Selected Abstracts from Other Physical Review Journals

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Quantum dynamics of phase transitions in broken symmetry $\lambda\phi^4$ field theory. Fred Cooper, *Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545;* John F. Dawson, *Department of Physics, University of New Hampshire, Durham, New Hampshire 03824;* Bogdan Mihaila, *Physics Division, Argonne National Laboratory, Argonne, Illinois 60439.* (Received 22 August 2002; published 28 March 2003)

We perform a detailed numerical investigation of the dynamics of a single component "explicitly broken symmetry" $\lambda\phi^4$ field theory in $1+1$ dimensions, using a Schwinger-Dyson equation truncation scheme based on ignoring vertex corrections. In an earlier paper, we called this the bare vertex approximation (BVA). We assume here that the initial state is described by a Gaussian density matrix peaked around some nonzero value of $\langle\phi(0)\rangle$, and characterized by a single particle Bose-Einstein distribution function at a given temperature. We compute the evolution of the system using three different approximations: the Hartree approximation, the BVA, and a related two-particle irreducible (2PI) $1/N$ expansion, as a function of coupling strength and initial temperature. In the Hartree approximation, the static phase diagram shows that there is a first order phase transition for this system. As we change the initial starting temperature of the system, we find that the BVA relaxes to a new final temperature and exhibits behavior consistent with a second order phase transition. We find that the average fields equilibrate for arbitrary initial conditions in the BVA, unlike the behavior exhibited by the Hartree approximation, and we illustrate how $\langle\phi(t)\rangle$ and $\langle\chi(t)\rangle$ depend on the initial temperature and on the coupling constant. The Fourier transform of the two-point functions at late times can be fitted by a Bose-Einstein distribution function whose temperature is independent of momentum. We interpret this as evidence for thermalization. [Phys. Rev. D **67**, 056003 (2003)]

Energy spectra of atmospheric muons measured with the CAPRICE98 balloon experiment. M. Boezio, V. Bonvicini, P. Schiavon, A. Vacchi, and N. Zampa, *University of Trieste and Sezione INFN di Trieste, Via A. Valerio 2, I-34147 Trieste, Italy;* D. Bergström, P. Carlson, T. Francke, P. Hansen, and E. Mocchiutti, *Royal Institute of Technology (KTH), AlbaNova University Center (SCFAB), S-10691 Stockholm, Sweden;* M. Suffert, *Centre des Recherches Nucléaires, BP20, F-67037 Strasbourg Cedex, France;* M. Hof, J. Kremer, W. Menn, and M. Simon, *Universität Siegen, 57068 Siegen, Germany;* M. Ambriola, R. Bellotti, F. Cafagna, F. Ciacio, M. Circella, and C. N. De Marzo, *University of Bari and Sezione INFN di Bari, Via Amendola 173, I-70126 Bari, Italy;* P. Papini, S. Piccardi, P. Spillantini, and E. Vannuccini, *University of Firenze and Sezione INFN di Firenze, Largo E. Fermi 2, I-50125 Firenze, Italy;* S. Bartalucci and M. Ricci, *INFN–Laboratori Nazionali di Frascati, Via E. Fermi 40, CP 13, I-00044 Frascati, Italy;* M. Casolino, M. P. De Pascale, A. Morselli, P. Picozza, and R. Sparvoli, *University of Roma "Tor Vergata" and Sezione INFN di Roma II, Via della Ricerca Scientifica 1, I-00133 Roma, Italy;* J. W. Mitchell, J. F. Ormes, S. A. Stephens, and R. E. Streitmatter, *Code 661, NASA/Goddard Space Flight Center, Greenbelt, Maryland 20771;* U. Bravar and S. J. Stochaj, *R. L. Golden Particle Astrophysics Lab, Box 3 PAL, New Mexico State University, Las Cruces, New Mexico 88003.* (Received 14 February 2003; published 24 April 2003)

The measurement of the atmospheric muon spectrum is currently of great interest because of the study of atmospheric neutrinos and the claim of neutrino oscillations made in 1998 by the Super-Kamiokande Collaboration. A measurement of the muon flux is an indirect measure of the neutrino flux. Therefore, it can be used to improve the calculation of the atmospheric neutrino flux, which in turn can be compared with the observed neutrino rates in underground detectors. This article reports a new measurement of the μ^+ and μ^- spectra at several atmospheric depths in the momentum ranges 0.3–20 GeV/c and 0.3–40 GeV/c, respectively. The data were collected by the balloon-borne experiment CAPRICE98 during the ascent of the payload on 28 May 1998 from Fort Sumner, N. M. The experiment used the NMSU-WIZARD/CAPRICE 98 balloon-borne magnet spectrometer equipped with a gas ring imaging Cherenkov detector and a silicon-tungsten calorimeter. [Phys. Rev. D **67**, 072003 (2003)]

Solar neutrino oscillation parameters after first KamLAND results. G. L. Fogli,[1] E. Lisi,[1] A. Marrone,[1] D. Montanino,[2] A. Palazzo,[1] and A. M. Rotunno[1] [1]*Dipartimento di Fisica and Sezione INFN di Bari, Via Amendola 173, 70126 Bari, Italy,* [2]*Dipartimento di Scienza dei Materiali and Sezione INFN di Lecce, Via Arnesano, 73100 Lecce, Italy.* (Received 10 December 2002; published 7 April 2003)

We analyze the energy spectrum of reactor neutrino events recently observed in the Kamioka Liquid Scintillator Antineutrino Detector (KamLAND) and combine them with solar and terrestrial neutrino data, in the context of two- and three-family active neutrino oscillations. In the 2ν case, we find that the solution to the solar neutrino problem at large mixing angle (LMA) is basically split into two subregions that we denote as LMA-I and LMA-II. The LMA-I solution, characterized by lower values of the squared neutrino mass gap, is favored by the global data fit. This picture is not significantly modified in the 3ν mixing case. A brief discussion is given about the discrimination of the LMA-I and LMA-II solutions with future KamLAND data. In both the 2ν and 3ν cases, we present a detailed analysis of the post-KamLAND bounds on the oscillation parameters. [Phys. Rev. D **67**, 073002 (2003)]

Radiatively generated ν_e oscillations: General analysis, textures, and models. Anjan S. Joshipura and Saurabh D. Rindani, *Theoretical Physics Group, Physical Research Laboratory, Navrangpura, Ahmedabad 380 009, India.* (Received 9 December 2002; published 15 April 2003)

We study the consequences of assuming that the mass scale $\Delta_\odot$ corresponding to the solar neutrino oscillations and mixing angle U_{e3} corresponding to the electron neutrino oscillation at CHOOZ are radiatively generated through the standard electroweak gauge interactions. All the leptonic mass matrices having zero $\Delta_\odot$ and U_{e3} at a high scale lead to a unique low energy value for the $\Delta_\odot$ which is determined by the (known) size of the radiative corrections, solar and the atmospheric mixing angle and the Majorana mass of the neutrino observed in neutrinoless double beta decay. This prediction leads to the following consequences. (i) The MSSM radiative corrections generate only the dark side of the solar neutrino solutions. (ii) The inverted mass hierarchy $(m,-m,0)$ at the high scale fails in generating the LMA solution but it can lead to the LOW or vacuum solutions. (iii) The $\Delta_\odot$ generated in models with maximal solar mixing at a high scale is zero to the lowest order in the radiative parameter. It tends to get suppressed as a result of this and lies in the vacuum region. We discuss specific textures which can lead to the LMA solution in the present framework and provide a gauge theoretical realization of this in the context of the seesaw model. [Phys. Rev. D **67**, 073009 (2003)]

Two-loop neutrino mass generation and its experimental consequences. K. S. Babu and C. Macesanu, *Department of Physics, Oklahoma State University, Stillwater, Oklahoma 74078.* (Received 6 December 2002; published 17 April 2003)

If neutrino masses have a radiative origin, their smallness can be naturally understood even when lepton number violation occurs near the weak scale. We analyze a specific model of this type wherein the neutrino masses arise as two-loop radiative corrections. We show that the model admits the near bimaximal mixing pattern suggested by the current neutrino oscillation data. Unlike the conventional seesaw models, these two-loop models can be directly tested in lepton flavor violating decays $\tau\to 3\mu$ and $\mu\to e+\gamma$ as well as at colliders by the direct observation of charged scalars needed for the mass generation. It is shown that consistency with the neutrino oscillation data requires that the leptonic rare decays should be within reach of forthcoming experiments and that the charged scalars are likely to be within reach of the CERN LHC. [Phys. Rev. D **67**, 073010 (2003)]

Simulation of atmospheric muon and neutrino fluxes with CORSIKA. Jürgen Wentz and Iliana M. Brancus, *"Horia Hulubei" National Institute of Physics and Nuclear Engineering, P. O. Box MG 6, 76900 Bucharest, Romania;* Alexandru Bercuci, Dieter Heck, Jürgen Oehlschläger, and Heinigerd Rebel, *Forschungszentrum Karlsruhe, Institut für Kernphysik, Postfach 3640, 76021 Karlsruhe, Germany;* Bogdan Vulpescu, *Universität Heidelberg, Physikalisches Institut, Philosophenweg 12, 69120 Heidelberg, Germany.* (Received 31 October 2002; published 28 April 2003)

The flux of atmospheric muons and neutrinos is calculated by a three dimensional Monte Carlo simulation with the air shower code CORSIKA using the hadronic interaction models DPMJET, VENUS, GHEISHA, and URQMD. For the simulation of low energy primary particles the original CORSIKA has been extended by a parametrization of the solar modulation and a microscopic calculation of the directional dependence of the geomagnetic cutoff functions. An accurate description for the geography of the Earth has been included by a digital elevation model, tables for the local magnetic field in the atmosphere, and various atmospheric models for different geographic latitudes and annual seasons. CORSIKA is used to calculate atmospheric muon fluxes for different locations and the neutrino fluxes for Kamioka. The results of CORSIKA for the muon fluxes are verified by an extensive comparison with recent measurements. The neutrino fluxes obtained are compared with results of other calculations, and the influence of the hadronic interaction model, the geomagnetic cutoff, and the local magnetic field on the neutrino fluxes is investigated. [Phys. Rev. D **67**, 073020 (2003)]

Atmospheric muon and neutrino flux from 3-dimensional simulation. Yong Liu, L. Derome, and M. Buénerd, *Institut des Sciences Nucléaires, 53 av. des Martyrs, 38026 Grenoble cedex, France.* (Received 29 November 2002; published 29 April 2003)

The atmospheric muon and neutrino flux have been simulated using the same approach which successfully accounted for the recent secondary proton, electron, and positron flux measurements in orbit by the AMS experiment. For the muon flux, good agreement is obtained with the CAPRICE and HEAT data for altitudes ranging from sea level up to about 38 km. The general features of the calculated atmospheric neutrino flux are reported and discussed. The flux obtained at the Super-Kamiokande experiment location are reported and compared with other calculations. For low neutrino energies the flux obtained is significantly smaller than that used in the data analysis of underground experiment. The simulation results for the SOUDAN experiment site are also reported. [Phys. Rev. D **67**, 073022 (2003)]

Calculation of vacuum properties from the global color symmetry model. Hong-shi Zong,[1,2] Jia-lun Ping,[3] Hong-ting Yang,[1] Xiao-fu Lü,[2,4] and Fang Wang[1] [1]*Department of Physics, Nanjing University, Nanjing 210093, People's Republic of China,* [2]*CCAST (World Laboratory), P.O. Box 8730, Beijing 100080, People's Republic of China,* [3]*Department of Physics, Nanjing Normal University, Nanjing 210097, People's Republic of China,* [4]*Department of Physics, Sichuan University, Chengdu 610064, People's Republic of China.* (Received 26 February 2002; revised manuscript received 29 January 2003; published 10 April 2003)

A modified method for calculating the nonperturbative quark vacuum condensates from the global color symmetry model is derived. Within this approach it is shown that the vacuum condensates are free of ultraviolet divergence which is different from previous studies. As special cases, the two-quark condensate $\langle\bar{q}q\rangle$ and the mixed quark-gluon condensate $g\langle\bar{q}G_{\mu\nu}\sigma^{\mu\nu}q\rangle$ are calculated. A comparison with the results of other nonperturbative QCD approaches is given. [Phys. Rev. D **67**, 074004 (2003)]

Lepton helicity distributions in the polarized Drell-Yan process. Jiro Kodaira, *Deutsches Elektronen-Synchrotron, DESY, Platanenallee 6, D 15738 Zeuthen, Germany, and Department of Physics,*

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The lepton helicity distributions in the polarized Drell-Yan process at BNL RHIC energy are investigated. For events with a relatively low invariant mass of a lepton pair in which the weak interaction is negligible, only a measurement of lepton helicity can prove the antisymmetric part of the hadronic tensor. Therefore it might be interesting to consider the helicity distributions of leptons to obtain more information on the structure of the nucleon from the polarized Drell-Yan process. We estimate the QCD corrections at the $\mathcal{O}(\alpha_s)$ level to the hadronic tensor including both intermediate γ and Z bosons. We present numerical analyses for different invariant masses and show that the u ($\overline{u}$) and d ($\overline{d}$) quarks give different and characteristic contributions to the lepton helicity distributions. We also estimate the lepton helicity asymmetry for the various proton spin configurations. [Phys. Rev. D **67**, 074008 (2003)]

Effect of pre-existing baryon inhomogeneities on the dynamics of the quark-hadron transition. Soma Sanyal, *Institute of Physics, Sachivalaya Marg, Bhubaneswar 751005, India.* (Received 30 November 2002; published 14 April 2003)

Baryon number inhomogeneities may be generated during the epoch when the baryon asymmetry of the universe is produced, e.g. at the electroweak phase transition. The regions with excess baryon number will have a lower temperature than the background temperature of the universe. Also the value of the quark hadron transition temperature T_c will be different in these regions as compared to the background region. Since a first-order quark hadron transition is very susceptible to small changes in temperature, we investigate the effect of the presence of such baryonic lumps on the dynamics of the quark-hadron transition. We find that the phase transition is delayed in these lumps for significant overdensities. Consequently, we argue that baryon concentration in these regions grows by the end of the transition. We briefly discuss some models which may give rise to such high overdensities at the onset of the quark-hadron transition. [Phys. Rev. D **67**, 074009 (2003)]

DIS structure functions and the double-spin asymmetry in ρ^0 electroproduction within a Regge approach. N. I. Kochelev, *Bogoliubov Laboratory of Theoretical Physics, JINR, Dubna, Moscow region, 141980 Russia;* K. Lipka and W.-D. Nowak, *DESY Zeuthen, 15738 Zeuthen, Germany;* V. Vento, *Departament de Física Teòrica and Institut de Física Corpuscular, Universitat de València-CSIC E-46100, Burjassot (Valencia), Spain;* A. V. Vinnikov, *Bogoliubov Laboratory of Theoretical Physics, JINR, Dubna, Moscow region, 141980 Russia.* (Received 12 December 2002; published 17 April 2003)

The proton, neutron and deuteron structure functions $F_2(x,Q^2)$ and $g_1(x,Q^2)$, measured at intermediate Q^2, are analyzed within a Regge approach. This analysis serves to fix the parameters of this scheme which are then used to calculate, in a unified Regge approach, the properties of ρ^0 meson electroproduction on the proton and the deuteron. In this way, the double-spin asymmetry observed at HERMES in ρ^0 electroproduction on the proton can be related to the anomalous behavior of the flavor-singlet part of the spin-dependent structure function $g_1(x,Q^2)$ at small x. [Phys. Rev. D **67**, 074014 (2003)]

Role of higher twist in polarized deep inelastic scattering. Elliot Leader, *Imperial College London, Prince Consort Road, London SW7 2BW, England;* Aleksander V. Sidorov, *Bogoliubov Theoretical Laboratory Joint Institute for Nuclear Research, 141980 Dubna, Russia;* Dimiter B. Stamenov, *Institute for Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences, Blvd. Tsarigradsko Chaussee 72, Sofia 1784, Bulgaria.* (Received 6 December 2002; published 21 April 2003)

The higher twist corrections $h^N(x)/Q^2$ to the spin dependent proton and neutron g_1 structure functions are extracted in a model independent way from experimental data on $g_1^N(x,Q^2)$ and found to be non-negligible. It is shown that the NLO QCD polarized parton densities determined from the data on g_1, including higher twist effects are in good agreement with those found earlier from our analysis of the data on g_1/F_1 and A_1 where higher twist effects are negligible. On the contrary, the LO QCD polarized parton densities obtained from the data on g_1, including higher twist, differ significantly from our previous results. [Phys. Rev. D **67**, 074017 (2003)]

From deep inelastic scattering to proton-nucleus collisions in the color glass condensate model. François Gelis, *Service de Physique Théorique, Bâtiment 774, CEA/DSM/Saclay, 91191, Gif-sur-Yvette Cedex, France;* Jamal Jalilian-Marian, *Physics Department, Brookhaven National Laboratory, Upton, New York 11973.* (Received 2 December 2002; published 21 April 2003)

We show that particle production in proton-nucleus (pA) collisions in the color glass condensate model can be related to deep inelastic scattering (DIS) of leptons on protons or nuclei. The common building block is the quark-antiquark (or gluon-gluon) dipole cross section which is present in both DIS and pA processes. This correspondence in a sense generalizes the standard leading twist approach to pA collisions based on collinear factorization and perturbative QCD, and allows one to express the pA cross sections in terms of a universal quantity (dipole cross section) which, in principle, can be measured in DIS or other processes. Therefore, using the parametrization of the dipole cross section at DESY HERA, one can calculate particle production cross sections in proton-nucleus collisions at high energies. Alternatively, one could use proton-nucleus experiments to further constrain models of the dipole cross section. We show that the McLerran-Venugopalan model predicts an enhancement of the cross sections at large $p_\perp$ (Cronin effect) and a suppression of the cross sections at low $p_\perp$. The crossover depends on rapidity and moves to higher $p_\perp$ as one goes to more forward rapidities. [Phys. Rev. D **67**, 074019 (2003)]

Compact stars with color superconducting quark matter. Mark Alford, *Physics and Astronomy Department, Glasgow University, Glasgow G12 8QQ, United Kingdom;* Sanjay Reddy, *Center for Theoretical Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, and Theoretical Division, Los Alamos*

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We study compact stars that contain quark matter. We look at the effect of color superconductivity in the quark matter on the nuclear-quark matter transition density, mass-radius relationship, and the density discontinuity at the boundary between nuclear and quark matter. We find that color superconducting quark matter will occur in compact stars at values of the bag constant where ordinary quark matter would not be allowed. We are able to construct ''hybrid'' stars with a color superconducting quark matter interior and nuclear matter surface, with masses in the range $1.3-1.6M_{\odot}$ and radii 8–11 km. Our results are consistent with recent mass-radius limits based on absorption lines from EXO0748-676. [Phys. Rev. D **67**, 074024 (2003)]

D-meson production from recombination in hadronic collisions. R. Rapp, *NORDITA, Blegdamsvej 17, DK-2100 Copenhagen, Denmark;* E. V. Shuryak, *Department of Physics and Astronomy, State University of New York, Stony Brook, New York 11794-3800.* (Received 6 February 2003; published 29 April 2003)

Nonperturbative effects in D-meson production in pion-nucleon and proton-nucleon collisions are investigated within the recombination model. The coalescence of perturbatively created charm quarks with sea and valence quarks from projectile and target fragments is shown to be competitive in magnitude with standard fragmentation calculations at both central (small x_F) and forward rapidities. Corresponding flavor asymmetries for inclusive D-meson production are thus mostly generated on the (light-) parton distribution level, and turn out to be in reasonable overall agreement with available fixed-target data. Predictions for upcoming measurements at BNL RHIC are given. [Phys. Rev. D **67**, 074036 (2003)]

Spin structure of the nucleon at low energies. Véronique Bernard, *Université Louis Pasteur, Laboratoire de Physique Théorique, F-67084 Strasbourg, France;* Thomas R. Hemmert, *Technische Universität München, Physik Department T-39, D-85747 Garching, Germany;* Ulf-G. Meißner, *Universität Bonn, Helmholtz Institut für Strahlen- und Kernphysik (Theorie), Nußallee 14-16, D-53115 Bonn, Germany.* (Received 4 December 2002; published 29 April 2003)

The spin structure of the nucleon is analyzed in the framework of a Lorentz-invariant formulation of baryon chiral perturbation theory. The structure functions of doubly virtual Compton scattering are calculated to one-loop accuracy (fourth order in the chiral expansion). We discuss the generalization of the Gerasimov-Drell-Hearn sum rule, the Burkhardt-Cottingham sum rule and other moments of the nucleon spin structure functions. We give predictions for the forward and the longitudinal-transverse spin polarizabilities of the proton and the neutron at zero and finite photon virtuality. A detailed comparison to results obtained in heavy baryon chiral perturbation theory is also given. [Phys. Rev. D **67**, 076008 (2003)]

Higher twists in the pion structure function. W. Melnitchouk, *Jefferson Lab, 12000 Jefferson Avenue, Newport News, Virginia 23606.* (Received 29 August 2002; published 21 April 2003)

We calculate the QCD moments of the pion structure function using Drell-Yan data on the quark distributions in the pion and a phenomenological model for the resonance region. The extracted higher twist corrections are found to be larger than those for the nucleon, contributing around 50% of the lowest moment at $Q^2 = 1$ GeV^2. [Phys. Rev. D **67**, 077502 (2003)]