Selected Abstracts from Physical Review D

Abstracts of papers published in **Physical Review D** *which may be of interest to our readers are printed here.*

Factorial moment analyses in diffractive lepton-nucleon scattering. Zhang Yang, *Institut für Theoretische Physik, FU Berlin, Arnimallee 14, 14195 Berlin, Germany.* (Received 12 August 1997; published 14 January 1998)

It is pointed out that ''the colorless objects'' in diffractive lepton-nucleon scattering in the small-x_B region can be probed by measuring the scaled factorial moments of final-state-hadrons of the diffractively produced system and the dependence of their scaling behavior upon the diffractive kinematic variables. The Monte Carlo implementations of RAPGAP and JETSET are discussed as illustrative examples. The results of these model calculations show in particular that the inclusion of the contributions from the gamma gluon fusion processes can considerably enlarge the power of the scaled factorial moments. The possibility for probing the anomalous scaling behaviors of probability moments of the transverse energies in the DESY ep collider HERA calorimeter environment is also discussed. [S0556-2821(98)50703-5] [Phys. Rev. D **57**, 1327 (1998)]

One-loop QCD corrections to deeply-virtual Compton scattering: The parton helicity-independent case. Xiangdong Ji and Jonathan Osborne, *Department of Physics, University of Maryland, College Park, Maryland 20742.* (Received 2 September 1997; published 31 December 1997)

We show that the one-loop QCD correction to deeply virtual Compton scattering can be factorized into finite perturbative contributions and collinearly divergent terms, which correspond to the matrix elements of the off-forward parton distributions. As a by-product, we obtain the next-to-leading order coefficient functions in the generalized operator product expansion of two vector currents. [S0556-2821(98)50203-2] [Phys. Rev. D **57**, 1337 (1998)]

Testing maximal electron and muon neutrino oscillations with sub-GeV SuperKamiokande atmospheric neutrino data. R. Foot and R. R. Volkas, *School of Physics, Research Centre for High Energy Physics, The University of Melbourne, Parkville, 3052 Australia;* O. Yasuda, *Department of Physics, Tokyo Metropolitan University, 1-1 Minami-Osawa Hachioji, Tokyo 192-03, Japan.* (Received 29 September 1997; published 7 January 1998)

Motivated by the exact parity model and other theories, the hypothesis that each of the known neutrinos oscillates maximally with a sterile partner has been put forward as an explanation of the atmospheric and solar neutrino anomalies. We provide detailed predictions for muon and electron flux ratios induced in the Kamiokande and SuperKamiokande detectors by sub-GeV atmospheric neutrinos. Several different, carefully chosen cuts on momentum and zenith angle are proposed, emphasizing the role of up-down flux asymmetries. [S0556-2821(98)50103-8] [Phys. Rev. D **57**, 1345 (1998)]

Finite-temperature reaction-rate formula: Finite-volume system, detailed balance, $T\rightarrow 0$ limit, and cutting rules. A. Niégawa, *Department of Physics, Osaka City University, Sumiyoshi-ku, Osaka 558, Japan.* (Received 23 June 1997; revised manuscript received 9 September 1997; published 24 December 1997)

A complete derivation, from first principles, of the reaction-rate formula for a generic process taking place in a heat bath of finite volume is given. It is shown that the formula involves no finite-volume correction. Through perturbative diagrammatic analysis of the resultant formula, the detailed-balance formula is derived. The zero-temperature limit of the formula is discussed. Thermal cutting rules, which are introduced in previous work, are compared with those introduced by other authors. [S0556-2821(98)00903-5] [Phys. Rev. D **57**, 1379 (1998)]

Possible Σ^0-Λ mixing in the QCD sum rule. Shi-lin Zhu, *Department of Physics, Peking University, Beijing, 100871, China and Institute of Theoretical Physics, Academia Sinica, P.O. Box 2735, Beijing 100080, China;* W-Y. P. Hwang, *Department of Physics, National Taiwan University, Taipei, Taiwan 10764;* Ze-sen Yang, *Department of Physics, Peking University, Beijing, 100871, China.* (Received 27 May 1997; published 8 January 1998)

We calculate the on-shell Σ^0-Λ mixing parameter θ with the method of the QCD sum rule. Our result is $\theta(m^2_{\Sigma^0})=(-)(0.5\pm 0.1)$ MeV. The electromagnetic interaction is not included. [S0556-2821(98)03103-8] [Phys. Rev. D **57**, 1524 (1998)]

Ω and $\Sigma^0\Lambda$ transition magnetic moment in QCD sum rules. Shi-lin Zhu, *Department of Physics, Peking University, Beijing, 100871, China and Institute of Theoretical Physics, Academia Sinica, P.O. Box 2735, Beijing 100080, China;* W-Y. P. Hwang, *Department of Physics, National Taiwan University, Taipei, Taiwan 10764;* Ze-sen Yang, *Department of Physics, Peking University, Beijing, 100871, China.* (Received 27 May 1997; published 8 January 1998)

The method of QCD sum rules in the presence of the external electromagnetic $F_{\mu\nu}$ field is used to calculate the Ω magnetic moment μ_Ω and the $\Sigma^0\Lambda$ transition magnetic moment $\mu_{\Sigma^0\Lambda}$, with the susceptibilities obtained previously from the study of octet baryon magnetic moments. The results $\mu_\Omega=-1.92\mu_N$ and $\mu_{\Sigma^0\Lambda}=1.5\mu_N$

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are in good agreement with the recent experimental data. [S0556-2821(98)03003-3] [Phys. Rev. D **57**, 1527 (1998)]

Dissipative field theory with the Caldeira-Leggett method and its application to disoriented chiral condensation. Hiroyuki Yabu, Kenji Nozawa, and Toru Suzuki, *Department of Physics, Tokyo Metropolitan University, Hachioji Tokyo 192-0397, Japan.* (Received 13 June 1997; published 14 January 1998)

The effective field theory including the dissipative effect is developed based on the Caldeira-Leggett theory at the classical level. After the integration of the small field fluctuations considered as the field radiation, the integrodifferential field equation is given and shown to include dissipative effects. In that derivation, special care should be taken for the boundary condition of the integration. Application to the linear σ model is given, and the decay process of the chiral condensate is calculated with it, both analytically in the linear approximation and numerically. With these results, we discuss the stability of chiral condensates within the quenched approximation. [S0556-2821(98)03803-X] [Phys. Rev. D **57**, 1687 (1998)]

On-shell approach to pion-nucleon physics. James V. Steele, *Department of Physics, SUNY, Stony Brook, New York 11794;* Hidenaga Yamagishi, *4 Chome 11-16-502, Shimomeguro, Meguro, Tokyo 153, Japan;* Ismail Zahed, *Department of Physics, SUNY, Stony Brook, New York 11794.* (Received 23 July 1997; published 24 December 1997)

We discuss an on-shell approach to pion-nucleon physics that is consistent order by order in a $1/f_\pi$ expansion with the chiral reduction formula, crossing, and relativistic unitarity. A number of constraints between the on-shell low-energy parameters are derived at tree level in the presence of the pion-nucleon sigma term, and found to be in fair agreement with experiment. We analyze the nucleon form factors, and the $\pi N \to \pi N$ scattering amplitude to one-loop, as well as $\pi N \to \pi\pi N$ to tree level. We use the latter to derive a new constraint for the pion-nucleon sigma term at threshold. We compare our results to both relativistic and nonrelativistic chiral perturbation theory, and discuss the convergence character of the expansion in light of experiment. [S0556-2821(98)02603-4] [Phys. Rev. D **57**, 1703 (1998)]

Effects of neutrino oscillations and neutrino magnetic moments on elastic neutrino-electron scattering. W. Grimus and P. Stockinger, *Institute for Theoretical Physics, University of Vienna, Boltzmanngasse 5, A-1090 Vienna, Austria.* (Received 7 August 1997; published 31 December 1997)

We consider elastic $\overline{\nu}_e e^-$ scattering taking into account the possible effects of neutrino masses and mixing and of neutrino magnetic moments and electric dipole moments. Having in mind antineutrinos produced in a nuclear reactor we compute, in particular, the weak-electromagnetic interference terms which are linear in the magnetic (electric dipole) moments and also in the neutrino masses. We show that these terms are, however, suppressed compared to the pure weak and electromagnetic cross sections. We also comment upon the possibility of using the electromagnetic cross section to investigate neutrino oscillations. [S0556-2821(98)01703-2] [Phys. Rev. D **57**, 1762 (1998)]

Determination of decuplet baryon magnetic moments from QCD sum rules. Frank X. Lee, *Nuclear Physics Laboratory, Department of Physics, University of Colorado, Boulder, Colorado 80309-0446.* (Received 13 August 1997; published 24 December 1997)

A complete set of QCD sum rules for the magnetic moments of decuplet baryons are derived using the external field method. They are analyzed thoroughly using a Monte Carlo based procedure. Valid sum rules are identified under the criteria of OPE convergence and ground state dominance and their predictions are obtained. The performances of these sum rules are further compared and a favorable sum rule is designated for each member. Correlations between the input and the output parameters are examined and large sensitivities to the quark condensate magnetic susceptibility χ are found. Using realistic estimates of the QCD input parameters, the uncertainties on the magnetic moments are found relatively large and they can be attributed mostly to the poorly known χ. It is shown that the accuracy can be improved to the 30% level, provided the uncertainties in the QCD input parameters can be determined to the 10% level. The computed magnetic moments are consistent with existing data. Comparisons with other calculations are made. [S0556-2821(98)03203-2] [Phys. Rev. D **57**, 1801 (1998)]

Universal behavior of multiplicity differences in the quark-hadron phase transition. Rudolph C. Hwa, *Institute of Theoretical Science and Department of Physics, University of Oregon, Eugene, Oregon 97403-5203.* (Received 11 July 1997; published 8 January 1998)

The scaling behavior of the factorial moments of the differences in multiplicities between well separated bins in heavy-ion collisions is proposed as a probe of the quark-hadron phase transition. The method takes into account some of the physical features of nuclear collisions that cause some difficulty in the application of the usual method. It is shown in the Ginzburg-Landau theory that a numerical value γ of the scaling exponent can be determined independent of the parameters in the problem. The universality of γ characterizes the quark-hadron phase transition, and can be tested directly by appropriately analyzed data. [S0556-2821(98)05103-0] [Phys. Rev. D **57**, 1831 (1998)]

Color-octet fraction in J/ψ production and absorption. Cheuk-Yin Wong, *Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831;* Chun Wa Wong, *University of California, Los Angeles, California 90095-1547.* (Received 26 February 1997; published 7 January 1998)

The cross section between a $c\overline{c}$ pair and a nucleon is small and sensitive to the c-$\overline{c}$ separation if the pair is in a color-singlet state, but very large and insensitive to the separation if it is in a color-octet state. We use this property in an absorption model involving both color components to deduce the color structure of $c\overline{c}$ pairs

produced in $pA \to \psi X$ reactions. Our analysis shows that the NA3, NA38, and E772 data are not inconsistent with the theoretical picture that color-octet and color-singlet precursors are produced in roughly equal proportions if the produced color-singlet precursors are pointlike and transparent. However, if the color-singlet precursors are not transparent but have a cross section of a few mb, these data do show a definite preference for a larger fraction of color-singlet precursors. In either case, the color-octet fraction increases with x_F, approaching close to unity as x_F increases to about 0.5. [S0556-2821(98)02103-1] [Phys. Rev. D **57**, 1838 (1998)]

QCD space-time analysis of quarkonium formation and evolution in hadronic collisions. Klaus Geiger, *Department of Physics, Brookhaven National Laboratory, Upton, New York 11973.* (Received 20 June 1997; published 12 January 1998)

The production of heavy quarkonium as $Q\overline{Q}$ bound states in hadron-hadron collisions is considered within the framework of a space-time description, combining parton-cascade evolution with a coalescence model for bound-state formation. The ''hard'' production of the initial $Q\overline{Q}$, directly or via gluon fragmentation and including both color-singlet and color-octet contributions, is calculated from the perturbative QCD cross sections. The subsequent development of the $Q\overline{Q}$ system is described within a space-time generalization of the Dokshitzer-Gribov-Lipatov-Altarelli-Parisi parton-evolution formalism in position and momentum space. The actual formation of the bound states is accomplished through overlap of the $Q\overline{Q}$ pair and a spectrum of quarkonium wave functions. This coalescence can only occur after sufficient gluon radiation reduces the $Q\overline{Q}$ relative velocity to a value commensurate with the nonrelativistic kinematics of these bound systems. The presence of gluon participants in the cascade then is both necessary and leads to the natural inclusion of both color-singlet and color-octet mechanisms. The application of this approach to pp $(p\overline{p})$ collisions from $\sqrt{s} =$ 30 GeV–14 TeV reveals very decent agreement with available data from the CERN Intersecting Storage Rings and Fermilab Tevatron—without the necessity of introducing fit parameters. Moreover, production probabilities are calculated for a complete spectrum of charmonium and bottomonium states, with the relative significance compared to open charm (bottom) production. An analysis of the space-time development is carried through which sheds light on the relevance of gluon radiation and color structure, suggesting a corresponding experimental investigation. [S0556-2821(98)05003-6] [Phys. Rev. D **57**, 1895 (1998)]

Bounds on long-baseline $\overline{\nu}_e \to \overline{\nu}_e$ and $\overset{(-)}{\nu}_\mu \to \overset{(-)}{\nu}_e$ transition probabilities. S. M. Bilenky, *Joint Institute for Nuclear Research, Dubna, Russia and Institute for Advanced Study, Princeton, New Jersey 08540;* C. Giunti, *INFN, Sezione di Torino, and Dipartimento di Fisica Teorica, Università di Torino, Via P. Giuria 1, I-10125 Torino, Italy;* W. Grimus, *Institute for Theoretical Physics, University of Vienna, Boltzmanngasse 5, A-1090 Vienna, Austria.* (Received 17 June 1997; published 15 January 1998)

We discuss long-baseline neutrino oscillations in the framework of the two 4-neutrino schemes which can accommodate all existing neutrino oscillation data. Negative results of short-baseline reactor and accelerator experiments allow us to obtain rather strong bounds on the long-baseline $\overline{\nu}_e \to \overline{\nu}_e$ and $\overset{(-)}{\nu}_\mu \to \overset{(-)}{\nu}_e$ transition probabilities. We consider in detail matter effects and show that the vacuum bounds are not substantially modified. We also comment on corresponding bounds in 3-neutrino scenarios. [S0556-2821(98)02703-9] [Phys. Rev. D **57**, 1920 (1998)]

***R*-parity-conserving supersymmetry, neutrino mass, and neutrinoless double beta decay.** M. Hirsch and H. V. Klapdor-Kleingrothaus, *Max-Plank-Institut für Kernphysik, P.O. Box 10 39 80, D-69029, Heidelberg, Germany;* S. G. Kovalenko, *Joint Institute for Nuclear Research, Dubna, Russia.* (Received 1 July 1997; published 22 December 1997)

We consider contributions of R-parity-conserving softly broken supersymmetry (SUSY) to neutrinoless double beta $(0\nu\beta\beta)$ decay via the $(B-L)$-violating sneutrino mass term. The latter is a generic ingredient of any weak-scale SUSY model with a Majorana neutrino mass. The new R-parity-conserving SUSY contributions to $0\nu\beta\beta$ are realized at the level of box diagrams. We derive the effective Lagrangian describing the SUSY-box mechanism of $0\nu\beta\beta$ decay and the corresponding nuclear matrix elements. The one-loop sneutrino contribution to the Majorana neutrino mass is also derived. Given the data on the $0\nu\beta\beta$ decay half-life of ^{76}Ge and the neutrino mass we obtain constraints on the $(B-L)$-violating sneutrino mass. These constraints leave room for accelerator searches for certain manifestations of the second and third generation $(B-L)$-violating sneutrino mass term, but are most probably too tight for first generation $(B-L)$-violating sneutrino masses to be searched for directly. [S0556-2821(98)03401-8] [Phys. Rev. D **57**, 1947 (1998)]

Path length distributions of atmospheric neutrinos. T. K. Gaisser and Todor Stanev, *Bartol Research Institute, University of Delaware, Newark, Delaware 19716.* (Received 13 August 1997; published 12 January 1998)

We present the distribution of the production heights of atmospheric neutrinos as a function of zenith angle and neutrino energy. The distributions can be used as the input for evaluation of neutrino propagation under various hypotheses for neutrino flavor oscillations. [S0556-2821(98)06201-8] [Phys. Rev. D **57**, 1977 (1998)]

Neutrino mass matrix with U(2) flavor symmetry and neutrino oscillations. Morimitsu Tanimoto, *Science Education Laboratory, Ehime University, 790-77 Matsuyama, Japan.* (Received 25 June 1997; revised manuscript received 25 September 1997; published 24 December 1997)

The three neutrino mass matrices in the SU(5)×U(2) model are studied focusing on neutrino oscillation experiments. The atmospheric neutrino anomaly could be explained by a large ν_μ-ν_τ oscillation. The long baseline experiments are expected to detect signatures of the neutrino oscillation even if the atmospheric neutrino anomaly is not due to the neutrino oscillation. However, the model cannot solve the solar neutrino deficit while it could be reconciled

with the LSND data. [S0556-2821(98)04101-0] [Phys. Rev. D **57**, 1983 (1998)]

Gluon and charm content of the η' meson and instantons. E. V. Shuryak, *Department of Physics, SUNY at Stony Brook, Stony Brook, New York 11790 and Isaac Newton Institute For Mathematical Sciences, 20 Clarkson Road, Cambridge CB3 0EH, United Kingdom;* A. R. Zhitnitsky, *Physics and Astronomy Department, University of British Columbia, Vancouver, British Columbia, Canada V6T 1Z1 and Isaac Newton Institute For Mathematical Sciences, 20 Clarkson Road, Cambridge CB3 0EH, United Kingdom.* (Received 29 July 1997; published 12 January 1998)

Motivated by recent CLEO measurements of the $B\to\eta' K$ decay, we evaluate the gluon and charm content of the η' meson using the interacting instanton liquid model of the QCD vacuum. Our main result is $\langle 0|g^3 f^{abc} G^a_{\mu\nu}\widetilde{G}^b_{\nu\alpha}G^c_{\alpha\mu}|\eta'\rangle = -(2.3\text{–}3.3)\ \mathrm{GeV}^2 \times\langle 0|g^2 G^a_{\mu\nu}\widetilde{G}^a_{\mu\nu}|\eta'\rangle$. It is very large due to the strong field of small-size instantons. We show that it provides quantitative explanations of the CLEO data on the $B\to\eta' K$ decay rate (as well as the inclusive process $B\to\eta'+X$), via a virtual Cabibbo-unsuppressed decay into a $\overline{cc}$ pair which then becomes η'. If so, a significant charm component may be present in other hadrons also: We briefly discuss the contribution of the charmed quark to the *polarized* deep-inelastic scattering on a proton. [S0556-2821(98)06103-7] [Phys. Rev. D **57**, 2001 (1998)]