Selected Abstracts from Other Physical Review Journals

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Neutrino interferometry in curved spacetime. Roland M. Crocker, *School of Physics, The University of Melbourne, 3010 Victoria, Australia;* Carlo Giunti, *INFN, Sezione di Torino, and Dipartimento di Fisica Teorica, Università di Torino, Via P. Giuria 1, I-10125 Torino, Italy;* Daniel J. Mortlock, *Institute of Astronomy, Madingley Road, Cambridge CB3 0HA, United Kingdom.* (Received 25 September 2003; published 25 March 2004)

Gravitational lensing introduces the possibility of multiple (macroscopic) paths from an astrophysical neutrino source to a detector. Such a multiplicity of paths can allow for quantum mechanical interference to take place that is qualitatively different from neutrino oscillations in flat space. After an illustrative example clarifying some underappreciated subtleties of the phase calculation, we derive the form of the quantum mechanical phase for a neutrino mass eigenstate propagating nonradially through a Schwarzschild metric. We subsequently determine the form of the interference pattern seen at a detector. We show that the neutrino signal from a supernova could exhibit the interference effects we discuss *were* it lensed by an object in a suitable mass range. We finally conclude, however, that—given current neutrino detector technology—the probability of such lensing occurring for a (neutrino-detectable) supernova is tiny in the immediate future. [Phys. Rev. D **69**, 063008 (2004)]

Generalized Ward identity and gauge invariance of the color-superconducting gap. De-fu Hou, *Institut für Theoretische Physik, J.W. Goethe-Universität, D-60054 Frankfurt/Main, Germany, and Institute of Particle Physics, Huazhong Normal University, Wuhan, 430079, People's Republic of China;* Qun Wang, *Institut für Theoretische Physik, J.W. Goethe-Universität, D-60054 Frankfurt/Main, Germany, and Physics Department, Shandong University, Jinan, Shandong, 250100, People's Republic of China;* Dirk H. Rischke, *Institut für Theoretische Physik, J.W. Goethe-Universität, D-60054 Frankfurt/Main, Germany.* (Received 22 January 2004; published 27 April 2004)

We derive a generalized Ward identity for color-superconducting quark matter via the functional integral approach. The identity implies the gauge independence of the color-superconducting gap parameter on the quasiparticle mass shell to subleading order in the covariant gauge. [Phys. Rev. D **69**, 071501 (2004)]

Radiative corrections to neutrino mixing and *CP* violation in the minimal seesaw model with leptogenesis. Jian-wei Mei and Zhi-zhong Xing, *CCAST (World Laboratory), P. O. Box 8730, Beijing 100080, China, and Institute of High Energy Physics, Chinese Academy of Sciences, P. O. Box 918 (4), Beijing 100039, China.* (Received 12 December 2003; published 9 April 2004)

Radiative corrections to neutrino mixing and *CP* violation are analyzed in the minimal seesaw model with two heavy right-handed neutrinos. We find that the textures of the effective Majorana neutrino mass matrix are essentially stable against renormalization effects. Taking into account the Frampton-Glashow-Yanagida *Ansatz* for the Dirac neutrino Yukawa coupling matrix, we calculate the running effects of light neutrino masses, lepton flavor mixing angles, and *CP*-violating phases for both the $m_1=0$ (normal mass hierarchy) and $m_3=0$ (inverted mass hierarchy) cases in the standard model and in its minimal supersymmetric extension. Very instructive predictions for the cosmological baryon number asymmetry via thermal leptogenesis are also given with the help of low-energy neutrino mixing quantities. [Phys. Rev. D **69**, 073003 (2004)]

Electroweak radiative corrections to deep-inelastic neutrino scattering: Implications for NuTeV? K.-P. O. Diener, *Paul-Scherrer-Institut, Würenlingen und Villigen, CH-5232 Villigen PSI, Switzerland;* S. Dittmaier and W. Hollik, *Max-Planck-Institut für Physik, Werner-Heisenberg-Institut, D-80805 München, Germany.* (Received 25 November 2003; published 12 April 2004)

We calculate the $O(\alpha)$ electroweak corrections to charged- and neutral-current deep-inelastic neutrino scattering off an isoscalar target. The full one-loop-corrected cross sections, including hard photonic corrections, are evaluated and compared to an earlier result which was used in the NuTeV analysis. In particular, we compare results that differ in the input-parameter scheme, treatment of real photon radiation, and factorization scheme. The associated shifts in the theoretical prediction for the ratio of neutral- and charged-current cross sections can be larger than the experimental accuracy of the NuTeV result. [Phys. Rev. D **69**, 073005 (2004)]

Day-night effect in solar neutrino oscillations with three flavors. Mattias Blennow, Tommy Ohlsson, and Håkan Snellman, *Division of Mathematical Physics, Department of Physics, Royal Institute of Technology (KTH), AlbaNova University Center, Roslagstullsbacken 11, 106 91 Stockholm, Sweden.* (Received 12 January 2004; published 14 April 2004)

We investigate the effects of a nonzero leptonic mixing angle θ_{13} on the solar neutrino day-night asymmetry. Using a constant matter density profile for the Earth and well-motivated approximations, we derive analytical expressions for the ν_e survival probabilities for solar neutrinos arriving directly at the detector and for solar neutrinos which have passed through the Earth. Furthermore, we numerically study the effects of a nonzero θ_{13} on the day-night asymmetry at detectors and find that they are small. Finally, we show that if the

uncertainties in the parameters θ_{12} and Δm^2 as well as the uncertainty in the day-night asymmetry itself were much smaller than they are today, this effect could, in principle, be used to determine θ_{13}. [Phys. Rev. D **69**, 073006 (2004)]

New window on strange quark matter as the ground state of strongly interacting matter. Vikram Soni, *National Physical Laboratory, K. S. Krishnan Marg, New Delhi 110012, India;* Dipankar Bhattacharya, *Raman Research Institute, Bangalore 560080, India.* (Received 8 September 2003; published 5 April 2004)

If strange quark matter is the true ground state of matter, it must have lower energy than nuclear matter. Simultaneously, two-flavor quark matter must have higher energy than nuclear matter, for otherwise the latter would convert to the former. We show, using an effective chiral Lagrangian, that the existence of a new lower energy ground state for two-flavor quark matter, the pion condensate, shrinks the window allowing strange quark matter to be the ground state of matter and sets new limits on the current strange quark mass. [Phys. Rev. D **69**, 074001 (2004)]

Magnetic moment of the Θ^+ pentaquark state. P.-Z. Huang, W.-Z. Deng, and X.-L. Chen, *Department of Physics, Peking University, Beijing 100871, China;* Shi-Lin Zhu, *Department of Physics, Peking University, Beijing 100871, China, and Key Laboratory of Heavy Ion Physics, Ministry of Education, Beijing, China.* (Received 10 November 2003; published 6 April 2004)

We calculate the magnetic moment of the recently observed Θ^+ pentaquark state in the framework of the light cone QCD sum rules using the photon distribution amplitudes. We find that $\mu_{\Theta^+} = (0.12 \pm 0.06)\mu_N$, which is quite small. We also compare our result with predictions of other groups. [Phys. Rev. D **69**, 074004 (2004)]

Determining the proximity of $\gamma^* N$ scattering to the black body limit using deep inelastic scattering and J/ψ production. T. Rogers and X. Zu, *Department of Physics, Pennsylvania State University, University Park, Pennsylvania 16802, USA;* V. Guzey, *Institut für Theoretische Physik II, Ruhr-Universität Bochum, D-44780 Bochum, Germany;* M. Strikman, *Department of Physics, Pennsylvania State University, University Park, Pennsylvania 16802, USA.* (Received 16 September 2003; published 12 April 2004)

We use information about DIS and J/ψ production on hydrogen to model the t dependence of the $\gamma^* N$ scattering amplitude. We investigate the profile function for elastic scattering of hadronic components of the virtual photon off both a nucleon and heavy nuclear target, and we estimate the value of the impact parameter where the blackbody limit is reached. We also estimate the fraction of the cross section that is due to hadronic configurations in the virtual photon wave function that approach the unitarity limit. We extract, from these considerations, approximate lower limits on the values of x where the leading twist approximation in DIS is violated. We observe that the blackbody limit may be approached within DESY HERA kinematics with Q^2 equal to a few GeV^2 and $x \sim 10^{-4}$. Comparisons are made with earlier predictions by Munier *et al.*, and the longitudinal structure function is compared with preliminary HERA data. The principle advantage of our method is that we do not rely solely on the t dependence of ρ-meson production data. This allows us to extend our analysis down to very small impact parameters and dipole sizes. Finally, we perform a similar calculation with a ^{208}Pb target, and we demonstrate that the blackbody limit is already approached at $Q^2 \sim 20$ GeV^2 and $x \sim 10^{-4}$. [Phys. Rev. D **69**, 074011 (2004)]

Thermal fluctuations of gauge fields and first order phase transitions in color superconductivity. Taeko Matsuura,[1] Kei Iida,[2] Tetsuo Hatsuda,[1] and Gordon Baym[3] [1]*Department of Physics, University of Tokyo, Tokyo 113-0033, Japan,* [2]*The Institute of Physical and Chemical Research (RIKEN), Wako, Saitama 351-0198, Japan,* [3]*Department of Physics, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801-3080, USA.* (Received 7 December 2003; published 14 April 2004)

We study the effects of thermal fluctuations of gluons and the diquark pairing field on the superconducting-to-normal state phase transition in a three-flavor color superconductor, using the Ginzburg-Landau free energy. At high baryon densities, where the system is a type I superconductor, gluonic fluctuations, which dominate over diquark fluctuations, induce a cubic term in the Ginzburg-Landau free energy, as well as large corrections to quadratic and quartic terms of the order parameter. The cubic term leads to a relatively strong first order transition, in contrast with the very weak first order transitions in metallic type I superconductors. The strength of the first order transition decreases with increasing baryon density. In addition gluonic fluctuations lower the critical temperature of the first order transition. We derive explicit formulas for the critical temperature and the discontinuity of the order parameter at the critical point. The validity of the first order transition obtained in the one-loop approximation is also examined by estimating the size of the critical region. [Phys. Rev. D **69**, 074012 (2004)]

Quark imaging in the proton via quantum phase-space distributions. A.V. Belitsky, Xiangdong Ji, and Feng Yuan, *Department of Physics, University of Maryland, College Park, Maryland 20742, USA, and Institute for Nuclear Theory, University of Washington, Box 351550, Seattle, Washington 98195, USA.* (Received 8 September 2003; published 16 April 2004)

We develop the concept of quantum phase-space (Wigner) distributions for quarks and gluons in the proton. To appreciate their physical content, we analyze the contraints from special relativity on the interpretation of elastic form factors, and examine the physics of the Feynman parton distributions in the proton's rest frame. We relate the quark Wigner functions to the transverse-momentum dependent parton distributions and generalized parton distributions, emphasizing the physical role of the skewness parameter. We show that the Wigner functions allow us to visualize quantum quarks and gluons using the language of classical phase space. We present two

examples of the quark Wigner distributions and point out some model-independent features. [Phys. Rev. D **69**, 074014 (2004)]

Θ^+ baryon production in *KN* and *NN* reactions. ∅ Yongseok Oh,[1,2] ∅ Hungchong Kim,[1] and ∅ Su Houng Lee[1], [1]*Institute of Physics and Applied Physics, Yonsei University, Seoul 120-749, Korea,* [2]*Thomas Jefferson National Accelerator Facility, 12000 Jefferson Avenue, Newport News, Virginia 23606, USA.* (Received 9 November 2003; published 20 April 2004)

We study $\Theta^+(1540)$ production in kaon-nucleon (KN) and nucleon-nucleon (NN) interactions by assuming that the Θ^+ is an isosinglet with $J^P=\frac{1}{2}^+$. Possible t-channel diagrams with K^* exchange are considered in both reactions as well as K exchange in NN reactions. The cross section for $np\to\Lambda^0\Theta^+$, which has not been considered in previous calculations, is found to be about a factor of 5 larger than that for $np\to\Sigma^0\Theta^+$ due to the large coupling of the $KN\Lambda$ interaction. The cross sections are obtained by setting $g_{KN\Theta}=1$ and varying the ratio of $g_{K^*N\Theta}/g_{KN\Theta}$ so that future experimental data can be used to estimate these couplings. We also find that the isospin relations hold for these reactions. [Phys. Rev. D **69**, 074016 (2004)]

Two-hadron semi-inclusive production including subleading twist contributions. Alessandro Bacchetta, *Institut für Theoretische Physik, Universität Regensburg, D-93040 Regensburg, Germany;* Marco Radici, *Dipartimento di Fisica Nucleare e Teorica, Università di Pavia, I-27100 Pavia, Italy, and Istituto Nazionale di Fisica Nucleare, Sezione di Pavia, I-27100 Pavia, Italy.* (Received 29 December 2003; published 27 April 2004)

We extend the analysis of two-hadron fragmentation functions to the subleading twist, discussing also the issue of color gauge invariance. Our results can be used anywhere two unpolarized hadrons are semi-inclusively produced in the same fragmentation region, also at moderate values of the hard scale Q. Here, we consider the example of polarized deep-inelastic production of two hadrons and we give a complete list of cross sections and spin asymmetries up to the subleading twist. Among the results, we highlight the possibility of extracting the transversity distribution with longitudinally polarized targets and also the twist-3 distribution $e(x)$, which is related to the pion-nucleon σ term and to the strangeness content of the nucleon. [Phys. Rev. D **69**, 074026 (2004)]

Nuclear parton distributions at next to leading order. D. de Florian and R. Sassot, *Departamento de Física, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Pabellón I, Ciudad Universitaria (1428) Buenos Aires, Argentina.* (Received 19 November 2003; published 28 April 2004)

We perform a next to leading order QCD global analysis of nuclear deep inelastic scattering and Drell-Yan data using the convolution approach to parametrize nuclear parton densities. We find both a significant improvement in the agreement with data compared to previous extractions, and substantial differences in the scale dependence of nuclear effects compared to leading order analyses. [Phys. Rev. D **69**, 074028 (2004)]

Confinement and gluon propagator in Coulomb gauge QCD. Adam P. Szczepaniak, *Physics Department and Nuclear Theory Center, Indiana University, Bloomington, Indiana 47405, USA.* (Received 9 June 2003; published 29 April 2004)

We consider the role of the Faddeev-Popov determinant in the Coulomb gauge on the confinement properties of the QCD vacuum. We show that the determinant is needed to regularize the otherwise divergent functional integrals near the Gribov horizon but still enables large field configurations to generate IR enhanced running coupling. The physical gluon propagator is found to be strongly suppressed in the IR consistent with expectations from lattice gauge calculations. [Phys. Rev. D **69**, 074031 (2004)]

Different couplings of the chemical potential with an identical partition function in QCD on a lattice. Fabrizio Palumbo, *INFN–Laboratori Nazionali di Frascati, P.O. Box 13, I-00044 Frascati, Italy.* (Received 25 October 2002; revised manuscript received 11 December 2003; published 29 April 2004)

New couplings of the chemical potential, closer to the continuum, are derived from the transfer matrix formulation of the partition function of QCD on a lattice. In particular the time splitting of the quark fields (and therefore the presence of the temporal gauge fields) can be avoided in some of these couplings. [Phys. Rev. D **69**, 074508 (2004)]

Numerical portrait of a relativistic BCS gapped superfluid. Simon Hands, *Department of Physics, University of Wales Swansea, Singleton Park, Swansea SA2 8PP, United Kingdom;* David N. Walters, *Theoretical Physics Group, Department of Physics and Astronomy, University of Manchester, Manchester M13 9PL, United Kingdom.* (Received 13 January 2004; published 29 April 2004)

We present results of numerical simulations of the $(3+1)$-dimensional Nambu–Jona-Lasinio model with a nonzero baryon density enforced via the introduction of a chemical potential $\mu\neq 0$. The triviality of the model with a number of dimensions $d\geqslant 4$ is dealt with by fitting low energy constants, calculated analytically in the large number of colors (Hartree) limit, to phenomenological values. Nonperturbative measurements of local order parameters for superfluidity and their related susceptibilities show that, in contrast with the $(2+1)$-dimensional model, the ground state at high chemical potential and low temperature is that of a traditional BCS superfluid. This conclusion is supported by the direct observation of a gap in the dispersion relation for $0.5\leqslant\mu a\leqslant 0.85$, which at $\mu a=0.8$ is found to be roughly 15% the size of the vacuum fermion mass. We also present results of an initial investigation of the stability of the BCS phase against thermal fluctuations. Finally, we discuss the effect of splitting the Fermi surfaces of the pairing part-

ners by the introduction of a nonzero isospin chemical potential. [Phys. Rev. D **69**, 076011 (2004)]

Analytical expression for the nonsinglet structure functions at small *x* in the double logarithmic approximation. Michael Lublinsky, *DESY Theory Group, DESY, Notkestrasse 85, 22607 Hamburg, Germany.* (Received 7 January 2004; published 8 April 2004)

A simple analytic expression for the nonsinglet structure function f_{NS} is given. The expression is derived from the result of Ermolaev, Manaenkov, and Ryskin obtained by low x resummation of the quark ladder diagrams in the double logarithmic approximation of perturbative QCD. [Phys. Rev. D **69**, 077502 (2004)]