Selected Abstracts from Other Physical Review Journals

Abstracts of papers which are published in **other Physical Review journals** *and may be of interest to Physical Review C readers are printed here. The Editors of Physical Review C routinely scan the abstracts of* **Physical Review D** *papers. Appropriate abstracts of papers in other Physical Review journals may be included upon request.*

Chiral symmetry breaking, color superconductivity, and color neutral quark matter: A variational approach. Amruta Mishra, *Institute für Theoretische Physik, Universität Frankfurt, D-60054 Frankfurt, Germany;* Hiranmaya Mishra, *Theory Division, Physical Research Laboratory, Navrangpura, Ahmedabad 380 009, India.* (Received 25 June 2003; published 30 January 2004)

We investigate the vacuum realignment for chiral symmetry breaking and color superconductivity at finite density in the Nambu–Jona-Lasinio model in a variational method. The treatment allows us to investigate the simultaneous formation of condensates in quark-antiquark as well as in diquark channels. The methodology involves an explicit construction of a variational ground state and minimization of the thermodynamic potential. Color and electric charge neutrality conditions are imposed through introduction of appropriate chemical potentials. Color and flavor dependent condensate functions are determined through minimization of the thermodynamic potential. The equation of state is calculated. Simultaneous existence of a mass gap and superconducting gap is seen in a small window of the quark chemical potential within the model when charge neutrality conditions are not imposed. Enforcing color and electric charge neutrality conditions gives rise to the existence of gapless superconducting modes depending upon the magnitude of the gap and the difference of the chemical potentials of the condensing quarks. [Phys. Rev. D **69**, 014014 (2004)]

Photoneutrino process in astrophysical systems. Sharada Iyer Dutta, Saša Ratković, and Madappa Prakash, *Department of Physics & Astronomy, State University of New York at Stony Brook, Stony Brook, New York 11794-3800, USA.* (Received 22 September 2003; revised manuscript received 4 November 2003; published 30 January 2004)

Explicit expressions for the differential and total rates and emissivities of neutrino pairs from the photoneutrino process $e^{\pm}+\gamma \rightarrow e^{\pm}+\nu+\overline{\nu}$ in hot and dense matter are derived. Full information about the emitted neutrinos is retained by evaluating the squared matrix elements for this process which was hitherto bypassed through the use of Lenard's identity in obtaining the total neutrino emissivities. Accurate numerical results are presented for widely varying conditions of temperature and density. Analytical results helpful in understanding the qualitative behaviors of the rates and emissivities in limiting situations are derived. The corresponding production and absorption kernels in the source term of the Boltzmann equation for neutrino transport are developed. The appropriate Legendre coefficients of these kernels, in forms suitable for multigroup flux-limited diffusion schemes, are also provided. [Phys. Rev. D **69**, 023005 (2004)]

Neutrinoless double beta decay in light of SNO salt data. Hitoshi Murayama and Carlos Peña-Garay, *School of Natural Sciences, Institute for Advanced Study, Einstein Dr., Princeton, New Jersey 08540, USA.* (Received 14 November 2003; published 20 February 2004)

In the SNO data from its salt run, probably the most significant result is the consistency with the previous results without assuming the ^{8}B energy spectrum. In addition, they have excluded the maximal mixing at a very high confidence level. This has important implications on the double beta decay experiments. For the inverted or degenerate mass spectrum, we find $|\langle m_\nu \rangle_{ee}| > 0.013$ eV at 95% C.L., and the next generation experiments can discriminate Majorana and Dirac neutrinos if the inverted or degenerate mass spectrum will be confirmed by the improvements in cosmology, tritium data beta decay, or long-baseline oscillation experiments. [Phys. Rev. D **69**, 031301 (2004)]

Landau-Pomeranchuk-Migdal effect for multihundred GeV electrons. H. D. Hansen and U. I. Uggerhøj, *Department of Physics and Astronomy, University of Aarhus, Denmark;* C. Biino, *CERN, Geneva, Switzerland;* S. Ballestrero, A. Mangiarotti, and P. Sona, *University of Florence, Florence, Italy;* T. J. Ketel, *Free University, Amsterdam, The Netherlands;* Z. Z. Vilakazi, *University of Cape Town, Cape Town, South Africa.* (Received 30 September 2003; published 13 February 2004)

Experimental results for the bremsstrahlung energy loss of 149, 207, and 287 GeV electrons in thin Ir, Ta, and Cu targets are presented. For each target and energy, a comparison between simulated values based on the Landau-Pomeranchuk-Migdal (LPM) suppression of incoherent bremsstrahlung is shown. For the electron energies investigated, the LPM effect enters the quantum regime where the recoil imposed on the electron by the emitted photon becomes important. Good agreement between simulations based on Migdal's theory and data from the experiment is found, indicating that the LPM suppression is well understood also in the quantum regime. Results from a comparison between simulations with the ''threshold'' energy E_{LPM} as a free parameter and the data are shown. This analysis reproduces the expected trend as a function of nominal radiation length, but yields values that tend to be low compared to Migdal's theory. [Phys. Rev. D **69**, 032001 (2004)]

A parametrization for the neutrino mixing matrix. Werner Rodejohann, *Scuola Internazionale Superiore di Studi Avanzati, I-34014 Trieste, Italy, and Istituto Nazionale di Fisica Nucleare, Sezione di Trieste, I-34014 Trieste, Italy.* (Received 23 September 2003; published 25 February 2004)

We propose a flexible and model independent parametrization of the neutrino mixing matrix, which takes advantage of the fact that there are up to three small quantities in neutrino mixing phenomenology: (i) the deviation from maximal mixing of solar neutrinos, (ii) the mixing matrix element U_{e3}, and (iii) the deviation from maximal mixing of atmospheric neutrinos. It is possible to quantify those three observations with a parameter $\lambda \sim 0.2$, which appears at least linearly in all elements of the mixing matrix. The limit $\lambda \to 0$ corresponds to exact bimaximal mixing. Present and future experiments can be used to pin down the power of λ required to usefully describe the observed phenomenology. Observing that the ratio of the two measured mass squared differences is roughly λ^2 allows us to further study the structure of the Majorana mass matrix. We comment on the implications of this parametrization for neutrinoless double beta decay and on the oscillation probabilities in long-baseline experiments. [Phys. Rev. D **69**, 033005 (2004)]

Sigma-term form factor of the nucleon in the large-N_c limit. P. Schweitzer, *Dipartimento di Fisica Nucleare e Teorica, Università degli Studi di Pavia, Pavia, Italy, and Institut für Theoretische Physik II, Ruhr-Universität Bochum, D-44780 Bochum, Germany.* (Received 9 August 2003; published 20 February 2004)

The scalar isoscalar form factor $\sigma(t)$ of the nucleon is calculated in the limit of a large number of colors in the framework of the chiral quark-soliton model. The calculation is free of adjustable parameters and based on an approximation justified by the small packing fraction of instantons in the QCD vacuum model, from which the chiral quark-soliton model was derived. The result for $\sigma(t)$ reproduces all features of the form factor observed in previous exact numerical calculations in the chiral quark-soliton model and in chiral perturbation theory, and agrees well with the available phenomenological information. The Feynman-Hellmann theorem is used to study the pion mass dependence of the nucleon mass and a good agreement with lattice QCD results is observed. The use of the present method to extrapolate lattice data to the chiral limit is discussed. [Phys. Rev. D **69**, 034003 (2004)]

One-pion-exchange final-state interaction and the $p\bar{p}$ near threshold enhancement in $J/\psi \to \gamma p\bar{p}$ decays. B. S. Zou and H. C. Chiang, *CCAST (World Lab.), P.O. Box 8730, Beijing 100080, China,, Institute of High Energy Physics, The Chinese Academy of Sciences, Beijing 100039, China, Institute of Theoretical Physics, The Chinese Academy of Sciences, Beijing 100080, China,, and Center of Theoretical Nuclear Physics, National Laboratory of Heavy Ion Accelerator, Lanzhou 730000, China.* (Received 25 September 2003; published 23 February 2004)

For the $N\bar{N}$ system, the one-pion-exchange (OPE) interaction gives the largest attractive force for $N\bar{N}$ with an isospin $I=0$ and spin $S=0$, while a near-threshold enhancement was observed for $p\bar{p}$ with $I=0$ and $S=0$ in $J/\psi \to \gamma p\bar{p}$ decays. With a K-matrix approach, we find that the OPE final-state interaction makes an important contribution to the near-threshold enhancement in the $p\bar{p}$ mass spectrum in $J/\psi \to \gamma p\bar{p}$ decays. [Phys. Rev. D **69**, 034004 (2004)]

Hybrid meson production by electromagnetic and weak interactions in a flux-tube model. F. E. Close and J. J. Dudek, *Department of Physics—Theoretical Physics, University of Oxford, 1 Keble Rd., Oxford OX1 3NP, United Kingdom.* (Received 28 October 2003; published 26 February 2004)

We calculate rates for hybrid meson production by electromagnetic and weak interactions in the flux-tube model. Applications include photoproduction and electroproduction at Jefferson Laboratory and DESY HERA, and the production of light strange and charmed hybrids in the weak decays of heavy flavors. Photoproduction of some light hybrids is predicted to be prominent in charge exchange reactions, $\gamma p \to n\mathcal{H}$ and accessible in $\gamma p \to p\mathcal{H}$. Production of light or charmed hybrids in B and D decays may be feasible with high statistics. Photoproduction of the axial hybrid meson is predicted to be large courtesy of π exchange, and its strange counterpart is predicted in $B \to \psi K_H(1^+)$ with $\mathrm{BR} \sim 10^{-4}$. Production rates for exotic hybrid candidates 1^{-+};$(0,2)^{+-}$ are given special attention. Selection rules that can help to distinguish between hybrid and conventional states with the same J^{PC} are noted. [Phys. Rev. D **69**, 034010 (2004)]

Geometric twist decomposition off the light cone for nonlocal QCD vector operators. Jörg Eilers and Bodo Geyer, *Center for Theoretical Studies and Institute of Theoretical Physics, Leipzig University, Augustusplatz 10, D-04109 Leipzig, Germany;* Markus Lazar, *Max-Planck-Institute for Mathematics in the Sciences, Inselstr. 22-26, D-04103 Leipzig, Germany.* (Received 7 October 2003; published 26 February 2004)

A general procedure is introduced allowing for the infinite decomposition of non-local vector operators off the light cone into operators of definite geometric twist. The method is applied to the operators $\bar{\psi}(x)\gamma_\mu\psi(-x)$ and $\bar{\psi}(x)\sigma_{\mu\nu}x^\nu\psi(-x)$ as well as to their matrix elements thereby determining all geometrical power (target mass) corrections being relevant for the related distribution amplitudes. [Phys. Rev. D **69**, 034015 (2004)]

Dynamics of phase transitions by hysteresis methods: Two-dimensional models. Bernd A. Berg,[1,2] Urs M. Heller,[3] Hildegard Meyer-Ortmanns,[4] and Alexander Velytsky[1,2] [1]*Department of Physics, Florida State University, Tallahassee, Florida 32306, USA,* [2]*School of Computational Science and Information Technology, Florida State University, Tallahassee, Florida 32306, USA,* [3]*American Physical Society, One Research Road, Box 9000, Ridge, New York 11961, USA,* [4]*School of Engineering and Science, International University Bremen, P.O. Box 750561, D-28725 Bremen, Germany.* (Received 22 September 2003; published 20 February 2004)

In studies of the QCD deconfining phase transition or crossover by means of heavy ion experiments, one ought to be concerned about nonequilibrium effects due to heating and cooling of the system. Motivated by this, we look at hysteresis methods to study the dynamics of phase transitions. Our systems are temperature driven through the phase transition using updating procedures in the Glauber universality class. Hysteresis calculations are presented for

a number of observables, including the (internal) energy, properties of Fortuin-Kasteleyn clusters and structure functions. We test the methods for 2D Potts models, which provide a rich collection of phase transitions with a number of rigorously known properties. Comparing with equilibrium configurations we find a scenario where the dynamics of the transition leads to a spinodal decomposition which dominates the statistical properties of the configurations. One may expect an enhancement of low energy gluon production due to spinodal decomposition of the Polyakov loops, if such a scenario is realized by nature. [Phys. Rev. D **69**, 034501 (2004)]

Nucleon mass, sigma term, and lattice QCD. Massimiliano Procura, *Physik-Department, Theoretische Physik, Technische Universität München, D-85747 Garching, Germany, and ECT, Villa Tambosi, I-38050 Villazzano, Trento, Italy;* Thomas R. Hemmert, *Physik-Department, Theoretische Physik, Technische Universität München, D-85747 Garching, Germany;* Wolfram Weise, *Physik-Department, Theoretische Physik, Technische Universität München, D-85747 Garching, Germany, and ECT, Villa Tambosi, I-38050 Villazzano, Trento, Italy.* (Received 30 September 2003; published 26 February 2004)

We investigate the quark mass dependence of the nucleon mass M_N. An interpolation of this observable, between a selected set of fully dynamical two-flavor lattice QCD data and its physical value, is studied using relativistic baryon chiral perturbation theory up to order p^4. In order to minimize uncertainties due to lattice discretization and finite volume effects our numerical analysis takes into account only simulations performed with lattice spacings $a<0.15$ fm and $m_\pi L>5$. We have also restricted ourselves to data with $m_\pi<600$ MeV and $m_{\mathrm{sea}}=m_{\mathrm{val}}$. A good interpolation function is found already at the one-loop level and chiral order p^3. We show that the next-to-leading one-loop corrections are small. From the p^4 numerical analysis we deduce the nucleon mass in the chiral limit $M_0\approx 0.88$ GeV and the pion-nucleon sigma term $\sigma_N=(49\pm 3)$ MeV at the physical value of the pion mass. [Phys. Rev. D **69**, 034505 (2004)]

Effect of color superconductivity on the mass and radius of a quark star. Stefan B. Rüster and Dirk H. Rischke, *Institut für Theoretische Physik, J. W. Goethe Universität, D-60054 Frankfurt am Main, Germany.* (Received 11 September 2003; published 20 February 2004)

We compare quark stars made of color-superconducting quark matter to normal-conducting quark stars. We focus on the most simple color-superconducting system, a two-flavor color superconductor, and employ the Nambu–Jona-Lasinio (NJL) model to compute the gap parameter and the equation of state. By varying the strength of the four-fermion coupling of the NJL model, we study the mass and the radius of the quark star as a function of the value of the gap parameter. If the coupling constant exceeds a critical value, the gap parameter does not vanish even at zero density. For coupling constants below this critical value, mass and radius of a color-superconducting quark star change at most by $\sim 20\%$ compared to a star consisting of normal-conducting quark matter. For coupling constants above the critical value, mass and radius may change by factors of two or more. [Phys. Rev. D **69**, 045011 (2004)]

Understanding the strong coupling limit of the $\mathcal{N}=4$ supersymmetric Yang-Mills theory at finite temperature. Edward Shuryak and Ismail Zahed, *Department of Physics and Astronomy, State University of New York, Stony Brook, New York 11794, USA.* (Received 13 August 2003; published 27 February 2004)

Recently, a number of intriguing results have been obtained for strongly coupled $\mathcal{N}=4$ supersymmetric Yang-Mills theory in vacuum and matter, using the AdS-CFT correspondence. In this work, we provide a physical picture supporting and explaining most of these results within the gauge theory. The modified Coulomb's law at strong coupling forces static charges to communicate via the high frequency modes of the gauge or scalar fields. Therefore, the interaction between even relativistically moving charges can be approximated by a potential. At strong coupling, WKB arguments yield a series of deeply bound states, whereby the large Coulomb attraction is balanced by centrifugation. The result is a constant density of light bound states at *any* value of the strong coupling, explaining why the thermodynamics and kinetics are coupling constant independent. In essence, at strong coupling the matter is not made of the original quasiparticles but of much lighter (binary) composites. A transition from weak to strong coupling is reminiscent of a transition from high to low temperature in QCD. We establish novel results for screening in vacuum and matter through a dominant set of diagrams some of which are in qualitative agreement with known strong coupling results. [Phys. Rev. D **69**, 046005 (2004)]

Addendum to "Coherent radio pulses from GEANT generated electromagnetic showers in ice". Soebur Razzaque,[1] Surujhdeo Seunarine,[2] Scott W. Chambers,[3] David Z. Besson,[3] Douglas W. McKay,[3] John P. Ralston,[3] and David Seckel[4] [1]*Department of Astronomy & Astrophysics, Penn State University, University Park, Pennsylvania 16802, USA,* [2]*Department of Physics and Astronomy, University of Canterbury, Private Bag 4800, Christchurch, New Zealand,* [3]*Department of Physics & Astronomy, University of Kansas, Lawrence, Kansas 66045, USA,* [4]*Bartol Research Institute, University of Delaware, Newark, Delaware 19716, USA.* (Received 17 June 2003; published 20 February 2004)

We reevaluate our published calculations of electromagnetic showers generated by GEANT 3.21 and the radio frequency pulses they produce in ice. We are prompted by a recent report showing that GEANT 3.21–modeled showers are sensitive to internal settings in the electron tracking subroutine. We report the shower and pulse characteristics obtained with different settings of GEANT 3.21 and with GEANT 4. The default setting of electron tracking in GEANT 3.21 we used in previous work speeds up the shower simulation at the cost of information near the end of the tracks. We find that settings tracking e^- and e^+ to lower energy yield a more accurate calculation, a more intense shower, and proportionately stronger radio pulses at low frequencies. The key features of the showers and pulses agree among GEANT 4 and Zas, Halzen, and Stanev and properly set GEANT 3.21 codes. At high frequencies the relation between the shower tracking algorithm and the pulse spectrum is more complex. We obtain radial distributions of shower particles and phase distributions of pulses from 100 GeV showers that are consistent with our published results. [Phys. Rev. D **69**, 047101 (2004)]