Selected Abstracts from Other Physical Review Journals

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Quark-number susceptibility, thermodynamic sum rule, and the hard thermal loop approximation. Purnendu Chakraborty, *Theory Group, Saha Institute of Nuclear Physics, 1/AF Bidhan Nagar, Kolkata 700 064, India;* Munshi G. Mustafa, *Theory Group, Saha Institute of Nuclear Physics, 1/AF Bidhan Nagar, Kolkata 700 064, India, and Institut für Theoretische Physik, Universität Giessen, 35392 Giessen, Germany;* Markus H. Thoma, *Centre for Interdisciplinary Plasma Science, Max-Planck-Institut für Extraterrestrische Physik, P.O. Box 1312, 85741 Garching, Germany.* (Received 4 March 2003; published 30 October 2003)

The quark number susceptibility, associated with the conserved quark number density, is closely related to the baryon and charge fluctuations in the quark-gluon plasma, which might serve as signature for the quark-gluon plasma formation in ultrarelativistic heavy-ion collisions. In addition to QCD lattice simulations, the quark number susceptibility has been calculated recently using a resummed perturbation theory (hard thermal loop resummation). In the present work we show, based on general arguments, that the computation of this quantity neglecting hard thermal loop vertices contradicts the Ward identity and violates the thermodynamic sum rule following from quark number conservation. We further show that the hard thermal loop perturbation theory is consistent with the thermodynamic sum rule. [Phys. Rev. D **68**, 085012 (2003)]

Chiral limit of strongly coupled lattice QCD at finite temperatures. Shailesh Chandrasekharan and Fu-Jiun Jiang, *Department of Physics, Box 90305, Duke University, Durham, North Carolina 27708, USA.* (Received 8 September 2003; published 18 November 2003)

We use the recently proposed directed-path algorithm to study the chiral limit of a strongly coupled lattice QCD with staggered quarks at finite temperatures. The new algorithm allows us to compute the chiral susceptibility and the pion decay constant accurately on large lattices for massless quarks. In the low temperature phase we find clear evidence for the singularities predicted by chiral perturbation theory. We also show convincingly that the chiral phase transition is of second order and belongs to the O(2) universality class. [Phys. Rev. D **68**, 091501 (2003)]

Search for periodic modulations of the solar neutrino flux in Super-Kamiokande-I. J. Yoo,[23] Y. Ashie,[1] S. Fukuda,[1] Y. Fukuda,[1] K. Ishihara,[1] Y. Itow,[1] Y. Koshio,[1] A. Minamino,[1] M. Miura,[1] S. Moriyama,[1] M. Nakahata,[1] T. Namba,[1] R. Nambu,[1] Y. Obayashi,[1] N. Sakurai,[1] M. Shiozawa,[1] Y. Suzuki,[1] H. Takeuchi,[1] Y. Takeuchi,[1] S. Yamada,[1] M. Ishitsuka,[2] T. Kajita,[2] K. Kaneyuki,[2] S. Nakayama,[2] A. Okada,[2] T. Ooyabu,[2] C. Saji,[2] S. Desai,[3] M. Earl,[3] E. Kearns,[3] M. D. Messier,[3] J. L. Stone,[3] L. R. Sulak,[3] C. W. Walter,[3] M. Goldhaber,[4] T. Barszczak,[5] D. Casper,[5] W. Gajewski,[5] W. R. Kropp,[5] S. Mine,[5] D. W. Liu,[5] M. B. Smy,[5] H. W. Sobel,[5] M. R. Vagins,[5] A. Gago,[6] K. S. Ganezer,[6] J. Hill,[6] W. E. Keig,[6] J. Y. Kim,[7] I. T. Lim,[7] R. W. Ellsworth,[8] S. Tasaka,[9] A. Kibayashi,[10] J. G. Learned,[10] S. Matsuno,[10] D. Takemori,[10] Y. Hayato,[11] A. K. Ichikawa,[11] T. Ishii,[11] J. Kameda,[11] T. Kobayashi,[11] T. Maruyama,[11] K. Nakamura,[11] K. Nitta,[11] Y. Oyama,[11] M. Sakuda,[11] Y. Totsuka,[11] M. Yoshida,[11] M. Kohama,[12] T. Iwashita,[12] A. T. Suzuki,[12] T. Inagaki,[13] I. Kato,[13] T. Nakaya,[13] K. Nishikawa,[13] T. J. Haines,[14,5] S. Dazeley,[15] S. Hatakeyama,[15] R. Svoboda,[15] E. Blaufuss,[16] M. L. Chen,[16] J. A. Goodman,[16] G. Guillian,[16] G. W. Sullivan,[16] D. Turcan,[16] K. Scholberg,[17] A. Habig,[18] M. Ackermann,[19] C. K. Jung,[19] T. Kato,[19] K. Kobayashi,[19] K. Martens,[19] M. Malek,[19] C. Mauger,[19] C. McGrew,[19] E. Sharkey,[19] B. Viren,[19,4] C. Yanagisawa,[19] T. Toshito,[20] C. Mitsuda,[21] K. Miyano,[21] T. Shibata,[21] Y. Kajiyama,[22] Y. Nagashima,[22] M. Takita,[22] H. I. Kim,[23] S. B. Kim,[23] H. Okazawa,[24] T. Ishizuka,[25] Y. Choi,[26] H. K. Seo,[26] M. Etoh,[27] Y. Gando,[27] T. Hasegawa,[27] K. Inoue,[27] J. Shirai,[27] A. Suzuki,[27] M. Koshiba,[28] Y. Hatakeyama,[29] Y. Ichikawa,[29] M. Koike,[29] K. Nishijima,[29] H. Ishino,[30] M. Morii,[30] R. Nishimura,[30] Y. Watanabe,[30] D. Kielczewska,[31,5] H. G. Berns,[32] S. C. Boyd,[32] A. L. Stachyra,[32] and R. J. Wilkes[32] (Super-Kamiokande Collaboration), [1]*Kamioka Observatory, Institute for Cosmic Ray Research, University of Tokyo, Kamioka, Gifu, 506-1205, Japan,* [2]*Research Center for Cosmic Neutrinos, Institute for Cosmic Ray Research, University of Tokyo, Kashiwa, Chiba 277-8582, Japan,* [3]*Department of Physics, Boston University, Boston, Massachusetts 02215, USA,* [4]*Physics Department, Brookhaven National Laboratory, Upton, New York 11973, USA,* [5]*Department of Physics and Astronomy, University of California, Irvine, Irvine, California 92697-4575, USA,* [6]*Department of Physics, California State University, Dominguez Hills, Carson, California 90747, USA,* [7]*Department of Physics, Chonnam National University, Kwangju 500-757, Korea,* [8]*Department of Physics, George Mason University, Fairfax, Virginia 22030, USA,* [9]*Department of Physics, Gifu University, Gifu, Gifu 501-1193, Japan,* [10]*Department of Physics and Astronomy, University of Hawaii, Honolulu, Hawaii 96822, USA,* [11]*Institute of Particle and Nuclear Studies, High Energy Accelerator Research Organization (KEK), Tsukuba, Ibaraki 305-0801, Japan,* [12]*Department of Physics, Kobe University, Kobe, Hyogo 657-8501, Japan,* [13]*Department of Physics, Kyoto University, Kyoto 606-8502, Japan,* [14]*Physics Division, P-23, Los Alamos National Laboratory, Los Alamos, New Mexico 87544, USA,* [15]*Department of Physics and Astronomy, Louisiana State University, Baton Rouge, Louisiana 70803, USA,* [16]*Department of Physics, University of Maryland, College Park, Maryland 20742, USA,* [17]*Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA,* [18]*Department of Physics, University of Minnesota, Duluth, Minnesota 55812-2496, USA,* [19]*Department of Physics and Astronomy, State University of New York, Stony Brook,*

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A search for periodic modulations of the solar neutrino flux was performed using the Super-Kamiokande-I data taken from 31 May 1996 to 15 July 2001. The detector's capability of measuring the exact time of events, combined with a relatively high yield of solar neutrino events, allows a search for short-time variations in the observed flux. We employed the Lomb test to look for periodic modulations of the observed solar neutrino flux. The obtained periodogram is consistent with statistical fluctuation and no significant periodicity was found. [Phys. Rev. D **68**, 092002 (2003)]

Parametrizing the neutrino mixing matrix. A. Zee, *Kavli Institute for Theoretical Physics, University of California, Santa Barbara, California 93106, USA.* (Received 6 August 2003; published 7 November 2003)

We propose parametrizations of the neutrino mixing matrix. We discuss several *Ansätze*: in some of them $V_{e3}=0$ but in others V_{e3} typically "comes out" to be of the order $\simeq 0.05$. [Phys. Rev. D **68**, 093002 (2003)]

Three-neutrino mixing after the first results from K2K and KamLAND. M. C. Gonzalez-Garcia, *YITP, SUNY at Stony Brook, Stony Brook, New York 11794-3840, USA, and IFIC, Universitat de València–CSIC, Apt 22085, 46071 València, Spain;* Carlos Peña-Garay, *School of Natural Sciences, Institute for Advanced Study, Princeton, New Jersey 08540, USA.* (Received 9 June 2003; published 11 November 2003)

We analyze the impact of the data on long-baseline ν_μ disappearance from the K2K experiment and reactor $\bar{\nu}_e$ disappearance from the KamLAND experiment on the determination of the leptonic three-generation mixing parameters. Performing an up-to-date global analysis of solar, atmospheric, reactor, and long-baseline neutrino data in the context of three-neutrino oscillations, we determine the presently allowed ranges of masses and mixing and we consistently derive the allowed magnitude of the elements of the leptonic mixing matrix. We also quantify the maximum allowed contribution of Δm^2_{21} oscillations to *CP*-odd and *CP*-even observables at future long-baseline experiments. [Phys. Rev. D **68**, 093003 (2003)]

Measuring flavor ratios of high-energy astrophysical neutrinos. John F. Beacom,[1] Nicole F. Bell,[1,2] Dan Hooper,[3] Sandip Pakvasa,[4,2] and Thomas J. Weiler[5,2] [1]*NASA/Fermilab Astrophysics Center, Fermi National Accelerator Laboratory, Batavia, Illinois 60510-0500, USA,* [2]*Kavli Institute for Theoretical Physics, University of California, Santa Barbara, California 93106, USA,* [3]*Department of Physics, University of Wisconsin, Madison, Wisconsin 53706, USA,* [4]*Department of Physics and Astronomy, University of Hawaii, Honolulu, Hawaii 96822, USA,* [5]*Department of Physics and Astronomy, Vanderbilt University, Nashville, Tennessee 37235, USA.* (Received 1 July 2003; published 11 November 2003)

We discuss the prospects for next generation neutrino telescopes, such as IceCube, to measure the flavor ratios of high-energy astrophysical neutrinos. The expected flavor ratios at the sources are $\phi_{\nu_e}:\phi_{\nu_\mu}:\phi_{\nu_\tau}=1:2:0$, and neutrino oscillations quickly transform these to $1:1:1$. The flavor ratios can be deduced from the relative rates of showers (ν_e charged current, most ν_τ charged current, and all flavors neutral current), muon tracks (ν_μ charged current only), and tau lepton lollipops and double bangs (ν_τ charged current only). The peak sensitivities for these interactions are at different neutrino energies, but the flavor ratios can be reliably connected by a reasonable measurement of the spectrum shape. Measurement of the astrophysical neutrino flavor ratios tests the assumed production mechanism and also provides a very long baseline test of a number of exotic scenarios, including neutrino decay, *CPT* violation, and small-δm^2 oscillations to sterile neutrinos. [Phys. Rev. D **68**, 093005 (2003)]

Three-dimensional simulation of the atmospheric neutrinos. J. Favier, R. Kossakowski, and J. P. Vialle, *Laboratoire d'Annecy-le-Vieux de Physique des Particules, LAPP, IN2P3-CNRS, Boîte Postal 110, F-74941 Annecy-le-Vieux, CEDEX, France.* (Received 16 July 2003; published 11 November 2003)

The first AMS flight in June 1998 on board the space shuttle Discovery at an altitude of approximately 380 km unveiled unexpected features of the cosmic rays spectra below Earth's geomagnetic cutoff. In addition to a secondary flux of particles at all latitudes, a ring of high energy particles (up to 6 GeV) and an anomalous ratio e^+/e^- as high as 4 was observed near the geomagnetic equator. This paper describes a simulation of the interaction of primary cosmic rays with the atmosphere in which the effect of Earth's magnetic field is included. Using the GEANT3 package for the tracking of particles with the GFLUKA associated package for the physics of interactions, this simulation reproduces quite well the AMS experimental results and the CAPRICE muon data at ground level. The predictions of this model for the flux of atmospheric neutrinos are compared with the Super-Kamiokande results and with the results of other atmospheric neutrino models. [Phys. Rev. D **68**, 093006 (2003)]

Ultrahigh energy neutrino-nucleon interactions. R. Fiore,[1] L.L. Jenkovszky,[2] A. Kotikov,[3] F. Paccanoni,[4] A. Papa,[1] and E. Predazzi[5] [1]*Dipartimento di Fisica, Università della Calabria, Istituto Nazionale di Fisica Nucleare, Gruppo Collegato di Cosenza, I-87036 Arcavacata di Rende, Cosenza, Italy,* [2]*Bogolyubov Institute for Theoretical Physics, Academy of Sciences of Ukraine, UA-03143 Kiev, Ukraine,* [3]*Bogolyubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research, RU-141980 Dubna, Russia,* [4]*Dipartimento di Fisica, Università di Padova, Istituto Nazionale di Fisica Nucleare, Sezione di Padova, Via F. Marzolo 8, I-35131 Padova, Italy,* [5]*Dipartimento di Fisica Teorica, Università di Torino, Istituto Nazionale di Fisica Nucleare, Sezione di Torino Via P. Giuria 1, I-10125 Torino, Italy.* (Received 28 February 2003; published 17 November 2003)

Ultrahigh energy ($E_\nu > 10^8$ GeV) neutrino-nucleon total cross sections $\sigma^{\nu N}$ are estimated from a soft nonperturbative model complemented by an approximate QCD evolution, explicitly calculated. The resulting asymptotic energy behavior of the neutrino-nucleon charged-current total cross section is derived analytically, and predictions concerning the observation of ultrahigh energy neutrinos in future experiments are presented. [Phys. Rev. D **68**, 093010 (2003)]

Supernova pointing with low- and high-energy neutrino detectors. R. Tomàs, D. Semikoz, G. G. Raffelt, M. Kachelrieß, and A. S. Dighe, *Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), Föhringer Ring 6, 80805 München, Germany.* (Received 14 July 2003; published 21 November 2003)

A future galactic SN can be located several hours before the optical explosion through the MeV-neutrino burst, exploiting the directionality of ν-e scattering in a water Cherenkov detector such as Super-Kamiokande. We study the statistical efficiency of different methods for extracting the SN direction and identify a simple approach that is nearly optimal, yet independent of the exact SN neutrino spectra. We use this method to quantify the increase in the pointing accuracy by the addition of gadolinium to water, which tags neutrons from the inverse beta decay background. We also study the dependence of the pointing accuracy on neutrino mixing scenarios and initial spectra. We find that in the ''worst case'' scenario the pointing accuracy is 8° at 95% C.L. in the absence of tagging, which improves to 3° with a tagging efficiency of 95%. At a megaton detector, this accuracy can be as good as 0.6°. A TeV-neutrino burst is also expected to be emitted contemporaneously with the SN optical explosion, which may locate the SN to within a few tenths of a degree at a future km^2 high-energy neutrino telescope. If the SN is not seen in the electromagnetic spectrum, locating it in the sky through neutrinos is crucial for identifying the Earth matter effects on SN neutrino oscillations. [Phys. Rev. D **68**, 093013 (2003)]

Local equilibrium of the quark-gluon plasma. Cristina Manuel, *Instituto de Física Corpuscular, Universitat de València-C.S.I.C., Edificio de Institutos de Paterna, Apt. 2085, 46071 València, Spain;* 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 30 June 2003; published 13 November 2003)

Within kinetic theory, we look for the local equilibrium configurations of a quark-gluon plasma by maximizing the local entropy. We use the well-established transport equations in the Vlasov limit, supplemented by the Waldmann-Snider collision terms. Two different classes of local equilibrium solutions are found. The first one corresponds to the configurations that comply with the so-called collisional invariants. The second one is given by the distribution functions that cancel the collision terms, representing the most probable binary interactions with soft gluon exchange in the t channel. The two sets of solutions agree with each other if we go beyond these dominant processes and take into account subleading quark-antiquark annihilation or creation and gluon number nonconserving processes. The local equilibrium state appears to be colorful, as the color charges are not locally neutralized. The properties of such an equilibrium state are analyzed. In particular, the related hydrodynamic equations of a colorful fluid are derived. Possible neutralization processes are also briefly discussed. [Phys. Rev. D **68**, 094010 (2003)]

Cronin effect and high-p_T suppression in pA collisions. Dmitri Kharzeev, *Nuclear Theory Group, Brookhaven National Laboratory, Building 510A, Upton, New York 11973, USA;* Yuri V. Kovchegov, *Department of Physics, University of Washington, Box 351560, Seattle, Washington 98195, USA;* Kirill Tuchin, *Institute for Nuclear Theory, University of Washington, Box 351550, Seattle, Washington 98195, USA.* (Received 3 July 2003; published 18 November 2003)

We review the predictions of the theory of a color glass condensate for a gluon production cross section in $p(d)A$ collisions. We demonstrate that, at moderate energies, when the gluon production cross section can be calculated in the framework of the McLerran-Venugopalan model, it has only a partonic level Cronin effect in it. At higher energies or rapidities corresponding to smaller values of the Bjorken x, quantum evolution becomes important. The effect of quantum evolution at higher energies or rapidities is to introduce the suppression of high-p_T gluons slightly decreasing the Cronin enhancement. At still higher energies or rapidities quantum evolution leads to the suppression of produced gluons at all values of p_T. [Phys. Rev. D **68**, 094013 (2003)]

Contributions of gluon recombination to saturation phenomena. Wei Zhu, Jianhong Ruan, Jifeng Yang, and Zhenqi Shen, *Department of Physics, East China Normal University, Shanghai 200062, People's Republic of China.* (Received 6 June 2003; revised manuscript received 13 August 2003; published 19 November 2003)

Parton distributions in the small x region are numerically predicted by using a modified Dokshitzer-Gribov-Lipatov-Altarelli-Parisi (DGLAP) equation with Glück-Reya-Vogt (GRV)-like input distributions. We find that gluon recombination at the twist-4 level obviously suppresses the rapid growth of parton densities with x decreasing. We show that before the saturation scale Q_s^2 is reached, saturation and partial saturation appear in the small x behavior of

parton distributions in the nucleus and free proton, respectively. The antishadowing contributions to the saturation phenomena are also discussed. [Phys. Rev. D **68**, 094015 (2003)]

Detailed QCD analysis of twist-3 effects in deeply virtual Compton scattering observables. A. Freund, *Institut für Theoretische Physik, Universität Regensburg, D-93040 Regensburg, Germany.* (Received 12 June 2003; published 21 November 2003)

In this paper I present a detailed QCD analysis of twist-3 effects in the Wandzura-Wilczek (WW) approximation in deeply virtual Compton scattering (DVCS) observables for various kinematical settings, representing the DESY HERA, HERMES, CLAS and the planned EIC (electron-ion-collider) experiments. I find that the twist-3 effects in the WW approximation are almost always negligible at collider energies but can be large for low Q^2 and smaller x_{bj} in observables for the lower energy, fixed target experiments directly sensitive to the real part of DVCS amplitudes like the charge asymmetry. Conclusions are then drawn about the reliability of extracting twist-2 generalized parton distributions (GPDs) from experimental data and a first, phenomenological, parametrization of the LO and NLO twist-2 GPD H, describing all the currently available DVCS data within the experimental errors is given. [Phys. Rev. D **68**, 096006 (2003)]

Spin polarization and color superconductivity in quark matter. E. Nakano, *Department of Physics, Tokyo Metropolitan University, 1-1 Minami-Ohsawa, Hachioji, Tokyo 192-0397, Japan;* T. Maruyama, *College of Bioresource Sciences, Nihon University, Fujisawa 252-8510, Japan; Japan Atomic Energy Research Institute, Tokai, Ibaraki 319-1195, Japan; and Institute for Quantum Energy, Nihon University, Chiyoda-ku, Tokyo 101-8308, Japan;* T. Tatsumi, *Department of Physics, Kyoto University, Kyoto 606-8502, Japan.* (Received 10 April 2003; published 3 November 2003)

A coexistent phase of spin polarization and color superconductivity in high-density QCD is investigated using a self-consistent mean-field method at zero temperature. The axial-vector self-energy stemming from the Fock exchange term of the one-gluon-exchange interaction has a central role in causing spin polarization. The magnitude of spin polarization is determined by the coupled Schwinger-Dyson equations with a superconducting gap function. As a significant feature, the Fermi surface is deformed by the axial-vector self-energy and then rotation symmetry is spontaneously broken down. The gap function results in being anisotropic in the momentum space in accordance with the deformation. As a result of numerical calculations, it is found that spin polarization barely conflicts with color superconductivity, but almost coexists with it. [Phys. Rev. D **68**, 105001 (2003)]

Semiclassical electroweak Weizsäcker-Williams method. Sean C. Ahern and John W. Norbury, *Physics Department, University of Wisconsin, Milwaukee, P.O. Box 413, Milwaukee, Wisconsin 53201, USA.* (Received 30 April 2003; revised manuscript received 19 September 2003; published 1 December 2003)

The Weizsäcker-Williams method is a semiclassical approximation scheme used to analyze a wide variety of electromagnetic interactions. It can greatly simplify calculations that would otherwise be impractical or impossible to carry out using the standard route of the Feynman rules. The method is rederived here under the more general assumptions that the couplings are either electromagnetic, charged weak, or neutral weak, and that the fields are massive. All major formulas are found to reduce to those of the traditional method when appropriate limits are taken. [Phys. Rev. D **68**, 113001 (2003)]