HK 58: Hadronenstruktur und -spektroskopie IX

Time: Thursday 16:30–19:00 Location: C-2

Group Report HK 58.1 Thu 16:30 C-2

Hadron Phenomenology: Glueball, Vector and Axial-Vector Mesons and Baryons in a Linear Sigma Model — •Denis Parganlija[1], Francesco Giacosa[1], Stanislaus Janowski[1], Susanna Gallas[1], Peter Kovacs[2], György Wolf[2], and Dirk H. Rischke[1,3] — [1]Institut für Theoretische Physik, Goethe-Universität, Max-von-Laue-Str. 1, D–60438 Frankfurt am Main — [2]Research Institute for Particle and Nuclear Physics, H–1525 Budapest, POB 49, Ungarn — [3]Frankfurt Institute for Advanced Studies, Goethe-Universität, Ruth-Moufang-Str. 1, D–60438 Frankfurt am Main

We study the vacuum phenomenology of low-energy hadrons in a globally chirally invariant linear sigma model with vector, axial-vector, glueball and baryon degreees of freedom. We present results regarding (*i*) spectroscopy of scalar quark-antiquark mesons (identification of scalar quarkonia from experimental data, decays of quarkonia), (*ii*) mixing between scalar $\bar{q}q$ states and the glueball (identification of predominantly glueball state from experimental data) and (*iii*) origin of nucleon mass (mass of the nucleon in the chiral limit) and the chiral partner of the nucleon. We also outline an extension of the model to include tetraquark degrees of freedom and charmed hadrons and present an outlook of calculations at finite temperatures and densities.

HK 58.2 Thu 17:00 C-2

The Glueball in a Chiral Linear Sigma Model with Vector Mesons — •Stanislaus Janowski[1], Denis Parganlija[1], Francesco Giacosa[1], and Dirk H. Rischke[1,2] — [1]Institut für Theoretische Physik, Goethe-Universität, Max-von-Laue-Str. 1, D–60438 Frankfurt am Main — [2]Frankfurt Institute for Advanced Studies, Goethe-Universität, Ruth-Moufang-Str. 1, D–60438 Frankfurt am Main

We present a two-flavour linear sigma model with global chiral symmetry and (axial-)vector mesons as well as an additional glueball degree of freedom. We consider the structure of the well-established resonances $f_0(1370)$ and $f_0(1500)$ by studying the mixing between the pure $\bar{q}q$ and the pure glueball state in the $J^{PC} = 0^{++}$ channel. This allows us to determine the dominant contribution to the structure of these two resonances - we find $f_0(1370)$ to be predominantly a $\bar{q}q$ state and $f_0(1500)$ to be predominantly a glueball state. Additionally, we also consider the decay channels of $f_0(1370)$ and $f_0(1500)$ and compare our results with experimental data in order to ascertain the correctness of the results obtained about the structure of these resonances. As a by-product of our analysis, the gluon condensate is determined.

HK 58.3 Thu 17:15 C-2

Complex-mass scheme and perturbative unitarity — Torsten Bauer[1], •Jambul Gegelia[1], George Japaridze[2], and Stefan Scherer[1] — [1]Institut fuer Kernphysik, Johannes Gutenberg-Universitaet, D-55099 Mainz, Germany — [2]Clark Atlanta University, Atlanta, GA 30314, USA

For the description of resonances one needs to take into account the finite widths of these states. The complex-mass scheme (CMS) provides with a consistent framework of handling this problem. This approach has proven successful in various applications in the standard model and chiral effective field theory.

In the framework of quantum field theory the usage of the CMS leads to complex-valued renormalized parameters. While the problems of unitarity and causality in field theories containing unstable particles have been resolved long ago, the issue of perturbative unitarity of the S-matrix in the CMS is still open. Using the CMS one does not change the bare Lagrangian, therefore unitarity is not violated in the complete theory. On the other hand, the perturbation theory is based on order-by-order approximation to the exact results. Therefore it is not obvious that the approximate expressions to the S-matrix also satisfy the unitarity condition.

We derive cutting rules for loop diagrams and demonstrate at the one-loop level perturbative unitarity of the scattering amplitude within the complex-mass scheme.

As an application of the CMS we consider the electromagnetic form factor of the pion in the timelike region.

HK 58.4 Thu 17:30 C-2

Large-N_c operator analysis of 2-body meson-baryon counter terms in the chiral Lagrangian. — •Alexander Semke — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Planckstraße 1, 64291 Darmstadt

The chiral $SU(3)$ Lagrangian with the baryon octet and decuplet fields is considered. The Q^2 counter terms involving the decuplet fields are constructed. We derive the parameter correlation implied by the $1/N_c$ expansion at leading order in QCD.

HK 58.5 Thu 17:45 C-2

Mass dependence of the heavy quark-antiquark potential and its effects on quarkonium spectra — •Alexander Laschka, Norbert Kaiser, and Wolfram Weise — Physik Department, Technische Universität München, D-85747 Garching, Germany

The heavy quark-antiquark potential can be studied in perturbative QCD and in lattice simulations. In addition to the leading order static potential, quark mass dependent corrections are examined. We show that for the static term as well as for the mass dependent corrections, the perturbative short-distance part can be matched at intermediate distances with results from lattice QCD. From these matched potentials, quarkonium spectra with a single free parameter (the heavy quark mass) are derived and compared with empirical spectra. Furthermore, charm and bottom quark masses are deduced and compared with values extracted from other schemes.

Work supported in part by BMBF, GSI and by the DFG Excellence Cluster "Origin and Structure of the Universe".

HK 58.6 Thu 18:00 C-2

Primakoff production of π^0, η and η' in the Coulomb field of a nucleus — •Murat Kaskulov and Ulrich Mosel — Institut für Theoretische Physik, Universität Giessen, Germany

The Primakoff production of neutral pseudoscalar mesons $\pi^0, \eta(587)$ and $\eta'(958)$ in the Coulomb field of an atomic nucleus is studied using a model which describes the coherent electromagnetic and nuclear parts of the production amplitude. At high energies the nuclear background is dominated by the exchange of C-parity odd Regge trajectories. In the coherent production the isospin filtering makes the $\omega(782)$ a dominant trajectory. We revise the production of pions which has been used to measure the $\pi^0 \to \gamma\gamma$ decay width at JLAB. The calculations are in agreement with data provided the photon shadowing and final state interactions of mesons are taken into account. The kinematic conditions which allow to study the Primakoff effect in η and η' photoproduction off nuclei are further discussed.
Supported by DFG through TR16.

HK 58.7 Thu 18:15 C-2

Roy–Steiner equations for πN scattering - The Muskhelishvili–Omnès problem for the t-channel partial waves — •Christoph Ditsche[1], Martin Hoferichter[1], Bastian Kubis[1], and Ulf-G. Meissner[1,2] — [1]Helmholtz-Institut für Strahlen- und Kernphysik (Theorie) and Bethe Center for Theoretical Physics, Universität Bonn, D-53115 Bonn, Germany — [2]Institut für Kernphysik (Theorie), Institute for Advanced Simulations, and Jülich Center for Hadron Physics, Forschungszentrum Jülich, D-52425 Jülich, Germany

Starting from (subtracted) hyperbolic dispersion relations for πN scattering, which are based on the general principles of Lorentz invariance, unitarity, crossing and analyticity as well as isospin symmetry, we propose a closed system of (subtracted) hyperbolic partial wave dispersion relations for the partial waves $f^J_{l\pm}(\sqrt{s})$ of the s-channel reaction $\pi N \to \pi N$ and the partial waves $f^J_\pm(t)$ of the t-channel reaction $\pi\pi \to \bar{N}N$ in the spirit of Roy and Steiner. A key step to the ultimate goal of solving this Roy–Steiner system is to first solve the corresponding (subtracted) Muskhelishvili–Omnès problem with inelasticities and a finite matching point for the lowest t-channel partial waves $f^0_+(t)$, $f^1_\pm(t)$. The recent status of this ongoing effort will be presented.

HK 58.8 Thu 18:30 C-2

Two- and three-body structure of the $Y(4660)$ — •Philipp Hagen[1], Hans-Werner Hammer[1], and Christoph Hanhart[2] — [1]Helmholtz-Institut für Strahlen- und Kernphysik and Bethe Center for Theoretical Physics, Universität Bonn — [2]Institut für Kernphysik, Institute for Advanced Simulation and Jülich Center for Hadron

Physics, Forschungszentrum Jülich

We study general features of three-meson bound states using the $Y(4660)$ as an example. Here the $Y(4660)$ is assumed to be either a two-body bound state of the $f_0(980)$, itself a bound state of K and $\bar{K}$, and the $\psi' = \psi(2s)$, or a three-body bound state of ψ', K, and $\bar{K}$. In particular, we investigate in detail the interplay of the various scales inherent in the problem, namely the f_0 binding energy, the Y binding energy, and the $K\psi'$ scattering length. This allows us to understand under which circumstances the substructure of the $f_0(980)$ can be neglected in the description of the $Y(4660)$.

HK 58.9 Thu 18:45 C-2

Electromagnetic properties of the nucleon and Delta(1232)-isobar in chiral EFT — •Tim Ledwig[1], Jorge Martin-Camalich[2], Vladimir Pascalutsa[1], and Marc Vanderhaeghen[1] — [1]Institut für Kernphysik, Johannes Gutenberg-Universität, D-55099 Mainz, Germany — [2]Departamento de Fisica Teorica and IFIC, Centro Mixto, Institutos de Investigacion de Paterna - Universidad de Valencia-CSIC, Spain

Recent lattice QCD and baryon chiral perturbation theory results show some discrepancies, e.g. in the nucleon iso-vector Pauli- and Dirac-radii. In this talk we discuss present progress in the study of the pion-mass and volume dependence of nucleon and Delta(1232)-isobar electromagnetic observables, namely: the nucleon iso-vector anomalous magnetic moment, Dirac- and Pauli-radii and the Delta(1232)-isobar electric quadrupole, magnetic dipole and magnetic octupole moments. In the case of the Delta(1232)-isobar we confront the situation of unstable particles in an external electromagnetic field.