

Selected Abstracts from Other Physical Review Journals

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Constraints on decay plus oscillation solutions of the solar neutrino problem. Anjan S. Joshipura, *Physical Research Laboratory, Navrangpura, Ahmedabad, 380 009, India*; Eduard Massó, *Grup de Física Teòrica and IFAE, Universitat Autònoma de Barcelona, Spain*; Subhendra Mohanty, *Physical Research Laboratory, Navrangpura, Ahmedabad, 380 009, India*. (Received 18 June 2002; published 31 December 2002)

We examine the constraints on the nonradiative decay of neutrinos from the observations of solar neutrino experiments. The standard oscillation hypothesis among three neutrinos solves the solar and atmospheric neutrino problems. The decay of a massive neutrino mixed with the electron neutrino results in the depletion of the solar neutrino flux. We introduce neutrino decay in the oscillation hypothesis and demand that decay does not spoil the successful explanation of solar and atmospheric observations. We obtain a lower bound on the ratio of the lifetime over the mass of ν_2 , $\tau_2/m_2 > 22.7$ s/MeV for the Mikheyev-Smirnov-Wolfenstein solution of the solar neutrino problem and $\tau_2/m_2 > 27.8$ s/MeV for the vacuum oscillation solution (at 99% C.L.). [Phys. Rev. D **66**, 113008 (2002)]

Active neutrino oscillations and the SNO neutral current measurement. Alexis A. Aguilar-Arevalo and J. C. D'Olivo, *Instituto de Ciencias Nucleares, Universidad Nacional Autónoma de México, Apartado Postal 70-543, 04510 México, Distrito Federal, Mexico*. (Received 28 June 2002; published 31 December 2002)

We discuss the relation between the observed charged current, elastic scattering, and neutral current fluxes and the flavor fractional content of the solar neutrino flux seen by SNO. By using existing estimates of the cross sections for the charged and neutral current reactions which take into account the detector resolution, we show how the forthcoming SNO rates unconstrained by the standard ^8B shape could test the oscillations into active states. We perform a model independent analysis for the Super-Kamiokande and SNO data, assuming a nondistorted spectrum. [Phys. Rev. D **66**, 113009 (2002)]

Infrared behavior of the gluon propagator in nonequilibrium situations. Fred Cooper, *T-8, Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545*; Chung-Wen Kao, *Theoretical Physics Group, Department of Physics and Astronomy, University of Manchester, Manchester M139PL, United Kingdom*; Gouranga C. Nayak, *T-8, Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545*. (Received 4 April 2002; published 30 December 2002)

The infrared behavior of the medium modified gluon propagator in nonequilibrium situations is studied in the covariant gauge using the Schwinger-Keldysh closed-time path formalism. It is shown that the magnetic screening mass is nonzero at the one loop level whenever the initial gluon distribution function is nonisotropic with the assumption that the distribution function of the gluon is not divergent at zero transverse momentum. For isotropic gluon distribution functions, such as those describing local equilibrium, the magnetic mass at the one loop level is zero, which is consistent with finite temperature field theory results. Assuming that a reasonable initial gluon distribution function can be obtained from a perturbative QCD calculation of minijets, we determine these out of equilibrium values for the initial magnetic and Debye screening masses at energy densities appropriate to BNL RHIC and CERN LHC. We also compare the magnetic masses obtained here with those obtained using finite temperature lattice QCD methods at similar temperatures at RHIC and LHC. [Phys. Rev. D **66**, 114016 (2002)]

Double logarithms, $\ln^2(1/x)$, and the NLO Dokshitzer-Gribov-Lipatov-Altarelli-Parisi evolution for the nonsinglet component of the nucleon spin structure function g_1 . Beata Ziaja, *Department of Theoretical Physics, Institute of Nuclear Physics, Radzikowskiego 152, 31-342 Cracow, Poland*, *Department of Biochemistry, Biomedical Centre, Box 576, Uppsala University, S-75123 Uppsala, Sweden*, and, *High Energy Physics, Uppsala University, P.O. Box 535, S-75121 Uppsala, Sweden*. (Received 28 June 2002; published 30 December 2002)

Theoretical predictions show that at low values of Bjorken x the spin structure function g_1 is influenced by large logarithmic corrections $\ln^2(1/x)$, which may be predominant in this region. These corrections are also partially contained in the next leading order (NLO) part of the standard Dokshitzer-Gribov-Lipatov-Altarelli-Parisi (DGLAP) evolution. Here we calculate the nonsinglet component of the nucleon structure function, $g_1^{NS} = g_1^p - g_1^n$, and its first moment, using a unified evolution equation. This equation incorporates the terms describing the NLO DGLAP evolution and the terms contributing to the $\ln^2(1/x)$ resummation. In order to avoid double counting in the overlapping regions of the phase space, a unique way of including the NLO terms into the unified evolution equation is proposed. The scheme-independent results obtained from this unified evolution are compared to the NLO fit to experimental data, GRSV2000. An analysis of the first moments of g_1^{NS} shows that the unified evolution including the $\ln^2(1/x)$ resummation goes beyond the NLO DGLAP analysis. Corrections generated by double logarithms at low x influence the Q^2 dependence of the first moments strongly. [Phys. Rev. D **66**, 114017 (2002)]

Novel constraints on $\Delta L = 1$ interactions from neutrino masses. Francesca Borzumati and Jae Sik Lee, *Theory Group, KEK, Tsukuba, Ibaraki 305-0801, Japan.* (Received 10 September 2002; published 31 December 2002)

We reanalyze the constraints imposed on lepton-number violating interactions by radiative contributions to neutrino masses at the one- and two-loop levels in supersymmetric models without R parity. The interactions considered are the $\Delta L = 1$ superpotential operators $\lambda_{ijk} L_i L_j E_k^c$ and $\lambda'_{ijk} L_i Q_j D_k^c$, and the $\Delta L = 1$ soft terms $A_{ijk} \tilde{L}_i \tilde{L}_j \tilde{E}_k^c$ and $A'_{ijk} \tilde{L}_i \tilde{Q}_j \tilde{D}_k^c$. The two-loop contributions analyzed are those induced by the radiatively generated mass splitting between the CP -even and CP -odd sneutrino states. It is shown how the constraints on the couplings λ_{ijk} and λ'_{ijk} coming from the one-loop analysis can be evaded. In such a case, the two-loop contributions to neutrino masses become important. The combined one- and two-loop analysis yields constraints on the couplings λ_{i33} and λ'_{i33} that are rather difficult to escape. The two-loop analysis yields also constraints on A_{i33} and A'_{i33} , which are not bounded at the one-loop level. More freedom remains for the couplings λ_{ijk} , λ'_{ijk} , and A_{ijk} , A'_{ijk} , when j and k are first- or second-generation indices. [Phys. Rev. D **66**, 115012 (2002)]

QCD based quark description of π - π scattering up to the σ and ρ regions. Stephen R. Cotanch and Pieter Maris, *Department of Physics, North Carolina State University, Raleigh, North Carolina 27695-8202.* (Received 9 October 2002; published 30 December 2002)

We study forward and backward π - π scattering within a QCD model based on the Dyson-Schwinger, Bethe-Salpeter equations truncated to the rainbow-ladder level. Our microscopic relativistic quark formulation preserves chiral symmetry and reproduces the observed scattering lengths for total isospin zero, one and two. At higher energies both scalar and vector meson resonances naturally occur in the scattering amplitudes. We also report a comparative study with phenomenological meson-exchange models and find such approaches are reasonable especially near π - π resonances. [Phys. Rev. D **66**, 116010 (2002)]

All-purpose neutrino mass matrix. Ernest Ma, *Physics Department, University of California, Riverside, California 92521.* (Received 8 August 2002; published 30 December 2002)

A four-parameter Majorana neutrino mass matrix is proposed, which is exactly diagonalizable with two mixing angles, one of which is $\pi/4$ and the other large but less than $\pi/4$. The form of this mass matrix allows seven realizations of the present data on atmospheric and solar neutrino oscillations: three have the normal hierarchy, two have the inverse hierarchy, and two have three nearly degenerate masses. The possible inclusion of CP violation is also discussed. [Phys. Rev. D **66**, 117301 (2002)]

Neutrino oscillation mechanism for pulsar kicks reexamined. M. Barkovich,¹ J. C. D'Olivo,¹ R. Montemayor,² and J. F. Zanella²
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Anisotropic neutrino emission during neutron star formation can be the origin of the observed proper motions of pulsars. We derive a general expression for the momentum asymmetry in terms of the neutrino energy flux gradient, and show that a nonvanishing effect is induced at the lowest order by a deformed neutrinosphere. In particular, this result is valid for a neutrino flux transported through a spherical atmosphere with constant luminosity. [Phys. Rev. D **66**, 123005 (2002)]

Local structure of topological charge fluctuations in QCD. I. Horváth,¹ S. J. Dong,¹ T. Draper,¹ F. X. Lee,^{2,3} K. F. Liu,¹ H. B. Thacker,⁴ and J. B. Zhang⁵ ¹Department of Physics, University of Kentucky, Lexington, Kentucky 40506, ²Center for Nuclear Studies and Department of Physics, George Washington University, Washington, D.C. 20052, ³Jefferson Lab, 12000 Jefferson Avenue, Newport News, Virginia 23606, ⁴Department of Physics, University of Virginia, Charlottesville, Virginia 22901, ⁵CSSM and Department of Physics and Mathematical Physics, University of Adelaide, Adelaide, SA 5005, Australia. (Received 8 April 2002; published 27 January 2003)

We consider the lattice topological charge density introduced by Hasenfratz, Laliena, and Niedermayer and propose its eigenmode expansion as a tool to investigate the structure of topological charge fluctuations in QCD. The resulting effective density is built from local chiralities studied previously. At every order of the expansion, the density exactly sums up to the global topological charge, and the leading term describes the maximally smooth space-time distribution of charge relevant for propagating light fermions. We use this framework to demonstrate our previous suggestion that the bulk of the topological charge in QCD does not effectively appear in the form of quantized unit lumps. Our conclusion implies that it is unlikely that the mixing of “would-be” zero modes associated with such lumps is the prevalent microscopic mechanism for spontaneous chiral symmetry breaking in QCD. We also present the first results quantitatively characterizing the space-time behavior of effective densities. For coherent fluctuations contained in spherical regions, we find a continuous distribution of associated charges essentially ending at ≈ 0.5 . [Phys. Rev. D **67**, 011501 (2003)]

Measuring the spectra of high energy neutrinos with a kilometer-scale neutrino telescope. D. Hooper,¹ H. Nunokawa,² O. L. G. Peres,³ and R. Zukanovich Funchal⁴ ¹Department of Physics, University of Wisconsin, 1150 University Avenue, Madison, Wisconsin 53706, ²Instituto de Física Teórica, Universidade Estadual Paulista, Rua Pamplona 145, 01405-900 São Paulo, Brazil, ³Instituto de Física Gleb Wataghin, Universidade Estadual de Campinas–UNICAMP, 13083-970 Campinas, Brazil, ⁴Instituto de

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We investigate the potential of a future kilometer-scale neutrino telescope, such as the proposed IceCube detector in the South Pole, to measure and disentangle the yet unknown components of the cosmic neutrino flux, the prompt atmospheric neutrinos coming from the decay of charmed particles and the extra-galactic neutrinos in the 10 TeV to 1 EeV energy range. Assuming a power law type spectra, $d\phi_\nu/dE_\nu \sim \alpha E_\nu^\beta$, we quantify the discriminating power of the IceCube detector and discuss how well we can determine magnitude (α) as well as slope (β) of these two components of the high energy neutrino spectrum, taking into account the background coming from the conventional atmospheric neutrinos. [Phys. Rev. D **67**, 013001 (2003)]

Nucleon's strange electromagnetic and scalar matrix elements.

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Quenched lattice QCD simulations and quenched chiral perturbation theory are used together for this study of strangeness in the nucleon. Dependences of the matrix elements on strange quark mass, valence quark mass and momentum transfer are discussed in both the lattice and chiral frameworks. The combined results of this study are in good agreement with existing experimental data and predictions are made for upcoming experiments. Possible future refinements of the theoretical method are suggested. [Phys. Rev. D **67**, 013003 (2003)]

Measuring CP violation and mass ordering in joint long baseline experiments with superbeams.

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We propose to measure the CP phase δ_{CP} , the magnitude of the neutrino mixing matrix element $|U_{e3}|$ and the sign of the atmospheric scale mass-squared difference Δm_{31}^2 with a superbeam by the joint analysis of two different long baseline neutrino oscillation experiments. One is a long baseline experiment (LBL) at 300 km and the other is a very long baseline (VLBL) experiment at 2100 km. We take the neutrino source to be the approved high intensity proton synchrotron, HIPA. The neutrino beam for the LBL is the 2-degree off-axis superbeam, and for the VLBL a narrowband superbeam. Taking into account all possible errors, we evaluate the event rates required and the sensitivities that can be attained for the determination of δ_{CP} and the sign of Δm_{31}^2 . We arrive at a repre-

sentative scenario for a reasonably precise probe of this part of neutrino physics. [Phys. Rev. D **67**, 013004 (2003)]

What can be learned with a lead-based supernova-neutrino detector?

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We examine the prospects for using lead as a supernova-neutrino detector by considering the spectrum of electrons produced, and the number of one- and two-neutron events. We show that the electron energy spectrum from charged-current reactions could be used to extract information about the high-temperature component of the neutrino spectrum. Some degree of electron neutrino oscillation is expected in the supernova envelope. We examine the prospects for untangling the signatures of various oscillation scenarios, including, e.g., normal or inverted hierarchies, and different values for the small mixing angle θ_{13} . [Phys. Rev. D **67**, 013005 (2003)]

Determination of neutrino mixing parameters after SNO oscillation evidence.

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An updated analysis of all available neutrino oscillation evidence in solar experiments (SK day and night spectra, global rates from Homestake, SAGE, and GALLEX) including the latest SNO CC and NC data is presented. Assuming that the shape of the SNO CC energy spectrum is undistorted and using the information provided by SNO we obtain, for the fraction of electron neutrinos remaining in the solar beam at energies ≥ 5 MeV, $\phi_{CC}/\phi_{NC} = 0.34^{+0.05}_{-0.04}$, which is nominally many standard deviations away from the standard value. The fraction of oscillating neutrinos into active ones is computed to be $(\Phi_{NC} - \Phi_{CC})/(\Phi_{SSM} - \Phi_{CC}) = 0.92^{+0.39}_{-0.20}$, nearly 5σ deviations from the pure sterile oscillation case. The data are still compatible with an important fraction of sterile component in the solar beam (up to 20%–30% of the total). In the framework of two active neutrino oscillations we determine individual neutrino mixing parameters and their errors in the region of no spectrum distortion ($\Delta\langle T_e \rangle < 1\%$); we obtain $\Delta m^2 = 4.5^{+2.7}_{-1.4} \times 10^{-5}$ eV², $\tan^2 \theta = 0.40^{+0.10}_{-0.08}$. These parameters are in agreement with those ones of the best χ^2 solution in the LMA region. [Phys. Rev. D **67**, 013006 (2003)]

Generalized parton distributions for qq pions. B. C. Tiburzi and G. A. Miller, *Department of Physics, University of Washington, Box 351560, Seattle, Washington 98195-1560*. (Received 2 October 2002; published 30 January 2003)

We use a two-body, light-cone pion wave function (which vanishes when one of the constituents carries all of the plus-momentum) to construct a double distribution. We show that the resulting generalized parton distribution has incorrect behavior at the crossover between kinematic regions. Furthermore, the positivity constraints are not respected. On the other hand, the field-theoretic, two-body double distribution gives generalized parton distributions that have a physically correct crossover behavior and respect the positivity constraints independent of the model wave function used. However, the sum rule and polynomiality conditions cannot be satisfied with a two-body wave function alone since Lorentz symmetry is not maintained. [Phys. Rev. D **67**, 013010 (2003)]

Constraining neutrino oscillation parameters with current solar and atmospheric data. M. Maltoni,¹ T. Schwetz,² M. A. Tórtola,¹ and J. W. F. Valle¹ ¹*Instituto de Física Corpuscular – C.S.I.C./Universitat de València, Edificio Institutos de Paterna, Apt 22085, E-46071 Valencia, Spain*, ²*Institut für Theoretische Physik, Universität Wien, Boltzmannngasse 5, A-1090 Wien, Austria*. (Received 22 July 2002; published 30 January 2003)

We analyze the impact of recent solar and atmospheric data on the determination of the neutrino oscillation parameters, taking into account that both the solar ν_e and the atmospheric ν_μ may convert to a mixture of active and sterile neutrinos. We use the most recent global solar neutrino data, including the 1496-day Super-K neutrino data sample, and we investigate in detail the impact of the recent Sudbury Neutrino Observatory (SNO) neutral current, spectral, and day/night data by performing also an analysis using only the charged current rate from SNO. We confirm the clear preference of the pure active large mixing angle solution of the solar neutrino problem and obtain that the LOW solution, vacuum oscillation, small mixing angle, and just-so² solutions are disfavored with a $\Delta\chi^2=9, 9, 23, 31$, respectively. Furthermore, we find that the global solar data constrains the admixture of a sterile neutrino to be less than 44% at 99% C.L. A pure sterile solution is ruled out with respect to the active one at 99.997% C.L. By performing an improved fit of the atmospheric data, we also update the corresponding regions of oscillation parameters. We find that the recent atmospheric Super-K (1489-day) and MACRO data have a strong impact on constraining a sterile component in atmospheric oscillations: if the ν_μ is restricted to the atmospheric mass states only a sterile admixture of 16% is allowed at 99% C.L., while a bound of 35% is obtained in the unconstrained case. Pure sterile oscillations are disfavored with a $\Delta\chi^2=34.6$ compared to the pure active case. [Phys. Rev. D **67**, 013011 (2003)]

Quantum description for a chiral condensate disoriented in a certain direction in isospace. S. Maedan, *Department of Physics, Tokyo National College of Technology, Tokyo 193-0997, Japan*. (Received 1 October 2002; published 6 January 2003)

We derive a quantum state of the disoriented chiral condensate dynamically, considering small quantum fluctuations around a classical chiral condensate disoriented in a certain direction $\vec{n}$ in isospace. The obtained nonisosinglet quantum state has the following characteristic features: (i) It has the form of the squeezed state; (ii) the state contains not only the component of pion quanta in the direction $\vec{n}$ but also the component in the perpendicular direction to $\vec{n}$; and (iii) the low momentum pions in the state violate the isospin symmetry. With the quantum state, we calculate the probability of the neutral fraction depending on the time and the pion's momentum, and find that the probability has an unfamiliar form. For the low momentum pions, the parametric resonance mechanism works with the results that the probability of the neutral fraction becomes the well known form approximately, and that the charge fluctuation is small. [Phys. Rev. D **67**, 014003 (2003)]

Prompt multigluon production in high-energy collisions from singular Yang-Mills solutions. Romuald A. Janik, *The Niels Bohr Institute, Blegdamsvej 17, DK-2100 Copenhagen, Denmark*, and M. Smoluchowski *Institute of Physics, Jagellonian University, Reymonta 4, 30-059 Cracow, Poland*; Edward Shuryak and Ismail Zahed, *Department of Physics and Astronomy, State University of New York, Stony Brook, New York 11794*. (Received 13 June 2002; published 16 January 2003)

Nonperturbative parton-parton scattering is studied using the Landau method. Specific singular O(3)-symmetric solutions to the Euclidean Yang-Mills equations are discussed, with instanton dynamics incorporated in the overlap between incoming and vacuum fields. We derive a high-energy solution at small times, and assess the gluonic state produced at the turning point (escape point to Minkowski space-time). We follow the solution as it escapes to Minkowski space and assess its *outgoing* gluon spectrum. The solution is found to follow from the Yang-Mills sphaleron problem studied recently through a simple rescaling. We also argue, by evaluating the number of *incoming* gluons for the same singular solution, that this scaling is in fact more general and presumably describes the energy dependence of the spectra and multiplicities at *all* energies. [Phys. Rev. D **67**, 014005 (2003)]

Prompt quark production by exploding sphalerons. Edward Shuryak and Ismail Zahed, *Department of Physics and Astronomy, State University of New York, Stony Brook, New York 11794*. (Received 13 June 2002; published 16 January 2003)

Following recent works on the production and subsequent explosive decay of QCD sphaleronlike clusters, we discuss the mechanism of quark pair production in this process. We first show how the gauge field explosive solution of Luscher and Schechter can be achieved by noncentral conformal mapping from the O(4)-symmetric solution. Our main result is a new solution to the Dirac equation in real time in this configuration, obtained by the same inversion of the fermion O(4) zero mode. It explicitly shows how the quark acceleration occurs, starting from the spherically O(3)-symmetric zero energy chiral quark state to the final spectrum of nonzero energies. The sphaleronlike clusters with any Chern-Simons number always produce $N_F \bar{L} R$ quarks, and the

antisphaleron-like clusters the opposite chirality. The result are relevant for hadron-hadron and nucleus-nucleus collisions at large $\sqrt{s}$, wherein such clusters can be produced. [Phys. Rev. D **67**, 014006 (2003)]

QCD effective actions from the solutions of the transport equations. Cristina Manuel, *Theory Division, CERN, CH-1211 Geneva 23, Switzerland*; Stanisław Mrówczyński, *Sołtan Institute for Nuclear Studies, ul. Hoża 69, PL-00-681 Warsaw, Poland, and Institute of Physics, Świętokrzyska Academy, ul. Świętokrzyska 15, PL-25-406 Kielce, Poland.* (Received 25 June 2002; published 21 January 2003)

We solve the collisionless transport equations of a quark-gluon plasma interacting through mean chromodynamic fields. The system is assumed to be translation invariant in one or more space-time directions. We present exact solutions that hold if the vector gauge fields in the direction of the translation invariance commute with their covariant derivatives. We also solve the equations perturbatively when the commutation condition is relaxed. Further, we derive the color current and the associated effective action. For the static quasiequilibrium system, our results reproduce the full one-loop effective action of QCD in the presence of constant background fields, where the above mentioned commutation condition is satisfied. [Phys. Rev. D **67**, 014015 (2003)]

Calculation of the pseudoscalar-isoscalar hadronic current correlation functions of the quark-gluon plasma. Bing He, Hu Li, C. M. Shakin, and Qing Sun, *Department of Physics and Center for Nuclear Theory, Brooklyn College of the City University of New York, Brooklyn, New York 11210.* (Received 28 October 2002; published 29 January 2003)

We report the results of calculations of pseudoscalar-isoscalar hadronic current correlators using the Nambu–Jona-Lasinio model and the real-time finite-temperature formalism. (This work represents a continuation of results reported previously for other current correlators.) Results are presented for the temperatures range $1.2 \leq T/T_c \leq 6.0$, where T_c is the temperature of the confinement-deconfinement transition, which we take to be $T_c = 170$ MeV. Some resonant features are seen in our calculations. In order to understand the origin of these resonances, we have performed relativistic random phase approximation (RPA) calculations of the temperature-dependent spectrum of the η mesons for $T < T_c$. For the RPA calculations, use is made of a simple model in which we introduce temperature-dependent constituent quark masses calculated in a mean-field approximation and a temperature-dependent confining interaction whose form is motivated by recent studies made using lattice simulations of QCD with dynamical quarks. We also introduce temperature-dependent coupling constants in our generalized NJL model. Our motivation in the latter case is the simulation of the approach to a weakly interacting system at high temperatures and the avoidance of “ η condensates” which would indicate instability of the ground state of the model. We present some evidence that supports our use of temperature-dependent coupling constants for the NJL model. We suggest that our results may be of interest to researchers who use lattice simulations of QCD to obtain

temperature-dependent spectral functions for various hadronic current correlation functions. [Phys. Rev. D **67**, 014022 (2003)]

Universality, the QCD critical and tricritical point, and the quark number susceptibility. Yoshitaka Hatta, *Department of Physics, Kyoto University, Kyoto 606-8502, Japan, and The Institute of Physical and Chemical Research (RIKEN), Wako, Saitama 351-0198, Japan*; Takashi Ikeda, *RIKEN BNL Research Center, Brookhaven National Laboratory, Upton, New York 11973-5000.* (Received 23 October 2002; published 31 January 2003)

The quark number susceptibility near the QCD critical end point (CEP), the tricritical point (TCP) and the $O(4)$ critical line at finite temperature and quark chemical potential are investigated. Based on the universality argument and numerical model calculations we propose the possibility that the hidden tricritical point strongly affects the critical phenomena around the critical end-point. We make a semiquantitative study of the quark number susceptibility near CEP or TCP for several quark masses on the basis of the Cornwall-Jackiw-Tomboulis potential for QCD in the improved-ladder approximation. The results show that the susceptibility is enhanced in a wide region around the CEP, inside which the critical exponent gradually changes from that of the CEP to that of the TCP, indicating a crossover of different universality classes. [Phys. Rev. D **67**, 014028 (2003)]

Finite density QCD via an imaginary chemical potential. Massimo D’Elia, *Dipartimento di Fisica dell’Università di Genova and INFN, I-16146, Genova, Italy*; Maria-Paola Lombardo, *INFN, Sezione di Padova, and Laboratori Nazionali di Frascati, I-00044 Frascati, Italy.* (Received 2 October 2002; published 28 January 2003)

We study QCD at nonzero temperature and baryon density in the framework of the analytic continuation from an imaginary chemical potential. We carry out simulations of QCD with four flavors of staggered fermions, and reconstruct the phase diagram in the temperature-imaginary μ plane. We consider *Ansätze* for the analytic continuation of the critical line and other observables motivated both by theoretical considerations and mean field calculations in four fermion models and random matrix theory. We determine the critical line, and the analytic continuation of the chiral condensate, up to $\mu_B \approx 500$ MeV. The results are in qualitative agreement with the predictions of model field theories, and consistent with a first order chiral transition. The correlation between the chiral transition and the deconfinement transition observed at $\mu = 0$ persists at nonzero density. [Phys. Rev. D **67**, 014505 (2003)]

S_{2L} permutation symmetry for left-handed μ and τ families and neutrino oscillations in an $SU(3)_L \times U(1)_N$ gauge model. Teruyuki Kitabayashi, *Accelerator Engineering Center, Mitsubishi Electric System & Service Engineering Co. Ltd., 2-8-8 Umezono,*

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We construct an $SU(3)_L \times U(1)_N$ gauge model based on an S_{2L} permutation symmetry for left-handed μ and τ families, which provides the almost maximal atmospheric neutrino mixing and the large solar neutrino mixing of the large mixing angle type. Neutrinos acquire one-loop radiative masses induced by the radiative mechanism of the Zee type as well as tree level masses induced by the type II seesaw mechanism utilizing interactions of lepton triplets with an $SU(3)$ -sextet scalar. The atmospheric neutrino mixing controlled by the tree-level and radiative masses turns out to be almost maximal owing to the presence of S_{2L} supplemented by a Z_4 discrete symmetry. These symmetries ensure the near equality between the ν_e - ν_μ and ν_e - ν_τ radiative masses dominated by contributions from heavy leptons contained in the third members of lepton triplets, whose Yukawa interactions conserve S_{2L} even after the spontaneous breaking. The solar neutrino mixing controlled by radiative masses, including a ν_μ - ν_τ mass, which are taken to be of similar order, turns out to be described by large solar neutrino mixing angles. [Phys. Rev. D **67**, 015006 (2003)]

Burkhardt-Cottingham sum rule and forward spin polarizabilities in heavy baryon chiral perturbation theory. Chung Wen Kao, *Department of Physics and Astronomy, University of Manchester, Manchester, M13 9PL, United Kingdom*; Thomas Spitzenberg and Marc Vanderhaeghen, *Institut für Kernphysik, Johannes Gutenberg-Universität, D-55099 Mainz, Germany.* (Received 20 September 2002; published 21 January 2003)

We study spin-dependent sum rules for forward virtual Compton scattering (VVCS) off the nucleon in heavy baryon chiral perturbation theory (HBChPT) at order $\mathcal{O}(p^4)$. We show how these sum rules can be evaluated from low energy expansions (in the virtual photon energy) of the forward VVCS amplitude. We study in particular the Burkhardt-Cottingham sum rule in HBChPT and the higher terms in the low energy expansion, which can be related to the generalized forward spin polarizabilities of the nucleon. The dependence of these observables on the photon virtuality Q^2 can be accessed, at small and intermediate Q^2 values, from existing and forthcoming data at Jefferson Lab. [Phys. Rev. D **67**, 016001 (2003)]

Baryon charge radii and quadrupole moments in the $1/N_c$ expansion: The 3-flavor case. Alfons J. Buchmann, *Institute for Theoretical Physics, University of Tübingen, D-72076, Germany*; Richard F. Lebed, *Department of Physics and Astronomy, Arizona State University, Tempe, Arizona 85287-1504.* (Received 2 August 2002; published 22 January 2003)

We develop a straightforward method to compute charge radii and quadrupole moments for baryons both with and without strangeness, when the number of QCD color charges is N_c . The minimal assumption of the single-photon exchange ansatz implies

that only two operators are required to describe these baryon observables. Our results are presented so that $SU(3)$ flavor and isospin symmetry breaking can be introduced according to any desired specification, although we also present results obtained from two patterns suggested by the quark model with gluon exchange interactions. The method also permits to extract a number of model-independent relations; a sample is $r_\Lambda^2/r_n^2 = 3/(N_c + 3)$, independent of $SU(3)$ symmetry breaking. [Phys. Rev. D **67**, 016002 (2003)]

On n - $\bar{n}$ oscillations of ultracold neutrons. Vladimir K. Ignatovich, *Frank Laboratory of Neutron Physics of Joint Institute for Nuclear Research, 141980, Dubna, Moscow Region, Russia.* (Received 17 November 2001; revised manuscript received 14 October 2002; published 27 January 2003)

The ultracold neutron (UCN) storage experiment for searching for n - $\bar{n}$ oscillations is discussed. The figure of merit of the UCN experiment with respect to a beam experiment is considered. The effect of neutron collisions with the walls on the production rate of the $\bar{n}$ component is analyzed. [Phys. Rev. D **67**, 016004 (2003)]

Measuring the prompt atmospheric neutrino flux with down-going muons in neutrino telescopes. Graciela Gelmini, *Department of Physics and Astronomy, University of California at Los Angeles, Los Angeles, California 90095-1547*; Paolo Gondolo, *Department of Physics, Case Western Reserve University, 10900 Euclid Avenue, Cleveland, Ohio 44106*; Gabriele Varieschi, *Department of Physics, Loyola Marymount University, One LMU Drive, Los Angeles, California 90045.* (Received 10 September 2002; published 23 January 2003)

In the TeV energy region and above, the uncertainty in the level of prompt atmospheric neutrinos would limit the search for diffuse astrophysical neutrinos. We suggest that neutrino telescopes may provide an empirical determination of the flux of prompt atmospheric electron and muon neutrinos by measuring the flux of prompt down-going muons. Our suggestion is based on the consideration that prompt neutrino and prompt muon fluxes at sea level are almost identical. [Phys. Rev. D **67**, 017301 (2003)]

Coulomb induced diffraction of energetic hadrons into jets. L. Frankfurt, *School of Physics and Astronomy, Tel Aviv University, 69978 Tel Aviv, Israel*; M. Strikman, *Department of Physics, Pennsylvania State University, University Park, Pennsylvania 16802.* (Received 4 September 2002; published 27 January 2003)

The electromagnetic (EM) current conservation and renormalizability of QCD are used to calculate the amplitude of energetic hadron (photon) diffraction into several jets with large relative transverse momenta off the nucleon (nucleus) Coulomb field. Numerical estimates of the ratio of EM and strong amplitudes show that within the kinematic range where the leading twist approximation for the strong amplitude is applicable, the EM contribution can be neglected. In pA scattering at the CERN Large Hadron Collider (LHC) and in the fragmentation of a photon into two jets in ultra-peripheral AA collisions in the black limit (which may be realistic at the LHC) the EM contribution may win. [Phys. Rev. D **67**, 017502 (2003)]