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Lectures on Weak Interactions of Strongly Interacting Particles
Springer Science & Business Media

This thesis is an attempt to understand the properties of the protons, pions and other hadrons in terms of their fundamental building blocks. In the first chapter the author reviews several of the approaches that have already been developed. The Nambu-Jona-Lasinio model offers the classic example of a derivation of meson properties from a quark Lagrangian. The chiral quark model encodes much of the intuition acquired in recent decades. The author also discusses the non-linear sigma model, the Skyrme model, and the constituent quark model, which is one of the oldest and most successful models. In the constituent quark model, the constituent quark appears to be different from the current quark that appears in the fundamental QCD Lagrangian. Recently it was proposed that the constituent quark is a topological soliton. In chapter 2 the author investigates this soliton, calculating its mass, radius, magnetic moment, color magnetic moment, and spin structure function. Within the approximations used, the magnetic moments and spin structure function cannot simultaneously be made to agree with the constituent quark model. In chapter 3 the author uses a different plan of attack. Rather than trying to model the constituents of the baryon, he begins with an effective field theory of baryons and mesons, with couplings and masses that are simply determined phenomenologically. Meson loop corrections to baryon axial currents are then computed in the $1/N$ expansion. It is already known that the one-loop corrections are suppressed by a factor $1/N$; here it is shown that the two-loop corrections are suppressed by $1/N^2$. To leading order, these corrections are exactly the same as would be calculated in the constituent quark model. This method therefore offers a different approach to the constituent quark.

Medium Modifications of Mesons North-Holland

The authors show that nuclear $[\sigma]$, $[\omega]$, and $[\pi]$ mesons can contribute coherently to enhance the electroproduction cross

section on nuclei for longitudinal virtual photons at low Q^2 while depleting the cross section for transverse photons. The authors are able to describe recent HERMES inelastic lepton-nucleus scattering data at low Q^2 and small x using photon-meson and meson-nucleus couplings which are consistent with (but not determined by) existing constraints from meson decay widths, nuclear structure, deep inelastic scattering, and lepton pair production data. The authors find that while nuclear-coherent pion currents are not important for the present data, they could be observed at different kinematics. Their model for coherent meson electroproduction requires the assumption of mesonic currents and couplings which can be verified in separate experiments. The observation of nuclear-coherent mesons in the final state would verify their theory and allow the identification of a specific dynamical mechanism for higher-twist processes.

An Investigation of Ward Identities for Eta Meson Decay Using Non-local Currents Cambridge University Press

The International Conference Mesons and Light Nuclei, organized by the Institute of Nuclear Physics (INP), Rez, was held during July 2 - 7, 1995 in small north Bohemian town Straz pod Ralskem. It was the sixth in a series of meetings which took place previously at Liblice 74 and 81, Bechyne 85 and 88, and Prague 91. The conferences gained already their firm position among intermediate energy nuclear physics activities. International nuclear physics community strongly supported our intention to continue the series. This year's venue for the conference was the accommodation and social area of the DIAMO company at Straz. The goal of the meeting was to summarize the present situation and the future perspectives concerning the experimental investigations and theoretical descriptions of light nuclei and their interactions with electromagnetic and hadronic probes, mainly at intermediate energies. The scientific program of the conference included the following areas of research: nuclear physics with pions and antiprotons, T -meson physics, baryonic systems with strangeness, relativistic few-body dynamics, and electroweak nuclear interaction. Representatives from many international groups working within different experimental facilities and with different theoretical methods were invited and

asked to present their latest results and future research programs. The Straz conference, attended by 102 physicist from institutions in 22 countries, was sponsored by the Austrian Ministry for Science and Research, Czech Ministry for Industry and Trade, and by SKODA PRAHA a.s. Thanks to this sponsorship we could also invite several participants and students at essentially reduced cost.

Vector Meson Decays and the Algebra of Currents Oxford University Press

The structure of light hadrons is dominated by the spontaneously broken chiral symmetry of the strongly interacting (QCD) vacuum. Low energy properties of light hadrons can be described in terms of quarks interacting with chiral fields. This book gives a comprehensive account of a large class of models which describe the restoration of chiral symmetry at high temperature and density, the effective interactions between quarks, mesons as solutions of the Bethe-Salpeter equation, and baryons in terms of solutions which rotate in flavor space. An in-depth analysis of regularization is given, including regularization by delocalized fields. Symmetry conserving approximations are formulated using both path integral and Feynmann graph methods. The book's style is pedagogical and well-suited to graduate and Ph.D. students who want to learn the techniques used in present day research. It can also serve as a reference for research and lecture courses.

Effective Field Theories of Baryons and Mesons, Or, what Do

Quarks Do? Sudwestdeutscher Verlag Fur Hochschulschriften AG
Current and Mesons is the most recent publication in the Chicago Lectures in Physics series. The book presents Professor Sakurai's introduction to a new field of elementary particle physics which has become increasingly important in the past few years. It is based on a course given to his advanced graduate students in theoretical high-energy physics at the University of Chicago. The author begins with a brief review of $SU(3)$. The major topics then treated are the divergence condition and current commutation relations, vector meson universality, PCAC and the Goldberger-Treiman relation, soft pion processes, and asymptotic symmetries and spectral-function sum rules. The book concludes with a

discussion of notation and of normalization convention. Professor Sakurai's work deals with topics on which much of current discussion on the theory of elementary particles is focused. The material is designed for the advanced student who is seriously interested in doing original work, and as such provides a much needed introduction to the present literature in the field.

New Scalar and Conserved Vector Currents in Dual-resonance Models Springer

The electroweak theory unifies two basic forces of nature: the weak force and electromagnetism. This 2007 book is a concise introduction to the structure of the electroweak theory and its applications. It describes the structure and properties of field theories with global and local symmetries, leading to the construction of the standard model. It describes the particles and processes predicted by the theory, and compares them with experimental results. It also covers neutral currents, the properties of W and Z bosons, the properties of quarks and mesons containing heavy quarks, neutrino oscillations, CP-asymmetries in K, D, and B meson decays, and the search for Higgs particles. Each chapter contains problems, stemming from the long teaching experience of the author, to supplement the text. This will be of great interest to graduate students and researchers in elementary particle physics.

Isoscalar Meson Exchange Currents and the Deuteron Form Factors University of Chicago Press

The electromagnetic form factors for the ρ and ω vertices are calculated from quark loop diagrams which take the qq structure of the π , σ , ρ , ω mesons into account. The resulting form factors decrease with increasing Q^2 (the square of the four-momentum of the off-shell photon) considerably more rapidly than the monopole form factors obtained from vector meson dominance. The implications of this behavior, which has a significant effect on the elastic electromagnetic form factors of deuteron, is discussed.

The Current Status of Meson Spectroscopy Springer

In 1947, the first of what have come to be known as "strange particles" were detected. As the number and variety of these particles proliferated, physicists began to try to make sense of them. Some seemed to have masses about 900 times that of the electron, and existed in both charged and neutral varieties. These

particles are now called kaons (or K mesons), and they have become the subject of some of the most exciting research in particle physics. *Kaon Physics at the Turn of the Millennium* presents cutting-edge papers by leading theorists and experimentalists that synthesize the current state of the field and suggest promising new directions for the future study of kaons. Topics covered include the history of kaon physics, direct CP violation in kaon decays, time reversal violation, CPT studies, theoretical aspects of kaon physics, rare kaon decays, hyperon physics, charm: CP violation and mixing, the physics of B mesons, and future opportunities for kaon physics in the twenty-first century.

Effective Field Theories of Baryons and Mesons Or, what Do Quarks Do? World Scientific

This volume deals with both the experimental and theoretical aspects of meson physics; in particular, it presents new results. The main topics are: hadronic and electromagnetic meson production in various reactions; meson interaction with mesons, nucleons and nuclei; the structure of hadrons; mesons and fundamental symmetries; exotic systems. The book provides an overview of the current status of these areas, as well as of new developments, besides giving a preview of the forthcoming investigations.

Theory of the Muon Anomalous Magnetic Moment North-Holland

The theory of the muon anomalous magnetic moment is particle physics in a nutshell. It is an interesting, exciting and difficult subject, and this book provides a comprehensive review of it. The theory of the muon anomalous magnetic moment is at the cutting edge of current research in particle physics, and any deviation between the theoretical prediction and the experimental value might be interpreted as a signal of an as-yet-unknown new physics.

Gauge Fields, Theory of Currents, and Vector Mesons Springer

The interplay of hadron properties and their modification in an ambient nuclear medium on the one hand and spontaneous chiral symmetry breaking and its restoration on the other hand is investigated. QCD sum rules for various heavy-light pseudoscalar mesons embedded in cold nuclear matter are evaluated, the

impact of order parameters is investigated and Weinberg type sum rules are derived. The consequences of a chirally symmetric scenario for the ρ meson are investigated and the complementarity of mass shift and broadening is discussed. Additionally, the analytic structure of quark propagators in the complex plane is investigated numerically within Dyson-Schwinger equations. The applicability of Bethe-Salpeter equations for heavy-light quark-antiquark bound states in the scalar and pseudo-scalar channels by variation of the momentum partitioning parameter is presented. The solutions of the Dyson-Schwinger equation in the Wigner-Weyl phase are used to investigate the hadron spectrum with explicit but without dynamical chiral symmetry breaking. An exhaustive introduction to chiral transformations within classical and quantum field theory and current-current correlators is given.

Intermediate Vector Mesons and Unitary Symmetry University of Chicago Press

Neutral current interactions are known from studies of K meson decays to conserve flavor to a high precision. Although flavor changing neutral currents (FCNC) are forbidden in the Weinberg-Salam model, many extensions of the Standard Model allow such processes. We present preliminary upper limits on FCNC-mediated decays of charmed particles, namely $D^0 \rightarrow e\bar{e}$, $D^0 \rightarrow \mu\bar{\mu}$, $D^0 \rightarrow e\mu$ and $D^+ \rightarrow \pi^+\mu e$.

Dual Resonance Models for Vector Currents

Giving emphasis on electroweak nuclear interactions the book collects more than 60 papers presented at the 5th International Symposium, Prague, September 1-6, 1991. Further topics covered are: nuclear physics with pions and antiprotons, nuclear physics with strange particles, relativistic nuclear physics, and quark degrees of freedom. They are viewed in their theoretical as well as experimental aspects.

Elementary Particle Physics

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Electroweak Theory

Two Topics in Elementary Particle Physics

Search for Flavor Changing Neutral Current Decays of Charm Mesons

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