

Selected Abstracts from Physical Review D

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Polarized double photon production in QCD to order α_s . Claudio Corianò, *Institute for Fundamental Theory, Physics Department, University of Florida at Gainesville, Florida 32611*; L. E. Gordon, *High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439*. (Received 15 February 1996)

We present a complete order α_s analysis of the process $pp \rightarrow \gamma\gamma + X$ with polarized initial states, previously studied by us with leading order structure functions. We include in our calculation new sets of parton densities evolved in NLO QCD, such as those of Gehrmann and Stirling and of Glück et al., which incorporate the new anomalous dimensions of Mertig and Van Neerven in the evolution equation. A detailed phenomenological analysis is also given which includes the photon isolation. Our results indicate that the asymmetries, although not very large, should be substantial enough at BNL RHIC energies to be measurable in future planned experiments. [S0556-2821(96)04413-X] [Phys. Rev. D **54**, 781 (1996)]

Polarized inclusive lepton production, $lN \rightarrow hX$, and the hadron helicity density matrix $\rho(h)$: Possible measurements and predictions. Mauro Anselmino and Maria Boglione, *Dipartimento di Fisica Teorica, Università di Torino and Istituto Nazionale di Fisica Nucleare, Sezione di Torino, Via P. Giuria 1, I-10125 Torino, Italy*; Johan Hansson, *Department of Physics, Luleå University of Technology, S-97187 Luleå, Sweden*; Francesco Murgia, *Istituto Nazionale di Fisica Nucleare, Sezione di Cagliari, Via Ada Negri 18, I-09127 Cagliari, Italy*. (Received 22 December 1995)

We discuss the production of hadrons in polarized lepton-nucleon interactions and in the current jet fragmentation region; using the QCD hard scattering formalism we compute the helicity density matrix of the hadron and show how its elements, when measurable, can give information on the spin structure of the nucleon and the spin dependence of the quark fragmentation process. The cases of ρ vector mesons and Λ baryons are considered in more detail and, within simplifying assumptions, some estimates are given. [S0556-2821(96)01913-3] [Phys. Rev. D **54**, 828 (1996)]

Intrinsic charm component of the nucleon. F. S. Navarra, M. Nielsen, C. A. A. Nunes, and M. Teixeira, *Nuclear Theory and Elementary Particle Phenomenology Group, Instituto de Física da Universidade de São Paulo, Caixa Postal 66318, 05389-970 São Paulo, Brazil*. (Received 19 June 1995)

Using a $\bar{D}$ meson cloud model we calculate the squared charm radius of the nucleon. The ratio between this squared radius and the ordinary baryon squared radius is identified with the probability of “seeing” the intrinsic charm component of the nucleon. Our esti-

mate is compatible with those used to successfully describe the charm production phenomenology. However, because of the lack of relevant experimental information, a large uncertainty in our result is unavoidable. [S0556-2821(96)02811-1] [Phys. Rev. D **54**, 842 (1996)]

“Hot spots” effect in nuclear shadowing. Wei Zhu and Jianhong Ruan, *CCAST (World Laboratory), P.O. Box 8730, Beijing 100080, People’s Republic of China and Department of Physics, East China Normal University, Shanghai 200062, People’s Republic of China*. (Received 12 February 1996)

Shadowing in inelastic lepton-nucleus scattering is analyzed by using the modified Gribov-Levin-Ryskin evolution equation. We find that a comparison of the structure functions between nuclear and proton targets at $x < 10^{-3}$ and $Q^2 > 1 \text{ GeV}^2$ can provide useful information about the hot spots of the nucleon. [S0556-2821(96)03513-8] [Phys. Rev. D **54**, 847 (1996)]

Quantum field kinetics of QCD: Quark-gluon transport theory for light-cone-dominated processes. Klaus Geiger, *CERN TH-Division, CH-1211 Geneva 23, Switzerland*. (Received 20 July 1995)

A quantum-kinetic formalism is developed to study the dynamical interplay of quantum and statistical-kinetic properties of non-equilibrium multiparton systems produced in high-energy QCD processes. The approach provides the means to follow the quantum dynamics in both space-time and energy-momentum, starting from an arbitrary initial configuration of high-momentum quarks and gluons. Using a generalized functional integral representation and adopting the “closed-time-path” Green function techniques, a self-consistent set of equations of motions is obtained: a Ginzburg-Landau equation for a possible color background field, and Dyson-Schwinger equations for the two-point functions of the gluon and quark fields. By exploiting the “two-scale nature” of light-cone-dominated QCD processes, i.e., the separation between the quantum scale that specifies the range of short-distance quantum fluctuations, and the kinetic scale that characterizes the range of statistical binary interactions, the quantum field equations of motion are converted into a corresponding set of “renormalization equations” and “transport equations.” The former describe renormalization and dissipation effects through the evolution of the spectral density of individual, dressed partons, whereas the latter determine the statistical occurrence of scattering processes among these dressed partons. The renormalization equations and the transport equations are coupled, and, hence, must be solved self-consistently. This amounts to evolving the multiparton system, from a specified initial configu-

ration, in time and full seven-dimensional phase space, constrained by the Heisenberg uncertainty principle. This quantum-kinetic description provides a probabilistic interpretation and is, therefore, of important practical value for the solution of the dynamical equations of motion, suggesting, for instance, the possibility of simulating the multiparticle dynamics with Monte Carlo methods. [S0556-2821(96)01113-7] [Phys. Rev. D **54**, 949 (1996)]

Hadronic correlation functions in the interacting instanton liquid. T. Schäfer, *Institute for Nuclear Theory, Department of Physics, University of Washington, Seattle, Washington 98195*; E. V. Shuryak, *Department of Physics, State University of New York at Stony Brook, Stony Brook, New York 11794*. (Received 17 January 1996)

In this paper we study hadronic correlation functions in the interacting instanton liquid model, both at zero and nonzero temperature T . At zero T we investigate the dependence of the correlators on the instanton ensemble, in particular, the effect of the fermionic determinant. We demonstrate that quark-induced correlations between instantons are important, especially in the repulsive η' and δ -meson channels. We also calculate a large number of mesonic and baryonic correlation functions as a function of temperature. We find three different types of behavior as $T \rightarrow T_c$. The vector channels ρ, a_1, Δ show a gradual melting of the resonance contribution and approach free quark behavior near the chiral phase transition. The light pseudoscalars and scalars π, σ as well as the nucleon show stable resonance contributions, probably even surviving above T_c . Correlation functions in the heavy scalar channels η', δ are enhanced as $T \rightarrow T_c$. [S0556-2821(96)04313-5] [Phys. Rev. D **54**, 1099 (1996)]

Effective chiral Lagrangian from dual resonance models. Maxim V. Polyakov, *Petersburg Nuclear Physics Institute, Gatchina 188350, St. Petersburg, Russia*; Vladimir V. Vereshagin, *Institute of Physics, St. Petersburg University, 198904 St. Petersburg, Russia*. (Received 4 January 1996)

The parameters of the effective chiral Lagrangian (EChL) of order $O(p^4)$ and $O(p^6)$ are extracted from the low-energy behavior of dual resonance models for $\pi\pi$ and πK scattering amplitudes. We discuss the dual resonance models in the presence of spontaneous and explicit chiral symmetry breaking. The obtained parameters of the EChL are used to estimate chiral corrections up to sixth order to various low-energy characteristics of $\pi\pi$ and πK scattering amplitudes. [S0556-2821(96)01413-0] [Phys. Rev. D **54**, 1112 (1996)]

Possible effects of quark and gluon condensates in heavy quarkonium spectra. Y. B. Ding,¹⁻³ X. H. Guo,^{3,5} X. Q. Li,^{1,3,4} and P. N. Shen,^{1,3,5,6} ¹*China Center of Advanced Science and Technology (World Laboratory), P.O. Box 8730, Beijing 100080, China* ²*Graduate School, Academia Sinica, P.O. Box 3908, Beijing*

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The Cornell potential with the best fitted parameters α_s and κ are modified by adding terms derived from nonperturbative QCD, which are characterized by a series of nonvanishing vacuum condensates of quarks and gluons. In terms of this potential, we study the system of heavy quarkonia. The results show that the correction caused by the additional terms reduces the deviation between the data and the values calculated with the pure Cornell potential and improves the splittings of energy levels. The achievements indicate that the nonperturbative effects induced by vacuum condensates play an important role for the correction to $1/q^2$, which in general was phenomenologically put in by hand. This result would be helpful for understanding nonperturbative QCD along a parallel direction to the QCD sum rules. [S0556-2821(96)04411-6] [Phys. Rev. D **54**, 1136 (1996)]

Neutral meson photoproduction in $SU_f(3)$ chiral perturbation theory: $\gamma N \rightarrow \pi^0 N$. M. K. Banerjee and J. Milana, *Department of Physics, University of Maryland, College Park, Maryland 20742*. (Received 24 January 1996; revised manuscript received 27 February 1996)

We present the results for the electric dipole amplitude for $\gamma N \rightarrow \pi^0 N$ at threshold at the $O(p^2)$ level in $SU_f(3)$ chiral perturbation theory. We find that the $SU_f(3)$ results differ only slightly from the $SU_f(2)$ results. At the $O(p^3)$ level one encounters new, unknown counterterms to fix which one is likely to need the threshold photoproduction data themselves, thus, losing predictive power. We suggest, instead, that the difference between the proton and neutron π^0 photoproduction amplitudes may provide a test of the convergence properties of χ PT in the present context. We urge that the neutron's electric dipole amplitude be measured. [S0556-2821(96)03313-9] [Phys. Rev. D **54**, 1182 (1996)]

Nonadiabatic three-neutrino oscillations in matter. J. C. D'Olivo, *Instituto de Ciencias Nucleares, Universidad Nacional Autónoma de México, Apartado Postal 70-543, 04510 México, D.F., Mexico*; J. A. Oteo, *Departament de Física Teòrica, Universitat de València and Instituto de Física Corpuscular, E-46100 Burjassot (València), Spain*. (Received 6 October 1995)

Oscillations of three neutrinos in matter are analyzed by using the Magnus expansion for the time-evolution operator. We derive a simple expression for the electron-neutrino survival probability which is applied to the examination of the effect of a third neutrino on the nonadiabatic flavor transformations. [S0556-2821(96)04511-0] [Phys. Rev. D **54**, 1187 (1996)]

Neutrino oscillations and the supernova 1987A signal. Beat Jegerlehner, Frank Neubig, and Georg Raffelt, *Max-Planck-Institut für Physik, Föhringer Ring 6, 80805 München, Germany.* (Received 22 January 1996)

We study the impact of neutrino oscillations on the interpretation of the supernova (SN) 1987A neutrino signal by means of a maximum-likelihood analysis. We focus on oscillations between ν_e with ν_μ or ν_τ with those mixing parameters that would solve the solar neutrino problem. For the small-angle MSW solution ($\Delta m^2 \approx 10^{-5} \text{ eV}^2$, $\sin^2 2\theta_0 \approx 0.007$), there are no significant oscillation effects on the Kelvin-Helmholtz cooling signal; we confirm previous best-fit values for the neutron-star binding energy and average spectral ν_e temperature. There is only marginal overlap between the upper end of the 95.4% C.L. inferred range of $\langle E_{\nu_e} \rangle$ and the lower end of the range of theoretical predictions. Any admixture of the stiffer ν_μ spectrum by oscillations aggravates the conflict between experimentally inferred and theoretically predicted spectral properties. For mixing parameters in the neighborhood of the large-angle MSW solution ($\Delta m^2 \approx 10^{-5} \text{ eV}^2$, $\sin^2 2\theta_0 \approx 0.7$) the oscillations in the SN are adiabatic, but one needs to include the regeneration effect in the Earth which causes the Kamiokande and IMB detectors to observe different ν_e spectra. For the solar vacuum solution ($\Delta m^2 \approx 10^{-10} \text{ eV}^2$, $\sin^2 2\theta_0 \approx 1$) the oscillations in the SN are nonadiabatic; vacuum oscillations take place between the SN and the detector. If one of the two large-angle solutions were borne out by the upcoming round of solar neutrino experiments, one would have to conclude that the SN 1987A ν_μ and/or ν_e spectra had been much softer than predicted by current treatments of neutrino transport. [S0556-2821(96)02613-6] [Phys. Rev. D **54**, 1194 (1996)]

Longitudinal quark polarization in transversely polarized nucleons. A. M. Kotzinian, *Yerevan Physics Institute, Alikhanian Brothers St. 2, AM-375036, Yerevan, Armenia*; P. J. Mulders, *Department of Physics and Astronomy, Free University of Amsterdam and National Institute for Nuclear Physics and High-Energy Physics, P.O. Box 41882, NL-1009 DB Amsterdam, The Netherlands.* (Received 27 November 1995)

Accounting for transverse momenta of the quarks, a longitudinal quark spin asymmetry exists in a transversely polarized nucleon target. The relevant leading quark distribution $g_{1T}(x, k_T^2)$ can be measured in semi-inclusive deep-inelastic scattering. The average k_T^2 weighted distribution function $g_{1T}^{(1)}$ can be obtained directly from the inclusive measurement of g_2 . [S0556-2821(96)03813-1] [Phys. Rev. D **54**, 1229 (1996)]

Positivity restrictions in polarized deep-inelastic electron scattering from the deuteron. V. Dmitrašinović, *Physics Department, University of Colorado, Nuclear Physics Lab, P.O. Box 446, Boulder, Colorado 80309.* (Received 12 January 1996)

We examine the restrictions on inclusive polarized deep-inelastic electronuclear scattering with spin-1 targets imposed by positivity. As a result we obtain a set of inequalities involving the polarized and unpolarized structure functions. [S0556-2821(96)03213-4] [Phys. Rev. D **54**, 1237 (1996)]