Exotic Hadron Spectroscopy 2023

Report of Contributions

https://conference.ippp.dur.ac.uk/e/1158

Contribution ID: **2** Type: **Talk**

High precision study of antineutron and hyperons interact with nuclei at a future super J/ψ factory

Thursday 20 April 2023 16:00 (30 minutes)

Physicists investigate the subatomic world by bombarding their subject of study with a hail of tiny subatomic "bullets". From the way these "bullets"bounce off their target one can infer a wealth of detailed information about the target's structure. Different kinds of subatomic "bullets" probe different aspects of the target, certain important aspects of the force holding atomic nuclei together can only be investigated by shooting particles called antineutrons and hyperons, which are believed to be very difficult to produce and control. However these usually rare particles can be produced in copious amounts and easily launched as a spinoff of a "super J/ψ factory". This opens fresh research opportunities in particle and nuclear physics, as well as in astrophysics and medical physics, requiring no additional infrastructure.

Presenter: SONG, Weimin (Jilin University)

Session Classification: Talks

Contribution ID: **3** Type: **Invited talk**

Role of a triangular singularity in the γ p ⟶ p π0 η reaction

Wednesday 19 April 2023 13:40 (30 minutes)

Recently structures in invariant mass distributions and excitation energy spectra have been attributed to triangular singularities as discussed in e.g.,[1,2] and in the review by Guo et al. [3]. These singularities emerge under specific kinematic conditions when new reaction channels open up. It will be shown that a triangular singularity associated with the opening of the γ p ⟶p a0 ⟶ p π0 η
channel may explain a structure in the Mpη invariant mass distribution near 1700 MeV/c2 observed in the γ p ⟶ p π0 η reaction [4].

[1] G. D. Alexeev et al., The COMPASS Collaboration, Phys. Rev. Lett
127, 082501 (2021)
[2] M. Mikhasenko, B. Ketzer and A. Sarantsev, Phys. Rev. D 91, 094015
(2015).
[3] F. K. Guo et al., Rev. Mod. Phys. D 90, 015004 (2018).
[4] V. Metag et al., EPJA 57 (2021) 325.
Supported by DFG through SFB/TR16.

Authors: Mrs NANOVA, Mariana (II. Physikalisches Institut); METAG, Volker (II. Physikalisches Institut, University of Giessen,Germany)

Presenter: METAG, Volker (II. Physikalisches Institut, University of Giessen,Germany)

Session Classification: Talks

Contribution ID: **4** Type: **Invited talk**

Tetraquarks with two heavy quarks from lattice QCD

Thursday 20 April 2023 10:00 (30 minutes)

I will discuss lattice QCD results on various tetraquarks with two heavy quarks or a heavy quark and an antiquark. This will include the doubly charm tetraquark and charmonium-like channels, which are of current experimental interest.

Author: PRELOVSEK, Sasa (University of Ljubljana)

Presenter: PRELOVSEK, Sasa (University of Ljubljana)

Session Classification: Talks

Contribution ID: **5** Type: **Invited talk**

Observation of multiple structures in the J/ψJ/ψ mass spectrum at CMS

Thursday 20 April 2023 14:00 (30 minutes)

A search for low-mass structures in the J/psiJ/psi mass spectrum produced by proton-proton collisions at sqrt(s) = 13 TeV is performed at the CMS experiment. The data sample corresponds to an integrated luminosity of 135 fb^-1 collected by the CMS at the CERN LHC. The previously observed X(6900) by LHCb is confirmed in this study, and a new structure at a lower mass is observed. Both structures have a significance well above 5 standard deviations. Evidence for a third structure around 7.2 GeV is found with a local significance of 4 sigma.

Author: Prof. HU, Zhen (Tsinghua University)

Presenter: Prof. HU, Zhen (Tsinghua University)

Session Classification: Talks

Contribution ID: **6** Type: **Talk**

Light hadron spectroscopy at BESIII

Wednesday 19 April 2023 14:10 (30 minutes)

Using the world's largest samples of J/ψ and $\psi(3686)$ events produced in e^+e^- annihilation, BESIII is uniquely positioned to study light hadrons in radiative and hadronic charmonium decays. In particular, exotic hadron candidates including multiquark states, hybrid mesons and glueballs can be studied in high detail. Recent highlights from the light hadron spectroscopy program, including the observation of an iso-scalar spin-exotic 1^{-+} state $\eta_1(1855)$ in $J/\psi \to \gamma\eta\eta'$, the observation of $X(2600)$ in $J/\psi \to \gamma\pi^+\pi^-\eta'$, a study of $\eta(1405)$and $\eta(1475)$ in $J/\psi \to \gamma K_S^0 K_S^0 \pi^0$ and a partial wave analysis of the decay $J/\psi \to \gamma\eta'\eta'$, will be presented.

Author: LIU, Beijiang (Institute of High Energy Physics, Chinese Acedemy of Sciences)

Presenter: ZHU, Yingchun (University of Science and Technology of China)

Session Classification: Talks

Contribution ID: **10** Type: **Talk**

Dibaryons –Molecule versus Hexaquark

Thursday 20 April 2023 11:30 (30 minutes)

Whereas exotic states observed in charm and beauty sectors appear as narrow resonances near particle thresholds constituting thus weakly bound systems of molecular character, such systems have to appear in the non-flavored sector as broad resonances, since the decay products themselves constitute very broad resonances. This complicates enormously their detection despite the fact that experiments in the unflavored sector are principally simpler.
The - on the hadronic level - narrow resonance d*(2380) with I(JP) = 0(3+) detected first in the pn⟶dπ0π0 reaction has been so far the only dibaryon resonance observed in all possible hadronic decay channels with evidence also in electromagnetic channels. Both quark model and LQCD calculations predict meanwhile such a hexaquark state decaying asymptotically via a ΔΔ configuration.*
In view of the recently discovered manifold threshold states in the flavored sectors also the longstanding discussion about further dibaryon resonances near the ΔN threshold appears in a new light. Partial-wave analyses based on a wealth of elastic scattering and single-pion production data provided unique results for isovector states with JP = 0-, 2+, 2-, 3- [1].
Recent results from WASA-at-COSY for the isoscalar single-pion production show that its cross section does not grow above threshold as expected conventionally, but rather exhibits a Lorerentzian shape (solid line) suggesting isoscalar states with JP = 1+ and 1- near the NN threshold [2]. Interestingly, a sophisticated NN-interaction model with intermediate dibaryon formation can account for all these states leading to a quantitative description of the corresponding experimental NN-phase-shifts covering the range from 0 up to 1 GeV [3].

[1] for a review see, e.g., H.Clement and T. Skorodko, Chin. Phys. C 45 (2021) 022001 and references therein
[2] H. Clement et al., Phys. Rev. C 106 (2022) 065204
[3] V. I. Kukulin et al., Chin. Phys. C 46 (2022) 114116

Author: CLEMENT, Heinz (University of Tueb ingen)

Presenter: CLEMENT, Heinz (University of Tueb ingen)

Session Classification: Talks

Contribution ID: **11** Type: **Invited talk**

Latest exotic spectroscopy results from LHCb

Thursday 20 April 2023 09:30 (30 minutes)

As a unique probe to low-energy properties of the strong interaction, exotic hadrons are of great interest in both theoretical and experimental communities. In recent years, LHCb have discovered dozens of such particles, providing fruitful inputs to the theoretical studies of the exotic hadron spectroscopy. The story is still going on, and some latest results about exotic hadrons from LHCb are presented in this talk.

Author: CHEN, Chen (Aix Marseille Univ, CNRS/IN2P3, CPPM, Marseille, France)

Presenter: CHEN, Chen (Aix Marseille Univ, CNRS/IN2P3, CPPM, Marseille, France)

Session Classification: Talks

Contribution ID: **12** Type: **Invited talk**

Hadron spectroscopy at GlueX

Wednesday 19 April 2023 13:10 (30 minutes)

The study of the spectrum of hadrons provides important insights into the interaction of the strong force. Photoproduction experiments play a key role in these investigations and are used in the search for hadrons with both conventional as well as exotic quantum numbers, such as mesons with gluonic degrees of freedom.
The GlueX experiment at Jefferson Lab, features a 9 GeV linearly polarized photon beam incident on a LH2 target, which is surrounded by an almost hermetic detector system. This makes GlueX an ideal tool to search for hadrons in a wide variety of final states with both charged and neutral final state particles, including strange hadrons decaying into kaons.
This talk presents results for from our initial campaign of data taking.

Author: HURCK, Peter (University of Glasgow)

Presenter: HURCK, Peter (University of Glasgow)

Session Classification: Talks

Contribution ID: **13** Type: **Invited talk**

Bound States and Resonances in Doubly Heavy Tetraquark States

Thursday 20 April 2023 14:30 (30 minutes)

I will give an update on our work studying antiheavy-antiheavy-light-light four-quark states using lattice QCD. We consider the three different tetraquark candidates $\bar{b}\bar{b}ud$, $\bar{b}\bar{b}us$ and $\bar{b}\bar{c}ud$ and search for possible existing bound states or resonances in all channels. In addition to commonly used local interpolating operators we also employ scattering interpolating operators, which seem to be very important for an accurate extraction of possibly existing bound states as well as low-lying scattering states.
Moreover, we investigate the effects of the finite lattice volume by performing a scattering analysis using Luscher's method. We extract infinite volume quantities like scattering lengths and phase shifts to obtain reliable statements about infinite volume binding energies.

Authors: ALEXANDROU, Constantia (University of Cyprus and The Cyprus Institute); FINKENRATH, Jacob (The Cyprus Institute); WAGNER, Marc (Goethe University Frankfurt); PFLAUMER, Martin; MEINEL, Stefan (University of Arizona / RIKEN BNL Research Center); LEONTIOU, Theodoros

Presenter: PFLAUMER, Martin

Session Classification: Talks

Contribution ID: **14** Type: **Invited talk**

Strangeness in Neutron Stars - Constraining the hyperon Nucleon Interaction

Thursday 20 April 2023 11:00 (30 minutes)

A comprehensive picture of the strong interaction can be obtained by extending our currently well understood nucleon-nucleon (NN) interaction to interactions involving strangeness degrees of freedom. The short lifetime of hyperons, however, prevents high-precision scattering experiments using typical procedures, and our efforts have been focused on complementary approaches utilising hypernuclear studies and final state interactions. The latter approach has only recently become feasible due to recent advancements in accelerator and detector technologies, which allow us to study exclusive reactions in hyperon photoproduction with high rates. Data collected using the CLAS detector housed in Hall-B of the Thomas Jefferson laboratory allow us to obtain a large set of observables, including cross section information [1] on the two-body (YN) and three-body (YNN) interaction and place stringent constraints on the underlying dynamics to address the "Hyperon Puzzle"[2]. In this talk I will provide an overview on the ongoing efforts currently underway that focus on extracting a large set of observables to constrain the interaction between hyperons and nucleons.
[1] J. Rowley, et. al. Phys. Rev. Lett. 127, 272303 (2021)
[2] I. Vidaña, Proc. R. Soc. A.474 01452 (2018)

Presenter: ZACHARIOU, Nicholas (University of York)

Session Classification: Talks

Contribution ID: **16** Type: **Invited talk**

Opportunities with J/psi and XYZP photo/lepto -production

Thursday 20 April 2023 16:30 (30 minutes)

I will discuss the recent results from JLab on J/\psi photo production and prospects and expectations for exotic charmonia at future photon-/lepton- machines

Author: SZCZEPANIAK, Adam (Indiana U/JLab)

Presenter: SZCZEPANIAK, Adam (Indiana U/JLab)

Session Classification: Talks

Contribution ID: **17** Type: **Invited talk**

J/ψ Near-Threshold Photoproduction at JLab

Wednesday 19 April 2023 16:10 (30 minutes)

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

The JLab CLAS, J/ψ-007 and GlueX Collaborations, based in Halls B, C and D respectively, aim to or have already measured the J/ψ near threshold photoproduction cross section using both hydrogen and deuteron targets. These offer the possibility of measuring the free proton, bound proton and bound neutron mass radii, with several measurements already published and additional analyses currently ongoing. This talk will describe the aims and experimental design for the measurements of J/ψ near threshold photoproduction on the proton, bound proton and bound neutron at JLab along with the current and upcoming results.

Author: TYSON, Richard (University of Glasgow)

Presenter: TYSON, Richard (University of Glasgow)

Session Classification: Talks

Contribution ID: **18** Type: **Invited talk**

On the long-standing quest for the tetra-neutron system: a recent observation of four-neutron correlations

Friday 21 April 2023 11:30 (30 minutes)

The search for chargeless nuclei consisting only of neutrons has been a long-lasting challenge in nuclear physics, dating more than six decades back (see Ref. [1] for a recent review). The tetra-neutron, in particular, has attracted a lot of experimental and theoretical attention. Most models agree that nuclear forces cannot bind four neutrons together without destroying many of the other successful predictions for light nuclei. The theoretical models, however, struggle to provide reliable and consistent predictions regarding the possibility of four neutrons forming a resonance system. On the other hand, no solid experimental information on possible correlations between four neutrons was available until recently as experiments suffer from low statistics and/or large background. The possibility of the tetraneutron forming a resonance state is still an open and fascinating question, which can now be probed theoretically with state-of-the-art ab-initio calculations and studied experimentally by employing new techniques in the upgraded, high-intensity, radioactive-ion beam facilities. In this talk, I will present a brief overview of this long-standing quest and discuss some recent, high-quality results from a novel experiment that was performed at the SAMURAI setup in RIKEN, Japan. This experiment probes the correlation energy between the four remaining neutrons after the quasi-elastic removal of alpha cluster from 8He projectiles and has provided for the first time a notably clean experimental signature. The results have been recently published in Nature [2]. The quest now continues with renewed interest as theoretical models attempt to reproduce the experimental result and new experiments aim to confirm and refine the measurement; hence, this talk will conclude with a brief discussion of these new perspectives.

[1] Marqués, F. M. & Carbonell, J. The quest for light multineutron systems. Eur. Phys. J. A 57, 105 (2021).

[2] Duer, M., Aumann, T., Gernhäuser, R., Panin, V., Paschalis, S., Rossi, D. M., et al. Observation of a correlated free four-neutron system. Nature 606, 678–682 (2022). https://doi.org/10.1038/s41586-022-04827-6

Author: PASCHALIS, Stefanos (University of York)

Presenter: PASCHALIS, Stefanos (University of York)

Session Classification: Talks

Contribution ID: **19** Type: **Invited talk**

Exclusive and Inclusive XYZ photoproduction

Thursday 20 April 2023 15:00 (30 minutes)

We will discuss model prediction for inclusive and exclusive XYZ production at JLab and at the EIC from the publications
10.1103/PhysRevD.102.114010
10.1103/PhysRevD.106.094009

Author: MATHIEU, Vincent (University of Barcelona)

Presenter: MATHIEU, Vincent (University of Barcelona)

Session Classification: Talks

Contribution ID: **20** Type: **Invited talk**

Exploring meson resonances using lattice QCD

Thursday 20 April 2023 09:00 (30 minutes)

Lattice QCD provides a means to rigorously compute hadronic scattering amplitudes within which hadron resonances appear. I'll show examples of the determination of resonances (non-exotic, exotic and possibly exotic) in coupled-channel situations, and illustrate how, by coupling scattering systems to external currents, we can study production mechanisms and explore resonance internal structure.

Author: DUDEK, Jozef (Jefferson Lab)

Presenter: DUDEK, Jozef (Jefferson Lab)

Session Classification: Talks

Contribution ID: **21** Type: **Invited talk**

New results and methods in heavy-baryon spectroscopy

Friday 21 April 2023 09:30 (30 minutes)

In this talk, I will discuss new results in the charm/bottom baryon sectors, including discoveries of new excited open-flavor baryons with the LHCb experiment, analyses of their properties, and development of the analysis techniques.

It is natural to classify baryonic excitation multiplets by quantum numbers of the light diquark in the ground configuration, which is 0^+, referred to the good diquark, or 1^+, referred to the good diquark. The new results for the bad-diquark multiplets come from studies of the Ω_c^{**0}, and Ξ_c^{**+} states in exclusive and prompt reactions. I will show new resonances in the "good"-diquark multiplets from the studied with the Ξ_b^{**} excitations.

Furthermore, I will introduce a new polarimeter vector field for multibody decays of a spin-half baryon. Using $\Lambda_c^+ \to pK^-\pi^+$ decays, I will demonstrate how it can facilitate polarization measurements of charm baryons and hadronic amplitude analyses.

Author: MIKHASENKO, Mikhail (ORIGINS Excellence Cluster)

Presenter: MIKHASENKO, Mikhail (ORIGINS Excellence Cluster)

Session Classification: Talks

Contribution ID: **22** Type: **Talk**

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

Thursday 20 April 2023 12:00 (30 minutes)

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

Highlighted results indicate a peak-like structure in the $\gamma n \rightarrow K^0\Sigma^0$ cross section at a centre-of-mass energy of 2 GeV consistent with a meson-baryon interaction model which predicted the charmed P_C states. The same $K^*\Sigma$ molecular nature of this proposed $N^*(2030)$ is also supported in a measurement of $\gamma p \rightarrow K^+\Lambda(1405) \rightarrow K^+\pi^0\Sigma^0$, where it is predicted to drive a triangle singularity mechanism. In the non-strange sector, coherent meson photoproduction off the deuteron enables access to proposed dibaryon states, including the recently discovered $d^*(2380)$. Data will be presented which support experimental claims of higher mass isoscalar and isovector dibaryons.

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

Author: JUDE, Thomas (Bonn University)

Presenter: JUDE, Thomas (Bonn University)

Session Classification: Talks

Contribution ID: **23** Type: **Invited talk**

Exotic mesons in the D- and B-meson sectors

Thursday 20 April 2023 17:00 (30 minutes)

I will discuss the scalar and axial-vector charmed mesons, including the Ds0*(2317), Ds1(2460) and their nonstrange partners. I will show that the hadronic molecular picture for these states is consistent with existing lattice results and LHCb measurements. Predictions on the decays of the Ds0* and Ds1 as well as properties of their bottom partners will be made.

Author: GUO, Feng-Kun (Institute of Theoretical Physics, CAS)

Presenter: GUO, Feng-Kun (Institute of Theoretical Physics, CAS)

Session Classification: Talks

Contribution ID: **24** Type: **Talk**

Charm baryons in lattice QCD at finite temperature

Friday 21 April 2023 10:00 (30 minutes)

Singly and doubly spin $1/2$ charmed baryons are investigated at multiple temperatures using the anisotropic FASTSUM 'Generation 2L' lattice QCD ensembles. We discuss the temperature dependence of these baryons' spectrum in both parity channel with a focus on the confining phase. We use fit independent methods to determine when a traditional fiting procedure and mass determination is appropriate. To further qualify the behaviour of these states around the pseudocritical temperature, the parity doubling due to the restoration of chiral symmetry is examined.

Author: BIGNELL, Ryan (Swansea University)

Presenter: BIGNELL, Ryan (Swansea University)

Session Classification: Talks

Contribution ID: **25** Type: **Invited talk**

Recent results on exotic hadrons from BESIII

Wednesday 19 April 2023 15:40 (30 minutes)

A 'second charm revolution' was sparked with the discovery of new 'XYZ' states, such as the $X(3872)$ or the $Y(4260)$ by the B factories Belle and BABAR. These states do not fit into the conventional picture of quark-antiquark bound systems. A number of further, non-conventional bound states have been discovered in different production processes at several experiments.

This talk will highlight several new states recently discovered at BESIII, both in the light quark and the charmonium(-like) sector.

Author: GRADL, Wolfgang (JGU Mainz, Inst. f. Nuclear Physics)

Presenter: GRADL, Wolfgang (JGU Mainz, Inst. f. Nuclear Physics)

Session Classification: Talks

Contribution ID: **26** Type: **Talk**

Discriminating among interpretations for the X(2900) states

Wednesday 19 April 2023 15:10 (30 minutes)

We make predictions for the production and decays of X(2900) states, and their possible charged partners, in B+ and B0 decays, considering a number of competing models for the states, including triangle diagrams mediated by quark exchange or pion exchange, and resonance scenarios including molecules and tetraquarks. Assuming only isospin symmetry and the dominance of color-favored weak decays, we find characteristic differences in the predictions of the different models. Future experimental studies can therefore discriminate among the competing interpretations for the states.

Author: BURNS, Timothy (Swansea University)

Presenter: BURNS, Timothy (Swansea University)

Session Classification: Talks

Contribution ID: **27** Type: **not specified**

Welcome

Wednesday 19 April 2023 13:00 (10 minutes)

Presenter: BURNS, Timothy (Swansea University)

Session Classification: Talks

Contribution ID: **28** Type: **Invited talk**

Physics of Multiquark States

Friday 21 April 2023 11:00 (30 minutes)

Exotic spectroscopy is a hot topic since there are several discoveries or observations per year. In this review talk, the last main experimental discoveries will be presented and then the main theoretical interpretations will be discussed. Finally, some results of which I am also one of the authors will be presented and discussed.

Author: SANTOPINTO, Elena (INFN Genoa)

Presenter: SANTOPINTO, Elena (INFN Genoa)

Session Classification: Talks