

Selected Abstracts from Other Physical Review Journals

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Exact calculation of ring diagrams and the off-shell effect on the equation of state. Jinfeng Liao, Xianglei Zhu, and Pengfei Zhuang, *Physics Department, Tsinghua University, Beijing 100084, China.* (Received 25 December 2002; revised manuscript received 18 February 2003; published 27 May 2003)

The partition function with ring diagrams at finite temperature is exactly calculated by using contour integrals in the complex energy plane. It contains a pole part with a temperature- and momentum-dependent mass and a phase shift part induced by the off-shell effect in a hot medium. The thermodynamic potentials for the ϕ^4 and ϕ^3 interactions are calculated and compared with the quasiparticle (pole) approximation. It is found that the off-shell effect on the equation of state is remarkable. [Phys. Rev. D **67**, 105023 (2003)]

Differential neutrino rates and emissivities from the plasma process in astrophysical systems. Saša Ratković, Sharada Iyer Dutta, and Madappa Prakash, *Department of Physics & Astronomy, State University of New York at Stony Brook, Stony Brook, New York 11794-3800, USA.* (Received 21 March 2003; published 17 June 2003)

The differential rates and emissivities of neutrino pairs from an equilibrium plasma are calculated for the wide range of density and temperature encountered in astrophysical systems. New analytical expressions are derived for the differential emissivities which yield total emissivities in full agreement with those previously calculated. The photon and plasmon pair production and absorption kernels in the source term of the Boltzmann equation for neutrino transport are provided. The appropriate Legendre coefficients of these kernels, in forms suitable for multi-group flux-limited diffusion schemes are also computed. [Phys. Rev. D **67**, 123002 (2003)]

Color superconducting quark matter core in the third family of compact stars. Sarmistha Banik and Debades Bandyopadhyay, *Saha Institute of Nuclear Physics, 1/AF Bidhannagar, Kolkata 700 064, India.* (Received 17 December 2002; published 20 June 2003)

We investigate first order phase transitions from β -equilibrated hadronic matter to color-flavor-locked quark matter in a compact star interior. The hadronic phase including hyperons and a Bose-Einstein condensate of K^- mesons is described by a relativistic field theoretical model with density dependent meson-baryon couplings. The early appearance of hyperons and/or a Bose-Einstein condensate of K^- mesons delays the onset of the phase transition to higher density. In the presence of hyperons and/or a K^- condensate, the overall equations of state become softer, resulting in smaller maximum masses than the cases without hyperons and a K^- condensate. We find that the maximum mass neutron stars may contain a mixed phase core of hyperons, K^- condensate, and color superconducting quark matter. Depending on the parameter space, we

also observe that there is a stable branch of superdense stars called the third family branch beyond the neutron star branch. Compact stars in the third family branch may contain a pure color superconducting core and have radii smaller than those of the neutron star branch. Our results are compared with the recent observations on RX J185635-3754 and the recently measured mass-radius relationship by the X-ray Multi Mirror–Newton observatory. [Phys. Rev. D **67**, 123003 (2003)]

Realistic Earth matter density for CP violation in a very long baseline neutrino oscillation. Lian-You Shan, *Institute of High Energy Physics, Chinese Academy of Sciences, P.O. Box 918, Beijing 100039, China, and CCAST (World Laboratory), P.O. Box 8730, Beijing 100080, China;* Yi-Fang Wang, Chang-Gen Yang, and Xinmin Zhang, *Institute of High Energy Physics, Chinese Academy of Sciences, P.O. Box 918, Beijing 100039, China;* Fu-Tian Liu, *Institute of Geology and Geophysics, Chinese Academy of Sciences, P.O. Box 9825 Beijing 100029, China;* Bing-Lin Young, *Department of Physics and Astronomy, Iowa State University, Ames, Iowa 50011, USA.* (Received 25 March 2003; published 7 July 2003)

We investigate three Earth density models for the measurement of the CP phase in very long baseline neutrino oscillation experiments to study the effect of the potential error due to Earth density uncertainties. Two of the density models which are commonly used are global models. The third provides a more realistic density profile which takes into account the local density variation along a specific 2100 km baseline. We find significant differences among these density models. The more realistic density model has a smaller intrinsic density fluctuation and hence allows better control of the error caused by the Earth density uncertainty. We also find that the conventional CP violation (CPV) variable, i.e., the CP odd difference, is in general small. Under the running conditions assumed in the present calculation, the differences of this CPV variable among the different density models and even the CPV variable itself can be dominated over by statistical and systematic errors. Therefore, other more suitable CPV variables have to be considered in the extraction of the CP phase. [Phys. Rev. D **68**, 013002 (2003)]

Do the KamLAND and solar neutrino data rule out solar density fluctuations? A. B. Balantekin and H. Yüksel, *Department of Physics, University of Wisconsin, Madison, Wisconsin 53706, USA.* (Received 19 March 2003; published 16 July 2003)

We elucidate the effects of solar density fluctuations on neutrino propagation through the Sun. Using data from the recent solar neutrino and KamLAND experiments we provide stringent limits on solar density fluctuations. It is shown that the neutrino data constrain solar density fluctuations to be less than $\beta=0.05$ at the 70% confidence level, where β is the fractional fluctuation around the

value given by the standard solar model. We find that the best fit to the combined solar neutrino and KamLAND data is given by $\beta = 0$. [Phys. Rev. D **68**, 013006 (2003)]

Parton distributions from deep-inelastic-scattering data. S. I. Alekhin, *Institute for High Energy Physics, 142281 Protvino, Russia*. (Received 19 November 2002; published 3 July 2003)

We perform the analysis of existing light-targets deep-inelastic-scattering data in the leading-order, next-to-leading-order, and next-to-next-to-leading-order (NNLO) QCD approximations and extract parton distribution functions (PDFs) simultaneously with the value of the strong coupling constant α_s and the high-twist contribution to the structure functions. The main theoretical uncertainties and experimental uncertainties due to all sources of experimental errors in the data are estimated; the latter generally dominate for the obtained PDFs. The uncertainty in the Higgs boson production cross section due to errors in PDFs is $\sim 2\%$ for the CERN LHC and varies from 2% to 10% for the Fermilab collider under variation of the Higgs boson mass from 100 GeV to 300 GeV. For the W -boson production cross section the uncertainty is $\sim 2\%$ for the both colliders. The value of $\alpha_s^{\text{NNLO}}(M_Z) = 0.1143 \pm 0.0014(\text{expt})$ is obtained, while the high-twist terms do not vanish up to the NNLO as required by comparison to data. [Phys. Rev. D **68**, 014002 (2003)]

Calculating quenching weights. Carlos A. Salgado and Urs Achim Wiedemann, *Theory Division, CERN, CH-1211 Geneva 23, Switzerland*. (Received 20 February 2003; published 10 July 2003)

We calculate the probability (“quenching weight”) that a hard parton radiates an *additional* energy fraction ΔE due to scattering in spatially extended QCD matter. This study is based on an exact treatment of a finite in-medium path length; it includes the case of a dynamically expanding medium, and it extends to the angular dependence of the medium-induced gluon radiation pattern. All calculations are done in the multiple soft scattering approximation [Baier-Dokshitzer-Mueller-Peigné-Schiff-Zakharov (BDMPSZ) formalism] and in the single hard scattering approximation [$N=1$ opacity approximation]. By comparison, we establish a simple relation between the transport coefficient, Debye screening mass and opacity, for which both approximations lead to comparable results. Together with this paper, a CPU-inexpensive numerical subroutine for calculating quenching weights is provided electronically. To illustrate its applications, we discuss the suppression of hadronic transverse momentum spectra in nucleus-nucleus collisions. Remarkably, the kinematic constraint resulting from finite in-medium path lengths reduces significantly the $p_\perp$ dependence of the nuclear modification factor, thus leading to consistency with the data measured at the BNL Relativistic Heavy Ion Collider. [Phys. Rev. D **68**, 014008 (2003)]

QCD phase diagram at nonzero temperature, baryon, and isospin chemical potentials in random matrix theory. B. Klein, *Department of Physics and Astronomy, State University of New York at Stony Brook, Stony Brook, New York 11794-3800, USA*; D. Toublan, *Department of Physics, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801-3080, USA*; J. J. M. Verbaarschot, *Department of Physics and Astronomy, State University of New York at Stony Brook, Stony Brook, New York 11794-3800, USA*.

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We introduce a random matrix model with the symmetries of QCD at finite temperature and chemical potentials for baryon number and isospin. We analyze the phase diagram of this model in the chemical potential plane for different temperatures and quark masses. We find a rich phase structure with five different phases separated by both first and second order lines. The phases are characterized by the pion condensate and the chiral condensate for *each* of the flavors. In agreement with lattice simulations, we find that in the phase with zero pion condensate the critical temperature depends in the same way on the baryon number chemical potential and on the isospin chemical potential. At nonzero quark mass, we find, remarkably, that the critical end point at nonzero temperature and baryon chemical potential is split in two by an arbitrarily small isospin chemical potential. As a consequence, there are *two* cross-overs that separate the hadronic phase from the quark-gluon plasma phase at high temperature. Detailed analytical results are obtained at zero temperature and in the chiral limit. [Phys. Rev. D **68**, 014009 (2003)]

Infinite temperature limit of meson spectral functions calculated on the lattice. F. Karsch, E. Laermann, and S. Stickan, *Fakultät für Physik, Universität Bielefeld, D-33615 Bielefeld, Germany*; P. Petreczky, *Nuclear Theory Group, Physics Department, Brookhaven National Laboratory, Upton, New York 11973, USA*. (Received 24 March 2003; published 10 July 2003)

We analyze the cutoff dependence of mesonic spectral functions calculated at finite temperature on Euclidean lattices with a finite temporal extent. In the infinite temperature limit we present analytic results for lattice spectral functions calculated with standard Wilson fermions as well as a truncated perfect action. We explicitly determine the influence of “Wilson doublers” on the high momentum structure of the mesonic spectral functions and show that this cutoff effect is strongly suppressed when using an improved fermion action. [Phys. Rev. D **68**, 014504 (2003)]

Weak charge of the proton and new physics. Jens Erler,^{1,2} Andriy Kurylov,³ and Michael J. Ramsey-Musolf^{2,3,4} ¹*Instituto de Física, Universidad Nacional Autónoma de México, 04510 México D.F., México*, ²*Institute for Nuclear Theory, University of Washington, Seattle, Washington 98195, USA*, ³*Kellogg Radiation Laboratory, California Institute of Technology, Pasadena, California 91125, USA*, ⁴*Department of Physics, University of Connecticut, Storrs, Connecticut 06269, USA*. (Received 27 February 2003; published 17 July 2003)

We address the physics implications of a precise determination of the weak charge of the proton, $Q_W(p)$, from a parity violating elastic electron proton scattering experiment to be performed at the Jefferson Laboratory. We present the standard model (SM) expression for $Q_W(p)$ including one-loop radiative corrections, and discuss in detail the theoretical uncertainties and missing higher order QCD corrections. Owing to a fortuitous cancellation, the value of $Q_W(p)$ is suppressed in the SM, making it a unique place to look for physics beyond the SM. Examples include extra neutral gauge bosons, supersymmetry, and leptiquarks. We argue that a $Q_W(p)$ measurement will provide an important complement to both high energy collider experiments and other low energy electroweak mea-

surements. The anticipated experimental precision requires the knowledge of the $O(\alpha_s)$ corrections to the pure electroweak box contributions. We compute these contributions for $Q_W(p)$, as well as for the weak charges of heavy elements as determined from atomic parity violation. [Phys. Rev. D **68**, 016006 (2003)]

Field dynamics and kink-antikink production in rapidly expanding systems. G. Holzwarth, *Institute of Theoretical Physics, University of Stellenbosch, 7602 Matieland, South Africa*. (Received 15 April 2003; revised manuscript received 21 May 2003; published 28 July 2003)

The field dynamics in a rapidly expanding system is investigated by transforming from space-time to the rapidity–proper-time frame.

The proper-time dependence of different contributions to the total energy is established. For systems characterized by a finite momentum cutoff, a freeze-out time can be defined after which the field propagation in rapidity space ends and the system decays into decoupled solitons, antisolitons, and local vacuum fluctuations. Numerical simulations of field evolutions on a lattice for the $(1+1)$ -dimensional Φ^4 model illustrate the general results and show that the freeze-out time and average multiplicities of kinks (plus antikinks) produced in this “phase transition” can be obtained from simple averages over the initial ensemble of field configurations. An extension to explicitly include additional dissipation is discussed. The validity of an adiabatic approximation for the case of an overdamped system is investigated. The $(3+1)$ -dimensional generalization may serve as model for baryon-antibaryon production after heavy-ion collisions. [Phys. Rev. D **68**, 016008 (2003)]