Selected Abstracts from Other Physical Review Journals

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Schwinger-Dyson approach to nonequilibrium classical field theory. Krastan B. Blagoev,[1] Fred Cooper,[2] John F. Dawson,[3] and Bogdan Mihaila[4] [1]*Department of Physics, Boston College, Chestnut Hill, Massachusetts 02167,* [2]*Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545,* [3]*Department of Physics, University of New Hampshire, Durham, New Hampshire 03824,* [4]*Physics Division, Argonne National Laboratory, Argonne, Illinois 60439.* (Received 28 June 2001; published 26 November 2001)

In this paper we discuss a Schwinger-Dyson (SD) approach for determining the time evolution of the unequal time correlation functions of a nonequilibrium classical field theory, where the classical system is described by an initial density matrix at time $t=0$. We focus on $\lambda\phi^4$ field theory in $1+1$ space-time dimensions where we can perform exact numerical simulations by sampling an ensemble of initial conditions specified by the initial density matrix. We discuss two approaches. The first, the bare vertex approximation (BVA), is based on ignoring vertex corrections to the SD equations in the auxiliary field formalism relevant for $1/N$ expansions. The second approximation is a related approximation made to the SD equations of the original formulation in terms of ϕ alone. We compare these SD approximations as well as a Hartree approximation with exact numerical simulations. We find that both approximations based on the SD equations yield good agreement with exact numerical simulations and cure the late time oscillation problem of the Hartree approximation. We also discuss the relationship between the quantum and classical SD equations. [Phys. Rev. D **64**, 125003 (2001)]

Seesaw mechanism in three flavors. Haijun Pan, *Lab of Quantum Communication and Quantum Computation, and Center of Nonlinear Science, University of Science and Technology of China, Hefei, Anhui 230026, People's Republic of China;* G. Cheng, *CCAST (World Laboratory), P.O. Box 8730, Beijing 10080, People's Republic of China, and Department of Astronomy and Applied Physics, University of Science and Technology of China, Hefei, Anhui 230026, People's Republic of China.* (Received 16 March 2001; published 7 December 2001)

We advance a method used to analyze the neutrino properties (masses and mixing) in the seesaw mechanism. Assuming quark-lepton symmetry and hierarchical light neutrino masses, we establish rather simple relations between the light and the heavy neutrino parameters in the favored regions of the solar and the atmospheric neutrino experiments. An empirical condition satisfied by the right-handed mixing angles is obtained. [Phys. Rev. D **65**, 013002 (2002)]

Radiative correction to the transferred polarization in elastic electron-proton scattering. A. V. Afanasev and I. Akushevich, *North Carolina Central University, Durham, North Carolina 27707, and Jefferson Lab (TJNAF), Newport News, Virginia 23606;* N. P. Merenkov, *National Science Centre (NSC) "Kharkov Institute of Physics and Technology," 61108, Akademicheskaya 1, Kharkov, Ukraine.* (Received 26 September 2000; published 11 December 2001)

Using a method of electron structure functions, we calculated a model independent radiative correction to the recoil proton polarization for elastic electron-proton scattering. Explicit expressions for the recoil proton polarization are represented as a convolution of the electron structure functions and the hard part of the polarization-dependent contribution into the cross section. The hard part is calculated with first order radiative corrections. The obtained representation includes leading radiative corrections in all orders of perturbation theory and the main part of the second order next-to-leading radiative corrections. Numerical calculations illustrate our analytical results. [Phys. Rev. D **65**, 013006 (2002)]

Probing neutrino nonstandard interactions with atmospheric neutrino data. N. Fornengo, *Dipartimento di Fisica Teorica, Università di Torino and INFN, Sezione di Torino, Via Pietro Giuria 1, I-10125 Torino, Italy;* M. Maltoni, R. Tomàs Bayo, and J. W. F. Valle, *Instituto de Física Corpuscular-CSIC/Universitat de Valèncía, Edificio Institutos de Paterna, Apt 22085, E-46071 Valencia, Spain.* (Received 9 August 2001; published 12 December 2001)

We reconsider the atmospheric neutrino anomaly in light of the latest data from Super-Kamiokande contained events and from Super-Kamiokande and MACRO upgoing muons. We reanalyze the proposed solution to the atmospheric neutrino anomaly in terms of nonstandard neutrino-matter interactions (NSI's) as well as the standard $\nu_\mu \to \nu_\tau$ oscillations (OSC's). Our statistical analysis shows that a pure NSI mechanism is now ruled out at 99%, while the standard $\nu_\mu \to \nu_\tau$ OSC mechanism provides a quite remarkably good description of the anomaly. We therefore study an extended mechanism of neutrino propagation which combines both oscillation and nonstandard neutrino-matter interactions, in order to derive limits on flavor-changing and nonuniversal neutrino interactions. We obtain that the off-diagonal flavor-changing neutrino parameter ε and the diagonal nonuniversality neutrino parameter ε' are confined to $-0.05<\varepsilon<0.04$ and $|\varepsilon'|<0.17$ at 99% C.L. These limits are model independent and they are obtained from pure neutrino-physics processes. The stability of the neutrino oscillation solution to the atmospheric neutrino anomaly against the presence of nonstandard neutrino interactions establishes the robustness of the near-maximal atmospheric mixing and massive-neutrino hypothesis. The best agreement with the data is obtained for $\Delta m^2 = 2.4 \times 10^{-3}$ eV^2, $\sin^2(2\theta)=0.99$, $\varepsilon = -9.1\times 10^{-3}$, and $\varepsilon' = -1.9$

$\times 10^{-3}$, although the χ^2 function is quite flat in the ε and ε' directions for $\varepsilon, \varepsilon' \to 0$. [Phys. Rev. D **65**, 013010 (2002)]

U(2)-like flavor symmetries and approximate bimaximal neutrino mixing. Alfredo Aranda, *Department of Physics, Boston University, 590 Commonwealth Avenue, Boston, Massachusetts 02215;* Christopher D. Carone and Patrick Meade, *Nuclear and Particle Theory Group, Department of Physics, College of William and Mary, Williamsburg, Virginia 23187-8795.* (Received 14 September 2001; published 12 December 2001)

Models involving a U(2) flavor symmetry, or any of a number of its non-Abelian discrete subgroups, can explain the observed hierarchy of charged fermion masses and Cabibbo-Kobayashi-Maskawa angles. It is known that a large neutrino mixing angle connecting second and third generation fields may arise via the seesaw mechanism in these models, without a fine-tuning of the parameters. Here we show that it is possible to obtain approximate bimaximal mixing in a class of models with U(2)-like Yukawa textures. We find a minimal form for Dirac and Majorana neutrino mass matrices that leads to two large mixing angles, and show that our result can quantitatively explain atmospheric neutrino oscillations while accommodating the favored, large-angle Mikheyev-Smirnov-Wolfenstein solution to the solar neutrino problem. We demonstrate that these textures can arise in models by presenting a number of explicit examples. [Phys. Rev. D **65**, 013011 (2002)]

Energy spectra of reactor neutrinos at KamLAND. Hitoshi Murayama and Aaron Pierce, *Center for Theoretical Physics, Department of Physics, University of California, Berkeley, California 94720, and Theory Group, Lawrence Berkeley National Laboratory, Berkeley, California 94720.* (Received 6 August 2001; published 12 December 2001)

The upcoming reactor neutrino experiment, KamLAND, has the ability to explore the large mixing angle solution to the solar neutrino problem. Here, we investigate the precision to which KamLAND should be able to measure these parameters, utilizing the distortion of the energy spectrum of reactor neutrinos. Incomplete knowledge of the fuel composition of the reactors will lead to some error on this measurement. We estimate the size of this effect. [Phys. Rev. D **65**, 013012 (2002)]

Asymmetry of the strange sea in nucleons. Xue-Qian Li and Xiao-Bing Zhang, *CCAST (The World Laboratory), P.O. Box 8730, Beijing, 100080, China, and Department of Physics, Nankai University, Tianjin, 300071, China;* Bo-Qiang Ma, *CCAST (The World Laboratory), P.O. Box 8730, Beijing, 100080, China, and Department of Physics, Peking University, Beijing, 100871, China* (Received 8 June 2001; published 28 November 2001)

Based on finite-temperature field theory, we evaluate medium effects in the nucleon, which can induce an asymmetry between quarks and antiquarks of the strange sea. The short-distance effects determined by the weak interaction can give rise to $\delta m \equiv \Delta m_s - \Delta m_{\bar{s}}$ where $\Delta m_{s(\bar{s})}$ is the medium-induced mass of the strange quark of a few keV at most, but the long-distance effects caused by strong interaction are sizable. Our numerical results show that there exists an obvious mass difference between strange and antistrange quarks, as large as 10–100 MeV.
12.40.−y, 11.10.Wx, 11.30.Na, 14.20.Dh

Heavy-quarkonium hadron cross section in QCD at leading twist. François Arleo, Pol-Bernard Gossiaux, Thierry Gousset, and Jörg Aichelin, *SUBATECH, Laboratoire de Physique Subatomique et des Technologies Associées, UMR Université de Nantes, IN2P3/CNRS, Ecole des Mines de Nantes, 4, rue Alfred Kastler, 44070 Nantes cedex 03, France.* (Received 9 February 2001; published 29 November 2001)

We compute the total cross section of a heavy quarkonium on a hadron target in leading twist QCD, including target mass corrections. Our method relies on the analytical continuation of the operator product expansion of the scattering amplitude, obtained long ago by Bhanot and Peskin. The cross section has a simple partonic form, which allows us to investigate the phenomenology of J/ψ and Υ dissociation by both pions and protons. [Phys. Rev. D **65**, 014005 (2002)]

Strange form factors in the context of SAMPLE, HAPPEX, and A4 experiments. António Silva, *Institut für Theoretische Physik II, Ruhr-Universität Bochum, D–44780 Bochum, Germany, and Departamento de Física and Centro de Física Computacional, Universidade de Coimbra, P-3000 Coimbra, Portugal;* Hyun-Chul Kim, *Department of Physics, Pusan National University, 609-735 Pusan, Republic of Korea;* Klaus Goeke, *Institut für Theoretische Physik II, Ruhr-Universität Bochum, D–44780 Bochum, Germany.* (Received 20 August 2001; published 12 December 2001)

The strange properties of the nucleon are investigated within the framework of the SU(3) chiral quark-soliton model assuming isospin symmetry and applying symmetry-conserving SU(3) quantization. We present the form factors $G^0_{E,M}(Q^2), G^Z_M(Q^2)$ and the electric and magnetic strange form factors $G^s_{E,M}(Q^2)$ incorporating pion and kaon asymptotics. The results show a fairly good agreement with the recent experimental data from the SAMPLE and HAPPEX collaborations. We also present predictions for future measurements including the A4 experiment at MAMI (Mainz). [Phys. Rev. D **65**, 014016 (2002)]

Comprehensive approach to structure functions. A. Donnachie, *Department of Physics and Astronomy, University of Manchester, Manchester M13 9PL, United Kingdom;* H. G. Dosch, *Institut für Theoretische Physik der Universität Heidelberg Philosophenweg 16, D-69120 Heidelberg, Germany.* (Received 12 July 2001; published 12 December 2001)

We present a model based on a dipole picture with a hard and a soft Pomeron in which large dipoles couple to the soft Pomeron and small dipoles couple to the hard Pomeron. The parameters in the model are fixed by proton-proton scattering and the proton structure

function $F_2(x,Q^2)$. The model is then applied successfully to the proton charm structure function $F_2^c(x,Q^2)$, the proton longitudinal structure function $F_2^L(x,Q^2)$, J/ψ photoproduction, deep virtual Compton scattering $\gamma^* p \to \gamma p$, the real photon-proton total cross section $\sigma_{\gamma p}^{\rm tot}(s)$, the real photon-photon total cross section $\sigma_{\gamma\gamma}^{\rm tot}(s)$, and the photon structure function $F_2^\gamma(x,Q^2)$. Differences between our predictions and data on charm production in real photon-photon interactions and the $\gamma^*\gamma^*$ cross section $\sigma_{\gamma\gamma}^{\rm tot}(s)$ are discussed. [Phys. Rev. D **65**, 014019 (2002)]

Solutions of the atmospheric, solar, and LSND neutrino anomalies from TeV scale quark-lepton unification. T. L. Yoon and R. Foot, *School of Physics, Research Centre for High Energy Physics, The University of Melbourne, Victoria 3010, Australia.* (Received 11 May 2001; published 29 November 2001)

There is a unique $SU(4)\otimes SU(2)_L\otimes SU(2)_R$ gauge model which allows quarks and leptons to be unified at the TeV scale. It is already known that the neutrino masses arise radiatively in the model and are naturally light. We study the atmospheric, solar, and LSND neutrino anomalies within the framework of this model. [Phys. Rev. D **65**, 015002 (2002)]

Effective field theory dimensional regularization. Dirk Lehmann and Gary Prézeau, *Department of Physics, Hampton University, Hampton, Virginia 23668.* (Received 14 February 2001; published 7 December 2001)

A Lorentz-covariant regularization scheme for effective field theories with an arbitrary number of propagating heavy and light particles is given. This regularization scheme leaves the low-energy analytic structure of Greens functions intact and preserves all the symmetries of the underlying Lagrangian. The power divergences of regularized loop integrals are controlled by the low-energy kinematic variables. Simple diagrammatic rules are derived for the regularization of arbitrary one-loop graphs and the generalization to higher loops is discussed. [Phys. Rev. D **65**, 016001 (2002)]

Chiral multiplets versus parity doublets in highly excited baryons. Thomas D. Cohen, *Department of Physics, University of Maryland, College Park, Maryland 20742-4111;* Leonid Ya. Glozman, *Institue for Theoretical Physics, University of Graz, Universitätsplatz 5, A-8010 Graz, Austria.* (Received 16 February 2001; published 12 December 2001)

It has recently been suggested that the parity doublet structure seen in the spectrum of highly excited baryons may be due to effective chiral restoration for these states. We argue how the idea of chiral symmetry restoration high in the spectrum is consistent with the concept of quark-hadron duality. If chiral symmetry is effectively restored for highly lying states, then the baryons should fall into representations of $SU(2)_L\times SU(2)_R$ that are compatible with the given parity of the states—the parity-chiral multiplets. We classify all possible parity-chiral multiplets: (i) $(1/2,0)\oplus(0,1/2)$ that contain parity doublet for nucleon spectrum, (ii) $(3/2,0)\oplus(0,3/2)$ consists of the parity doublet for delta spectrum, (iii) $(1/2,1)\oplus(1,1/2)$ contains one parity doublet in the nucleon spectrum and one parity doublet in the delta spectrum of the same spins that are degenerate in mass. Here we show that the available spectroscopic data for nonstrange baryons in the ~ 2 GeV range are consistent with all possibilities, but the approximate degeneracy of parity doublets in nucleon and delta spectra support the latter possibility with excited baryons approximately falling into $(1/2,1)\oplus(1,1/2)$ representation of $SU(2)_L\times SU(2)_R$ with approximate degeneracy between positive and negative parity N and Δ resonances of the same spin. [Phys. Rev. D **65**, 016006 (2002)]

Remarks on Δ radiative and Dalitz decays. M. I. Krivoruchenko, *Institut für Theoretische Physik, Universität Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen, Germany and Institute for Theoretical and Experimental Physics, B. Cheremushkinskaya 25, 117259 Moscow, Russia;* Amand Faessler, *Institut für Theoretische Physik, Universität Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen, Germany.* (Received 12 April 2001; published 11 December 2001)

Phenomenological expressions are derived for the rates of the $\Delta(1232)$ radiative and Dalitz decays $\Delta(1232)\to N\gamma$ and $\Delta(1232)\to Ne^+e^-$. Earlier calculations of these decays are commented upon. [Phys. Rev. D **65**, 017502 (2002)]

Meson mass differences in two dimensional gauged four-Fermi models. Kenichiro Aoki, *Hiyoshi Department of Physics, Keio University, 4-1-1 Hiyoshi, Kouhoku-ku, Yokohama 223-8521, Japan;* Kenji Ito, *Department of Physics, Tokyo Institute of Technology, 2-12-1 Oh-okayama, Meguro-ku, Tokyo 152-0033, Japan.* (Received 26 July 2001; published 19 December 2001)

We quantitatively analyze the meson mass inequality relations of two dimensional gauged four-Fermi models in the large N limit. The class of models we study includes the 't Hooft model and the chiral and nonchiral Gross-Neveu models as special points in the space of field theories. Cases in which the chiral symmetry is spontaneously or explicitly broken are both studied. We study the meson mass differences quantitatively and define a susceptibility which allows us to systematically analyze these quantities. In the generalized Gross-Neveu model limit, we derive an analytic expression for this susceptibility. Even though no analytic proof of the validity of the classic mass inequality exists for the generic case, the mass difference is found to have the standard sign throughout most of the parameter space. We point out that the difference might have the opposite sign in certain cases. [Phys. Rev. D **65**, 025003 (2002)]

Coulomb gauge QCD, confinement, and the constituent representation. Adam P. Szczepaniak, *Department of Physics and Nuclear Theory Center, Indiana University, Bloomington, Indiana 47405-4202;* Eric S. Swanson, *Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh, Pennslyvania 15260, and Jefferson Lab, 12000 Jefferson Ave, Newport News,*

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Quark confinement and the genesis of the constituent quark model are examined in nonperturbative QCD in Coulomb gauge. We employ a self-consistent method to construct a quasiparticle basis and to determine the quasiparticle interaction. The results agree remarkably well with lattice computations. They also illustrate the mechanism by which confinement and constituent quarks emerge, provide support for the Gribov-Zwanziger confinement scenario, clarify several perplexing issues in the constituent quark model, and permit the construction of an improved model of low energy QCD. [Phys. Rev. D **65**, 025012 (2002)]

Electroweak radiative corrections to parity-violating electroexcitation of the Δ. Shi-Lin Zhu,[1,2] C. M. Maekawa,[2] G. Sacco,[1,2] B. R. Holstein,[3] and M. J. Ramsey-Musolf[1,2,4] [1]*Department of Physics, University of Connecticut, Storrs, Connecticut 06269,* [2]*Kellogg Radiation Laboratory, California Institute of Technology, Pasadena, California 91125,* [3]*Department of Physics, University of Massachusetts, Amherst, Massachusetts 01003,* [4]*Theory Group, Thomas Jefferson National Accelerator Facility, Newport News, Virginia 23606.* (Received 10 July 2001; published 20 December 2001)

We analyze the degree to which parity-violating (PV) electroexcitation of the $\Delta(1232)$ resonance may be used to extract the weak neutral axial vector transition form factors. We find that the axial vector electroweak radiative corrections are large and theoretically uncertain, thereby modifying the nominal interpretation of the PV asymmetry in terms of the weak neutral form factors. We also show that, in contrast with the situation for elastic electron scattering, the axial $N\rightarrow\Delta$ PV asymmetry does not vanish at the photon point as a consequence of a new term entering the radiative corrections. We argue that an experimental determination of these radiative corrections would be of interest for hadron structure theory, possibly shedding light on the violation of Hara's theorem in weak, radiative hyperon decays. [Phys. Rev. D **65**, 033001 (2002)]