC), energy discretized single channel analysis (EDSSC) and energy discretized coupled channel analysis (EDSCC). For the first two analyses (ED group) it is essential to set up the elaborate model which is describing the physics reality, for the second two analyses (EDS group) some simplest ways of avoiding the multiplicity of solutions (continuum ambiguities) and imposing analyticity and unitarity are needed. The first approach is demanding because it requires solving elaborate physics models, fitting their parameters to the experimental data and analytic continuation into the complex energy plane. However, the second approach is also complicated because of different reasons: we have to impose quasi energy continuity, analyticity, unitarity and at the end we have to extract resonance signals as poles in the complex energy plane. And let us recall that for the last issue we had no really good solution until recently. It is important to stress that imposing the analyticity in both approaches is essential because it ensures the extrapolating of existing measurements into non-measured areas via analytic continuation. In the first set of approaches (ED group) the analyticity is imposed from the start, and if it is violated it is done because only of complexity of solving theoretical models. In

the second approach (EDS group) the analyticity has to be imposed otherwise. In this talk I shall discuss present status of all mentioned issues, and in more details discuss EDS group of models. I shall first pay the attention to discussing how the poles are extracted from a discrete set of numbers (all present approaches and new and checked Laurent+Pietarinen expansion in single channel case, but I shall also announce and discuss the essence of new, yet unpublished generalization of L+P approach to coupled-channel situation). Second, I shall discuss how the analyticity is introduced into EDS analyses with the special attention to almost forgotten fixed-t Karlsruhe-Helsinki method [1, 2] which is now to be applied in the MAID model [3].

References:

[1] G. Höhler, Pion Nucleon Scattering, Part 2, Landolt-Bornstein: Elastic and Charge Exchange Scattering of Elementary Particles, Vol. 9b (Springer-Verlag, Berlin, 1983).

[2] J. Stahov, <http://www.kph.uni-mainz.de/1066.php>

[3] <http://portal.kph.uni-mainz.de/MAID//maid2007/>

Lothar Tiator, Ron Workman

Monday 5pm

Mainz University, The George Washington University

Discussion on PDG issues for Baryons and Mesons

In this discussion session, we will present some plans for changes to the Baryon and Meson sections of the Review of Particle Physics. For a decade, the importance of pole positions and pole parameters has been stressed and discussed in many conferences and workshops. More in focus, recently, has been the model dependence of Breit-Wigner parameters, with the complex poles and residues of resonances emerging as the only fundamental quantities. Already, many groups active in baryon spectroscopy and partial wave analysis publish their results not only for the Breit-Wigner parametrization but also as complex pole positions and elastic and inelastic residues. We will propose rearrangements of the tables, the removal of most older entries from years prior to a set date, and introduce a whole new class of residues that should be determined in all analyses of the complex pole positions. In addition, we plan to discuss the star-rating system, requirements for entries in the tables, and the classification of results above and below the line. In the light meson sector the number of states recognized as resonances is too large compared to the quark model predictions. Understanding of their nature is often hampered by interference effects for broad scalar and tensor states. In the heavy meson sector there are also many states with unknown origin and of obviously exotic nature inconsistent with the plain quark-antiquark interpretation.

Tuesday April 14

Reinhard Beck

Tuesday 9:00am

University Bonn

Pion Photoproduction Experiments on Protons

Hartmut Schmieden

Tuesday 9:30am

Physikalisches Institut, University of Bonn

Photoproduction of Vector Mesons

Besides the rather well measured and analyzed pseudoscalar meson production channels, also vector-meson photoproduction is a reaction class important to disentangle nucleon and, more generally, baryonic excitations. Demanding Partial Wave Analyses – due to the very nature of the Spin 1 mesons – carry the promise to find hitherto unobserved states, and to improve our understanding of meson-nucleon dynamics and thus the internal structure of excited states. I will briefly review the current status of experiments and analyses, and present recent results and future prospects from ELSA.

Andrew Sandorfi

Tuesday 10:00am

Thomas Jefferson National Accelerator Facility

KY photoproduction and the potential for PWA from "complete" experiments

KY photoproduction and the potential for PWA from "complete" experiments A.M. Sandorfi Thomas Jefferson National Accelerator Facility Abstract. New complete experiments in pseudoscalar meson photo-production are being pursued at several laboratories. Here the designation of complete refers to measurements of most if not all of the possible reaction observables, of which there are 16 involving spins of the beam, target and recoil baryon. Hyperon production to Λ or Σ^+ final states affords attractive opportunities, since their weak decays provide an efficient self-analysis of their spin. PWA of published $K^+\Lambda$ photoproduction data have been used to study the uniqueness of solutions. Experiments with realistically achievable uncertainties require a significantly greater number of spin asymmetries than the in-principle minimum needed for a mathematical solution of the amplitude. Emerging data and their potential impact will be discussed.

Yannick Wunderlich

Tuesday 10:30am

HISKP, University of Bonn

Complete Experiments in pseudoscalar meson photoproduction

The investigation of the nucleon excitation spectrum has been an important experimental and theoretical task in the recent years. One of the most interesting reactions in this field is the production of mesons by impinging photons off a nucleon target. When only one pseudoscalar meson φ is produced in the reaction $\gamma N \rightarrow \varphi N$, 16 polarization observables (not completely independent) can be accessed via the spin degrees of freedom of the incident and final states.

A so called 'Complete Experiment' allows for the unambiguous extraction of the underlying amplitudes. It has been shown that at least 8 carefully selected observables have to be measured for this purpose. For a truncated partial wave expansion, fewer observables can be already sufficient. This presentation will discuss such truncated analyses with special focus on the influence of measurement uncertainties. Supported by the Deutsche Forschungsgemeinschaft (SFB/TR16).

Deborah Rönchen
HISKP, Bonn University

Tuesday 11:30am

The Jülich Partial-Wave Analysis

The hadronic resonance spectrum provides an important testing ground for theories of the strong interactions in the medium-energy regime, where a perturbative solution of QCD is not possible. In order to connect predictions of the baryon spectrum from quark models or lattice calculations to experimental data, different approaches have been developed over the time. Among those a framework especially suited for a simultaneous partial-wave analysis of multiple reactions with different initial and final states is given by the so-called dynamical coupled-channel models. The Jülich model is a dynamical coupled-channel approach which preserve unitarity and analyticity. The later is a prerequisite for the extraction of resonance parameters in terms of pole positions and residues. In this talk, I will give an introduction to the basic concepts of the approach and present recent results of a simultaneous study of several pion-induced reactions together with pion and eta photoproduction.

Hiroyuki Kamano
RCNP, Osaka University

Tuesday 12:00pm

ANL-Osaka PWA for light-quark baryon spectroscopy

I overview our recent efforts on determining the resonance parameters associated with light-quark hadrons by making use of the ANL-Osaka dynamical coupled-channels approach. I mainly focus on talking about the spectroscopy of light-quark baryon resonances ($N, \Delta, \Lambda, \Sigma$). Our activities for the meson spectroscopy would also be presented if time permitted.

Beijiang Liu (for BESIII collaboration)
Institute of High Energy Physics, Chinese Academy of Sciences

Tuesday 12:30pm

Baryon Resonance Production at BESIII

The BESIII detector and BEPCII accelerator represent major upgrades over the previous versions, BESII and BEPC; the facility is used for studies of hadron spectroscopy and τ -charm physics. The design peak luminosity of the double-ring e^+e^- collider, BEPCII, is $10^{33} \text{ cm}^{-2} \text{ s}^{-1}$ at a beam current of 0.93 A. . Since 2009, it has collected the world's largest data samples of J/ψ , $\psi(3686)$, $\psi(3770)$ and $\psi(4040)$ decays. These data are being used to make a variety of interesting and unique studies of light hadron spectroscopy precision charmonium physics and high-statistics measurements of D meson decays.

The J/ψ and ψ' experiments at BES provide an excellent place for studying excited nucleons and hyperons – N^* , Λ^* , Σ^* and Ξ^* resonances.

Complementary to other facilities, the baryon program at BES3 has several advantages . For instance, πN and $\pi\pi N$ systems from $J/\psi \rightarrow \bar{N}N\pi$ and $\bar{N}N\pi\pi$ processes have an isospin of 1/2 due to isospin conservation; ψ mesons decay to baryon-antibaryon pairs through three or more gluons, where is a favorable place for producing hybrid (qqqg) baryons, and for searching some "missing" N^* resonances which have weak coupling to both πN and γN , but stronger coupling to $g^3 N$.

In this presentation, we will report the partial wave analysis program of baryon spectroscopy at BESIII. The PWA results of $\psi(3686) \rightarrow p\bar{p}\eta$ and $\psi(3686) \rightarrow p\bar{p}\pi^0$. In addition, some recent measurements of branching fractions and cross sections involving with baryon final states will be presented.

Eulogio Oset
IFIC, University of Valencia

Tuesday 2:00pm

Analysis and interpretation of data

By means of a couple channel scheme incorporating unitarity, analyticity and chiral dynamics when applicable, I discuss methods to analyze data, extract resonances and interpret the nature of these resonances. I shall address a few problems: πN scattering in the region of the $N^*(1535)$ and $N^*(1650)$ resonances, photoproduction of the $\Lambda(1405)$, the content of DK in the $D_s^0(2317)$ from lattice data and B and B_s decays into J/ψ and the $f_0(980)$ and $f_0(500)$ resonances.

Daniel Mohler
Fermilab

Tuesday 2:30pm

Exploratory calculations of meson resonances and bound states from lattice QCD

David Wilson
Old Dominion University

Tuesday 3:00pm

Coupled-channel scattering from lattice QCD

Recently it has become possible to obtain coupled-channel scattering amplitudes using lattice QCD. Using a large basis of operators we are able to obtain a reliable finite volume spectrum describing the $\pi - K$, $\eta - K$ coupled system. Utilizing the finite volume formalism proposed by Luescher and extended by several others, we are able to describe the spectra from each lattice symmetry group and this enables constraints to be derived for S, P and D-wave scattering. We find resonant scattering amplitudes and investigate their structure in the complex plane, finding poles that display a pattern similar to the physical $K^*(892)$, $K_0^*(1430)$ and $K_2^*(1435)$ resonances.

Vincent Mathieu
Indiana University

Tuesday 4:00pm

Analyticity Constraints and Finite Energy Sum Rules

I explain how the resonance region can be constrained by the high energy (Regge) region via analyticity. I illustrate finite energy sum rules on some examples taken from pion-nucleon scattering and pion photoproduction.

Volker D. Burkert and **Victor Mokeev**
Jefferson Lab

Tuesday 4:30pm

Resonance Parameters from $\pi^+\pi^-p$ Photo- and Electroproduction

Studies of the transition $N \rightarrow N^*$ photo- and electroexcitation amplitudes (i. e. $\gamma_{r,v}NN^*$ photo- and electrocouplings) from the data of exclusive $\pi^+\pi^-p$ channel will be reviewed. The meson-baryon reaction model JM [1] is the only available approach worldwide that provided $\gamma_{r,v}NN^*$ photo-, electrocouplings, and $\pi\Delta$ and ρp hadronic decay widths of most resonances in the mass range up to 1.8 GeV and at photon virtualities up to 1.5 GeV² from the data of this exclusive channel. The recent model developments will be presented, including the special procedure allowing us to eliminate double counting between the resonance contributions to s- and t-channel processes in $\pi\Delta$ isobar channels, the evidences for three-body final state interactions from the preliminary CLAS $\pi^+\pi^-p$ photoproduction data. Preliminary results on the electrocouplings and the $\pi\Delta$ and ρp hadronic decay widths of several high-lying N^* states ($M > 1.6$ GeV) that decay preferentially to the $N\pi\pi$ final states have become available from the data on $\pi^+\pi^-p$ electroproduction for the first time [2]. New evidence in support of a $3/2^+(1720)$ candidate N^* state come from these studies. The prospects for the future exploration of exclusive $\pi^+\pi^-p$ electroproduction extending the coverage of photon virtualities up to 12.0 GeV² with the CLAS12 detector will be outlined.

References:

- [1] V.I. Mokeev *et al.* (*CLAS Collaboration*), Phys. Rev. C **86**, 035203 (2012).
- [2] V.I. Mokeev and I.G. Aznauryan, Int. J. of Mod. Phys. Conf. Ser. **26**, 1460080 (2014).

Ross Young

Tuesday 5:00pm

CSSM, University of Adelaide

Lambda(1405) on the lattice

Discussion Session on the $\Lambda(1405)$

Volker Burkert

Tuesday 7:45pm

Jefferson Lab

Experimental Status of the $\Lambda(1405)$

Eulogio Oset

Tuesday 7:55pm

IFIC, University of Valencia

Discussion on the Lambda(1405)

I explain the reason and the meaning of poles in the complex plane. I will stress the approach of chiral unitary theory to the $\Lambda(1405)$. Show how many reactions have very different shapes, and its natural interpretation through the existence of two poles. Address briefly the photoproduction data and its analysis, leading to two poles, and make predictions for the Λ_b decay into J/ψ and the $\Lambda(1405)$.

Raquel Molina

Tuesday 8:05pm

The George Washington University

Evolution of the $\bar{K}N$ - $\pi\Sigma$ System with M_π^2 in a box from UCHPT

The $\Lambda(1405)$ baryon is of continued interest in hadronic physics, being absent in many quark model calculations and supposedly manifesting itself in a two-pole structure. Finite-volume Lattice-QCD eigenvalues for different quark masses were recently reported by the Adelaide group. We compare these eigenvalues to those of a unitary Chiral Perturbation Theory (UCHPT) model, evaluated in the finite volume. The UCHPT calculation predicts the quark mass dependence remarkably well. It also explains the overlap pattern with different meson-baryon components, mainly $\pi\Sigma$ and $\bar{K}N$, at different quark masses. More accurate Lattice QCD data are required to draw definite conclusions on the nature of the $\Lambda(1405)$.

Hiroyuki Kamano

Tuesday 8:15pm

RCNP, Osaka University

S wave Λ resonances below $\bar{K}N$ threshold from ANL-Osaka DCC analysis

I will present our preliminary result on S wave Λ resonances found below the $\bar{K}N$ threshold from the current ANL-Osaka dynamical coupled-channels model of $\bar{K}N$ reactions. I also discuss what kinds of data would be preferable to establish the Y^* resonances below and near the $\bar{K}N$ threshold.

Wednesday April 15

Sadaharu Uehara
KEK-IPNS

Wednesday 9:00am

Light mesons at Belle

Light mesons at Belle (tentative title) Sadaharu Uehara (KEK) for the Belle Collaboration We report on results from our PWA for light mesons applied to our measurements of several kinds of exclusive $\gamma\gamma \rightarrow$ hadrons processes using Belle data. The analyses provide us information on spin-parity, mass, width and two-photon decay width of meson states in the mass region of 0.9 - 2.6 GeV.

Moskov Amaryan
Old Dominion University

Wednesday 9:30am

Meson Spectroscopy with CLAS6 and CLAS12

In this talk we present preliminary experimental results on photo-production and decay of light mesons obtained with the CLAS setup at JLAB with 6 GeV CEBAF electron beam. Prospects for meson spectroscopy with CLAS12 are discussed.

César Fernández Ramirez
Jefferson Lab

Wednesday 10:00am

Paving the way for $\gamma p \rightarrow K^+ K^- p$ partial-wave analysis: $\bar{K}N$ Scattering

We present a unitary multichannel model for $\bar{K}N$ scattering in the resonance region that fulfills analyticity and unitarity. The model has been designed to be suitable for extension to the $\gamma p \rightarrow K^+ K^- p$ of interest at JLab for exotic mesons and strangeonia.

Sasa Ceci
Ruđer Bošković Institute

Wednesday 11:00am

Fundamental role of the Breit-Wigner parameters in the description of resonances

It is generally assumed that the Breit-Wigner mass of a resonance is formalism dependent, i.e., that it is unphysical. Here, we show that this is not the case by devising a simple first-order method for extraction of the fundamental resonance parameters, the S-matrix poles, from the data. When we impose unitarity to the method, the Breit-Wigner parameters emerge naturally as an integral part of fundamental resonant properties. The proposed method is very simple but, close to the Breit-Wigner masses, it behaves similarly to advanced analytic and coupled-channel models.

Sven Schumann
Johannes Gutenberg University Mainz

Wednesday 11:30am

Single Energy PWA for π^0 , π^+ , and η Photoproduction

With the availability of polarised frozen spin targets as well as polarised photon beams at different facilities like MAMI, ELSA, or JLab, new types of experiments in pseudoscalar meson photopro-

duction have become possible. Various single and double photoproduction polarisation observables are now experimentally accessible and provide new information about the spectrum of baryon resonances. These now available data are used for a truncated single-energy partial wave analysis within the newly developed Mainz PWA framework. Recent single-energy fits for π^0 , π^+ , and η photoproduction channels will be presented and discussed with respect to remaining model dependencies and different techniques for applying constraints in the fitting process.

Thursday April 16

Andrzej Kupsc
Uppsala University

Thursday 9:00am

Experiments on light meson decays – experience from MesonNet

I will discuss techniques of amplitude analysis for the decays of the lightest neutral mesons: η , ω , η' and ϕ . These processes were the scope of collaboration between theory and experiment within MesonNet EU project 2012-2014. I will present some conclusions and ideas regarding parametrization of Dalitz plots and inclusion of systematic uncertainties in the theoretical analyses for these decays.

Marco Battaglieri
INFN-GE

Thursday 9:30am

The MesonEx program at Jefferson Lab

In this contribution I will present the meson spectroscopy program (MesoEx) that will run with the 12 GeV upgrade of the Hall-B at Jefferson Lab. An extended experimental program will measure many different final states to shed light on gluon excitations in the light-quark mesons spectrum. A high intensity, low-Q² electron beam will be tagged by the Forward Tagger facility that will complement the good resolution and the particle ID capability of the CLAS12 detector, allowing MesonEx to access the poorly known strangeness-rich final states. A comprehensive review of the hardware that is being built as well as the analysis tools and strategies that the HASPECT (Hadron Spectroscopy Center in Genova) is providing will be given.

Igor Danilkin
Jefferson Lab

Thursday 10:00am

Dispersive approach: application to $\eta/\omega \rightarrow 3\pi$

I will focus my talk on the recent Joint Physics Analysis Center (JPAC) studies of three-body final state interactions. We considered the decays $\omega/\phi/\eta \rightarrow 3\pi$ in the dispersive framework that is based on the Khuri-Treiman equation. Our results indicated that the final state interactions may be sizable. In my talk the Dalitz plot distributions and integrated decay widths will be presented.

Peng Guo
Indiana University

Thursday 10:30am

Three-body effect and its applications

I will talk about dispersive approach to three-body final state interaction and its application in eta to three-pion decay.

Bastian Kubis
Bonn University

Thursday 11:30am

Towards a data-driven analysis of hadronic light-by-light scattering

I discuss ongoing efforts to analyze the hadronic light-by-light scattering contribution to the anomalous magnetic moment of the muon using dispersion theory, employing as much information from experimental data as possible. The main focus will be on the transition form factors of the π^0 and η , which determine the lightest pseudoscalar pole terms.

Jacobo Ruiz de Elvira
INFN-Genova

Thursday 12:00pm

Application of the Veneziano model to the light meson decays

Starting from hyperbolic dispersion relations for the invariant amplitudes of pion-nucleon scattering together with crossing symmetry and unitarity, we derive and solve a closed system of integral equations for the partial waves of both, s-channel ($\pi N \rightarrow \pi N$) and t-channel ($\pi\pi \rightarrow \bar{N}N$) reactions, called Roy-Steiner equations. Special attention is given to the possible sources of uncertainties and to the obtained $\sigma_{\pi N}$ term value.

Andrea Celentano, for the CLAS collaboration
INFN-Genova

Thursday 12:30pm

Application of the Veneziano model to the light meson decays

In this talk I will present preliminary results from the analysis of the decay process $\omega \rightarrow 3\pi$ employing a Veneziano model. Data were obtained by measuring the reaction $\gamma p \rightarrow p\omega \rightarrow p\pi^+\pi^-(\pi^0)$, in the \sqrt{s} range from 1.9 to 2.6 GeV, with the CEBAF Large Acceptance Spectrometer (CLAS) at Jefferson Laboratory. The theoretical input for this analysis was provided by the JLab Physics Analysis Center (JPAC). The amplitude employed to fit the data was constructed starting from a set of covariant Veneziano terms, resulting to a finite sum of partial waves that receive contributions from selected Regge trajectories, including the daughters, while still keeping the proper asymptotic limit. Given the phase-space available to the $\omega \rightarrow 3\pi$ decay process, data sensitivity is limited to the first $\pi\pi$ Regge trajectory, containing the $\rho(770)$ pole. For this reason, the simple, linear parametrization of the real part of the Regge trajectory was employed. The imaginary part, instead, was “ad-hoc” tuned to reproduce the finite ρ width.

I will conclude by presenting preliminary results from other ongoing light meson n decays analysis, i.e. $\eta' \rightarrow \pi^+\pi^-\eta$ and $f_1(1285) \rightarrow \pi^+\pi^-\eta$ processes, using the same Veneziano model. Although the statistics for these channel is expected to be lower, with a higher background contamination, the larger available phase-space will permit to probe the effect of trajectories above the leading one.

Fabian Krinner
Technische Universität München Physik Department E18

Thursday 2:00pm

First studies of a Partial-Wave Analysis including non-resonant contributions

The COMPASS experiment, is a multi-purpose fixed-target experiment, located at CERN’s north area. It is supplied by the Super Proton Synchrotron with secondary hadron and tertiary muon beams. Due to its two-staged design, COMPASS is able to cover a wide kinematic range and thus

supports a wide physics program.

This program includes the spectroscopy of diffractively produced light mesons, where one of the studied processes is $\pi^- p \rightarrow \pi^- \pi^+ \pi^- p$. For this reaction COMPASS has recorded an unmatched data sample of about 50 million events.

Due to the size of this data set, the amplitude analysis reveals many previously unseen details and in principle permits to study resonances with small production cross section and rare decay modes of known states. However, in certain partial waves the data also exhibit significant effects from non-resonant contributions, which interfere with the resonances. For a reliable extraction of resonance parameters it is therefore indispensable to describe these non-resonant contributions. The most important one is the so-called Deck effect, which is expected to have a sizeable influence e.g. in the $J^{PC} = 1^{++}$ and the spin-exotic 1^-+ waves. We will discuss a model of the Deck effect and a new method to treat this contribution in the amplitude analysis.

Edmond Berger

Thursday 2:30pm

Argonne National Laboratory

One or two a_1 axial vector mesons

In the context of final-state resonant re-scattering corrections, we show that a single $I = 1$ spin-parity $J^{PC} = 1^{++}$ a_1 resonance can manifest itself as two separated mass peaks, one decaying into an S-wave $\rho\pi$ system and the second decaying into a P-wave $f_0(980)\pi$ system, with a rapid increase of the phase difference between their amplitudes arising mainly from the structure of the production process. This study clarifies questions related to the mass, width, and decay rates of the a_1 resonance raised by the recent high statistics data of the COMPASS collaboration on a_1 production in $\pi N \rightarrow \pi\pi\pi N$ at high energies.

Michael Williams

Thursday 3:00pm

MIT

Blinding PWA decisions

Selection of which amplitudes to include in a PWA is a vital step in the process. This step is easily biased by what the analyst desires to find. I will present some options that permit choosing a wave set blindly and can be used to rigorously define statistical significance.

Lorenzo Zana

Thursday 3:30pm

The University of Edinburgh

MC tools for hadron spectroscopy at Thomas Jefferson Lab

MonteCarlo simulation of detector systems and reaction processes is a key tool in analysing the complex, high statistics experimental data expected to emerge from the next generation meson photoproduction facilities. The complexity of the physics analysis for these experimental data requires an established chain of tested software tools. In my talk I will show the chain of software in development by the HASPECT collaboration [http://wiki.ge.infn.it/haspect/index.php/Main_Page], which is currently focused on developing the analysis tools for meson spectroscopy data from the future CLAS12 detector in Hall-B, at the Thomas Jefferson National Laboratory in the USA. The new HASPECT software tools are currently being tested and developed using existing experimental meson photoproduction data from the CLAS6 detector at JLAB.

Qiang Zhao

Thursday 4:30pm

Institute of High Energy Physics, Chinese Academy of Sciences

The nature of $a_1(1420)$ and triangle singularity mechanism

We demonstrate that the triangle singularity mechanism would account for the creation of the $a_1(1420)$ in the invariant mass spectrum of $\pi^-\pi^-\pi^+$ in the π^-p scattering observed recently by the COMPASS Collaboration. The same mechanism has been found to account for the $\eta(1405/1475)$ puzzle since its interference will lead to significant changes to the lineshapes and peak positions for the same state when it decays into different channels such as $K\bar{K}\pi$, $\eta\pi\pi$, and 3π . The property of its isospin-0 partner $f_1(1420)$ is also driven by the same mechanism.

Part of the works has been published in [J.-J. Wu, X.-H. Liu, Q. Zhao, B.-S. Zou, The puzzle of anomalously large isospin violations in $\eta(1405/1475) \rightarrow 3\pi$, Phys. Rev. Lett. 108, 081803 (2012)] and [X.-G. Wu, J.-J. Wu, Q. Zhao, and B.-S. Zou, Understanding the property of $\eta(1405/1475)$ in the J/ψ radiative decay, Phys. Rev. D 87, 014023 (2013)].

Mikhail Mikhasenko

Thursday 5:00pm

Universität Bonn

Triangle singularities in light meson decays

A high order correction to a decay amplitude $1 \rightarrow 2$ is the rescattering in a triangle diagram. On the complex plane of external invariants it can have singularity as a logarithmic branch point. The position of the branch point is determined by masses of the particles taking part in the process. Appearance of the branching point to kinematically allowed region can change the amplitude dramatically, for instance this might cause a "resonance-like" effect. We demonstrate an example of the resonance-like signal with the axial-vector quantum numbers $J^{PC} = 1^{++}$ at a mass of 1420 MeV and a width of 140 MeV, recently observed by the COMPASS and VES experiments in the $f_0(980)\pi$ final state and tentatively called $a_1(1420)$. It has all manifestation of new state, but it is also well described by the triangle singularity effect. Further influences of a triangle singularity in the light meson sector are discussed.

Qian Wang

Thursday 5:30pm

FORSCHUNGSZENTRUM Jülich

Could the near-threshold XYZ states be simply kinematic effects?

In recent years various narrow peaks were discovered in both charmonium and bottomonium mass regions that do not fit into the so far very successful quark model. For instance, the most prominent ones include $X(3872)$, $Z_c(3900)$, $Z_c(4020)$, $Z_b(10610)$ and $Z_b(10650)$, which are located close to the $D\bar{D}^*$, $D\bar{D}^*$, $D^*\bar{D}^*$, $B\bar{B}^*$ and $B^*\bar{B}^*$ thresholds in a relative S -wave, respectively. Based on the properties of their proximity to the thresholds, these five states were proposed to be of a molecular nature. As an alternative explanation various groups conclude from the mentioned proximity of the states to the thresholds that the structures are simply kinematical effects that necessarily occur near every S -wave threshold. Especially, it has been claimed that the structures are not related to a pole in the S -matrix and therefore should not be interpreted as states.

In this presentation we will show that the latter statement is based on calculations performed within an inconsistent formalism. In particular, we will demonstrate that, while there is always a cusp at the opening of an S -wave threshold, in order to produce peaks as pronounced and narrow as observed in experiment non-perturbative interactions amongst the heavy mesons are necessary, and as a consequence, a near-by pole must be generated dynamically in the S -matrix.

Friday April 17

José Peláez

Friday 9:00am

Universidad Complutense, Madrid

Identification of non-ordinary mesons from their Regge trajectories obtained from partial wave poles

We show how the pole that appears associated to a resonance in a scattering partial wave allows for a dispersive calculation of its Regge trajectory. The form of this trajectory allows for an identification of ordinary and non-ordinary mesons.

Wolfgang Gradl

Friday 9:30am

Uni Mainz

BESIII for meson and baryon spectroscopy

The BESIII experiment is a tau-charm factory operating at the BEPCII e+e- collider in the centre-of-mass energy region between 2 and 4.6 GeV. Data samples taken since the start of operation in 2008 include 1.2 billion J/ψ events and several fb^{-1} above $\sqrt{s} = 4$ GeV. This talk will highlight recent results on light hadron spectroscopy and studies of charmonium and charmonium-like states.

Lei Guo

Friday 10:00am

Florida International University

Photoproduction of the Omega, Cascades and Excited Hyperons at Jefferson Lab

Compared with the excited nucleon resonance sector, the spectrum of the excited hyperons have not been thoroughly investigated. Future experiments at CLAS12 and GlueX have great potential of discovering previously unknown Ξ^* resonances, and providing essential information about the photoproduction mechanism of $S = -3$ Ω^- baryons, particularly interesting since none of the constituent quark is from the target. The production of $S = -1$ hyperons are also intimately related to the intermediate nucleon resonances, as have been demonstrated in various studies of photoproduction of ground state hyperons. The analysis of various channels involving the cross section, beam helicity asymmetries, PWA results, and the polarization measurements from CLAS involving hyperons will be presented. The projected results from future CLAS12/GlueX experiments will also be discussed.

Jonas Rademacker

Friday 11:00am

University of Bristol

Determination of strong phases and the analysis of CP violation in heavy meson decays with LHCb; final-state interactions

Partial wave analyses, with their intrinsic sensitivity to interference effects, are a powerful tool in the precision measurement of CP violating weak phases at LHCb. Phases introduced by the strong interaction are a nuisance to these measurements, which either requires reliable amplitude models (which are often not available) or model-independent methods. In this presentations we present recent results related to strong and weak phase measurements in beauty and charm decays at LHCb.

Franz Niecknig
HISKP University Bonn

Friday 11:30am

Dispersive analysis of $D \rightarrow K\pi\pi$

Heavy flavor three-body decays into light mesons provide a valuable source for standard model tests and beyond. They play an important role due to their richer kinematic structure compared to two-body decays which can be exploited e.g. in CP violation studies. We introduce a dispersive framework for three-body decays that satisfies analyticity, unitarity and crossing symmetry by construction and includes crossed-channel rescattering effects. The dispersive method has been applied successfully to light meson decays and thus the Cabbibo favored $D^+ \rightarrow K^- \pi^+ \pi^+$ decay provides an ideal test to establish the framework at higher decaying masses.

Elena Santopinto
INFN-GE

Friday 12:00am

Quark structure of excited mesons