Exotic multi-quark states and baryon spectroscopy workshop

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Universitätsclub Bonn, the University of Bonn

Book of Abstracts

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Low-energy kaon-nuclei interaction studies at the DAFNE collider: a strangeness Odyssey

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The low-energy QCD, the theory within the Standard Model describing the strong interaction, is still missing fundamental experimental results to achieve a breakthrough in its understanding. Among these, the low-energy kaon-nucleon/nuclei interaction studies are playing a key-role.
Combining the excellent quality of the low-energy kaon beam delivered by the DAFNE collider of INFN-LNF with new experimental techniques, like high-precision spectroscopic Silicon Drift Detectors, we performed unprecedented measurements in the low-energy strangeness sector in the framework of the SIDDHARTA Collaboration and are presently running the SIDDHARTA-2 experiment for very challenging kaonic atoms measurements, such as kaonic deuterium first measurement.
I shall introduce the physics of kaonic atoms, the experiment, the first exciting results, and discuss future plans. I shall also present AMADEUS collaboration results on studies of low-energy kaons interacting with various nuclei.
The experiments at DAFNE represent a unique opportunity to unlock QCD secrets in the strangeness sector and contribute to better understand the role of strangeness in the Universe, from nuclei to the stars.

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Coherent neutral-pion and eta-meson photoproduction on the deuteron studied at ELPH

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We have studied the interaction between the eta meson and deuteron from measurement of cross sections for coherent neutral-pion and eta-meson photoproduction on the deuteron. We have found a narrow resonance-like bump in the eta-deuteron subsystem at the vicinity of the threshold, suggesting strong eta-deuteron attraction. The sharp backward-peaking angular dependence of deuteron emission, predicted by the existing theoretical calculations, does not appear. We discuss the possibilities of using coherent neutral-pion and eta-meson photoproduction on a nucleus to study the eta-nuclear interaction.

References:
Phys. Rev. C 104, L052201 (2021); Phys. Rev. C 105, 045201 (2022).

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Three methods to search for the two $\Xi(1820)$ states

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The chiral unitary approach produces two states from the pseudoscalar-baryon decuplet interaction in the region of the $\Xi(1820)$. A recent BESIII experiment on the $\Psi(3868) \to \bar{\Xi} K^- \Lambda$ showed a clean peak that had an abnormally large width and was interpreted in [1] in terms of the two $\Xi(1820)$. In view of this, we propose to look at the $\Omega_c \to \pi^+ (\pi^0, \eta) \pi \Xi^*$ reaction [2], where the $\pi\Xi^*$ invariant mass shows an interference pattern of the two resonances. A third reaction $\Psi(3686) \to {}^{-+}\bar{K}^{0*-}$ [3] looks at the $\bar{K}^{0*}$ invariant mass distribution, where due to phase space restrictions, the lower mass $\Xi(1820)$ is suppressed and the higher mass around 1875 MeV with a larger width shows up clearly.

[1] R.~Molina, W.~H.~Liang, C.~W.~Xiao, Z.~F.~Sun and E.~Oset,
%"Two states for the $\Xi(1820)$ resonance,"
[arXiv:2309.03618 [hep-ph]].

[2] W.~H.~Liang, R.~Molina and E.~Oset,
%"The $\Omega_c \to \pi^+ (\pi^0, \eta) \pi \Xi^*$ reactions and the two $\Xi(1820)$ states,"
[arXiv:2404.18882 [hep-ph]].

[3] Man-Yu Duan, Jing Song, Wei-Hong Liang and E. Oset

Searching for the two poles of the Ξ(1820) in the $\Psi(3686) \to {}^{-+}\bar{K}^{0*-}$ decay

to be submitted.

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Σ beam asymmetry for η photoproduction on the proton at BGOOD

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The Σ beam asymmetry in meson photoproduction off the nucleon is a very sensitive observable in the investigation of the nucleon structure. The BGOOD experiment at ELSA, with its linearly polarized γ beam and large solid angle detector, is an ideal facility for the detection of charged and neutral particle final states.
New results of Σ beam asymmetry will be presented for η photoproduction off the proton in the energy range 1250-1730 MeV; these results have been obtained analyzing at the same time all the available statistics from the main η decay channels with an original technique that allows to treat simultaneously periods with different efficiencies and polarization degrees.

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Multi-meson photoproduction off the proton - recent results from the CBELSA/TAPS experiment

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A good understanding of the spectrum and the properties of baryon resonances requires a detailed study of the excited states and their decays. To extract contributing resonances from data, cross

sections and polarization observables must be determined and further investigated by partial wave analysis.
Multi-meson final states are particularly important at high energies, where still resonances are predicted which remained so far unobserved. They also allow the interesting investigation of sequential decay chains, where a high mass resonance decays via an intermediate excited state down into the ground state.

The Crystal Barrel/TAPS experiment is ideally suited to measure the photoproduction of neutral mesons decaying into photons due to its good energy resolution, high detection efficiency for photons, and the nearly complete solid angle coverage. A longitudinally or transversely polarized target and a linearly or circularly polarized photon beam allow extensive measurements of polarization observables.

Recent results are presented, giving a particular emphasis to $\gamma p \to p\pi^0\pi^0$.

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The LHCb Pentaquarks as hadronic molecules

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In the talk the concept of hadronic molecules is introduced and the implications of this structure illustrated on three examples: The nature of the Y(4230), the Zb states and finally the LHCb pentaquarks. In particular, it is described which features of the LHCb pentaquarks point at their possible molecular nature and what further predictions can be deduced from that property.

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The baryon resonance spectrum in Jülich-Bonn dynamical coupled-channel model

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Co-authors: Chao-Wei Shen ; Christian Schneider ; Maxim Mai ; Michael Döring ; Ron Workman ; Ulf-G. Meißner ; Yu-Fei Wang

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In order to connect predictions for the baryon spectrum in the non-perturbative energy regime from quark models or lattice calculations to experimental data, coupled-channel frameworks are especially suited. In those approaches a simultaneous partial-wave analysis of multiple reactions with different initial and final states is performed.
I will present recent results from the Jülich-Bonn dynamical coupled-channel approach, where the spectrum of nucleon and Delta resonances is extracted based on a combined study of the pion- and photon-induced reactions. The amplitudes of the Juelich-Bonn model also enter the study of electroproduction reactions as constraints at Q^2=0 and allow the determination of baryon transition form factors beyond the Roper and Delta(1232) resonances.
The Jülich-Bonn approach was also extended to hidden-charm reactions including the $J/\psi p$ channel to explore possible P_c states.

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η and η' photoproduction on nucleons

The most interesting experimental data for η and η′ photoproduction on nucleons are presented. Besides, results of the phenomenological analysis of these reactions with updated version of EtaMAID model are discussed. The model well describes both differential cross sections and polarization observables at photon beam energies from the threshold upto 9 GeV. The nature of some interesting specifics in the data is discussed.

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Results of JRA7 - light and heavy quark hadron spectroscopy

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Exotic hadrons: tetraquarks, pentaquarks and hadronic molecules

Recently the LHCb Collaboration announced the discovery of a new type of exotic hadron – a doubly-charmed tetraquark T_{cc}^{+}, whose mass agrees precisely with a 2017 theoretical prediction. I will discuss the recent related experimental and theoretical developments regarding new types of hadrons: tetraquark and pentaquark hadronic molecules, doubly heavy baryons, stable tetraquarks and others.

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The study of exotic baryon structure via strangeness photoproduction at BGOOD

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Two-pole structures in QCD

The term two-pole structure refers to the fact that particular single states in the hadron spec- trum as listed in the PDG tables are often two states. In this talk, I will discuss in some detail the cases of the two $\Lambda(1405)$ and the two D^0 (2300) states. I further discuss the consequences for our understanding of bound states in QCD and point out some sins committed in the current literature.

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Hadronic resonances from lattice QCD

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Coherent meson photoproduction off the deuteron at forward angles at BGOOD

Author: Thomas Jude[None]

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STRONG-2020 status and prospects

STRONG-2020 succeeded in gathering a large community in Europe and beyond that focuses on all aspects of the strong interaction.
It encompasses both fundamental research and applications using top-level infrastructures as a backbone, with the ambition of pushing further the frontier of knowledge in hadron physics.
We present at this workshop a general summary of the project which is about to reach its termination as well as several achievements including some from FTD/ELSA.
Prospects beyond STRONG-2020 in the framework of Horizon Europe will also be discussed.

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Closing remarks and discussion

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QCD Exotics and where to find them