

Selected Abstracts from Other Physical Review Journals

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Neutrino oscillations, supersymmetric grand unification, and B decay. Seungwon Baek,¹ Toru Goto,¹ Yasuhiro Okada,^{1,2} and Ken-ichi Okumura,^{1,3} ¹Theory Group, KEK, Tsukuba, Ibaraki 305-0801, Japan ²Department of Particle and Nuclear Physics, The Graduate University of Advanced Studies, Tsukuba, Ibaraki 305-0801, Japan ³Department of Accelerator Science, The Graduate University of Advanced Studies, Tsukuba, Ibaraki 305-0801, Japan. (Received 14 February 2000; published 23 January 2001)

The effects of supersymmetric particles on flavor changing neutral current and lepton flavor violating processes are studied in supersymmetric SU(5) grand unified theory with right-handed neutrino supermultiplets. Using input parameters motivated by neutrino oscillation, it is shown that the time-dependent *CP* asymmetry of radiative *B* decay can be as large as 25% when the $\tau \rightarrow \mu \gamma$ branching ratio becomes close to the present experimental upper bound. We also show that the $B_s - \bar{B}_s$ mixing can be significantly different from the presently allowed range in the standard model. [Phys. Rev. D **63**, 051701 (2001)]

Enhanced photon production from quark-gluon plasma: Finite-lifetime effect. Shang-Yung Wang and Daniel Boyanovsky, *Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh, Pennsylvania 15260*. (Received 18 September 2000; published 31 January 2001)

Photon production from a thermalized quark-gluon plasma of finite lifetime is studied directly in real time with a nonequilibrium formulation that includes off-shell (energy nonconserving) effects. To lowest order we find that production of direct photons from a quark-gluon plasma of temperature $T \sim 200$ MeV and lifetime $t \sim 10\text{--}20$ fm/c is strongly enhanced by off-shell (anti)quark bremsstrahlung $q(\bar{q}) \rightarrow q(\bar{q})\gamma$. The yield from this nonequilibrium finite-lifetime effect dominates over those obtained from higher order equilibrium rate calculations in the range of energy $E > 2$ GeV and falls off with a power law for $E \gg T$. [Phys. Rev. D **63**, 051702 (2001)]

Measurement of charge symmetry breaking by the comparison of $\pi^+ d \rightarrow pp\eta$ with $\pi^- d \rightarrow nn\eta$. W. B. Tippens,¹ V. Abaev,² M. Batinić,³ V. Bekrenev,² W. J. Briscoe,⁴ R. E. Chrien,⁵ M. Clajus,¹ D. Isenhower,⁶ N. Kozlenko,² S. Kruglov,² M. J. Leitch,⁷ A. Marušić,³ T. Moriwaki,⁶ T. Morrison,⁴ B. M. K. Nefkens,¹ J. C. Peng,⁷ P. H. Pile,⁵ J. W. Price,¹ D. Rigsby,⁶ M. E. Sadler,⁶ R. Sawafte,⁵ I. Šlaus,³ H. Seyfarth,⁸ A. Starostin,^{1,2} I. Supek,³ R. J. Sutter,⁵ A. Švarc,³ and D. B. White,¹ ¹University of California, Los Angeles, Los Angeles, California 90095-1547 ²Petersburg Nuclear Physics Institute, Gatchina, Leningrad District, 188350, Russia ³Rudjer Bosković Institute, Zagreb 10000, Croatia ⁴George Washington University, Washington, D.C. 20052 ⁵Brookhaven National Laboratory, Upton, New York 11973 ⁶Abilene Christian University, Abilene, Texas 79699 ⁷Los Alamos National Laboratory, Los Alamos, New Mexico 87545 ⁸Forschungszentrum, Jülich D-52425, Jü-

lich, Germany. (Received 16 June 2000; published 6 February 2001)

We report a measurement of charge symmetry breaking in the *NN* η system. We have measured the ratio of the differential cross sections of the charge-symmetric reactions $\pi^+ d \rightarrow pp\eta$ and $\pi^- d \rightarrow nn\eta$ in the energy region of the η threshold. Our result is $R \equiv d\sigma(\pi^+ d \rightarrow pp\eta)/d\sigma(\pi^- d \rightarrow nn\eta) = 0.938 \pm 0.009$ after a phase-space correction is made for the difference in the threshold energies of the two reactions. The deviation of *R* from unity is an indication of charge symmetry breaking, which is mostly due to π^0 - η mixing. A theoretical model for η production which includes π^0 - η mixing was used to fit the data and yields a mixing angle of $(1.5 \pm 0.4)^\circ$. Our result is consistent with the mixing angle determined in particle decay and isospin-forbidden processes as well as predictions by several theoretical analyses which yield $\approx 1^\circ$ and another which yields $\approx 2^\circ$. [Phys. Rev. D **63**, 052001 (2001)]

Four-neutrino oscillation solutions of the atmospheric neutrino anomaly. G. L. Fogli, E. Lisi, and A. Marrone, *Dipartimento di Fisica and Sezione INFN di Bari, Via Amendola 173, I-70126 Bari, Italy*. (Received 2 October 2000; published 7 February 2001)

In the context of neutrino scenarios characterized by four (three active plus one sterile) neutrino species and by mass spectra with two separated doublets, we analyze solutions to the atmospheric neutrino anomaly which smoothly interpolate between $\nu_\mu \rightarrow \nu_\tau$ and $\nu_\mu \rightarrow \nu_s$ oscillations. We show that, although the Super-Kamiokande data disfavor the *pure* $\nu_\mu \rightarrow \nu_s$ channel, they do not exclude its occurrence, with sizable amplitude, *in addition* to the $\nu_\mu \rightarrow \nu_\tau$ channel. High energy muon data appear to be crucial in assessing the relative amplitude of active and sterile neutrino oscillations. It is also qualitatively shown that such atmospheric ν solutions are compatible with analogous solutions to the solar neutrino problem, which involve oscillations of ν_e in both sterile and active states. [Phys. Rev. D **63**, 053008 (2001)]

Correlations of solar neutrino observables for SNO. John N. Bahcall, *School of Natural Sciences, Institute for Advanced Study, Princeton, New Jersey 08540*; Plamen I. Krastev, *Department of Physics, University of Wisconsin, Madison, Wisconsin 53706*; Alexei Yu. Smirnov, *School of Natural Sciences, Institute for Advanced Study, Princeton, New Jersey 08540 and International Center for Theoretical Physics, 34100 Trieste, Italy*. (Received 20 August 2000; published 9 February 2001)

Neutrino oscillation scenarios predict correlations, and zones of avoidance, among measurable quantities such as spectral energy distortions, total fluxes, time dependences, and flavor content. The comparison of observed and predicted correlations will enhance the diagnostic power of solar neutrino experiments. A general test of all presently allowed (2ν) oscillation solutions is that future measurements must yield values outside the predicted zones of avoidance.

To illustrate the discriminatory power of the simultaneous analysis of multiple observables, we map currently allowed regions of $\Delta m^2 - \sin^2 2\theta$ onto planes of quantities measurable with the Sudbury Neutrino Observatory (SNO). We calculate the correlations that are predicted by vacuum and MSW (active and sterile) neutrino oscillation solutions that are globally consistent with all available neutrino data. We derive approximate analytic expressions for the dependence of individual observables and specific correlations upon neutrino oscillations parameters. We also discuss the prospects for identifying the correct oscillation solution using multiple SNO observables. [Phys. Rev. D **63**, 053012 (2001)]

Skyrmion-anti-Skyrmion annihilation with ω mesons. M. Á. Halász and R. D. Amado, *Department of Physics and Astronomy, University of Pennsylvania, Philadelphia, Pennsylvania 19104-6396*. (Received 21 September 2000; published 7 February 2001)

We study numerically the annihilation of an ω -stabilized Skyrmin and an anti-Skyrmion in three spatial dimensions. To our knowledge this is the first successful simulation of Skyrmin-anti-Skyrmion annihilation which follows through to the point where the energy is carried by outgoing meson waves. We encounter instabilities similar to those encountered in earlier calculations, but in our case these are not fatal and we are able to simulate through this process with a global energy loss of less than 8% and to identify robust features of the final radiation pattern. The system passes through a singular configuration at the time of half-annihilation. This is followed by the onset of fast oscillations which are superimposed on the smoother process which leads to the appearance of outgoing waves peaked at roughly 45° to the incident direction. We investigate the two prominent features of this process: the proliferation of small, fast oscillations and the singular intermediate configuration. We find that our equations of motion allow for a regime in which the amplitude of certain small perturbations increases exponentially. This regime is similar but not identical to the situation pointed out earlier regarding the original Skyrme model. We argue that the singularity may be seen as the result of a pinch effect similar to that encountered in plasmas. [Phys. Rev. D **63**, 054020 (2001)]

Existence of the σ meson below 1 GeV and chiral symmetry. Yuri S. Surovtsev, *Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research, Dubna 141 980, Russia*; Dalibor Krupa and Miroslav Nagy, *Institute of Physics, Slovak Academy of Sciences, Dúbravská cesta 9, 842 28 Bratislava, Slovakia*. (Received 18 September 2000; published 7 February 2001)

On the basis of a simultaneous description of the isoscalar s-wave channel of $\pi\pi$ scattering (from the threshold up to 1.9 GeV) and the $\pi\pi \rightarrow K\bar{K}$ process (from the threshold to ~ 1.4 GeV where the 2-channel unitarity is valid), a confirmation of the σ meson at ~ 665 MeV and an indication for the glueball nature of the $f_0(1500)$ state are obtained. These results are achieved in the model-independent approach consisting of the immediate application of such general principles as analyticity and unitarity to the analysis of experimental data. A parameterless description of the $\pi\pi$ background is first given by allowance for the left-hand branch point in the proper uniformizing variable. It is shown that the large $\pi\pi$ background, usually obtained, combines, in reality, the influence of the left-hand branch point and the contribution of a wide resonance at ~ 665 MeV. The coupling constants of the observed states with the $\pi\pi$ and $K\bar{K}$ systems and lengths of the $\pi\pi$ and $K\bar{K}$

scattering are obtained. The existence of the $f_0(665)$ state and the obtained $\pi\pi$ -scattering length ($a_0^0 = 0.27 \pm 0.06 [m_\pi^{-1}]$) seem to suggest the linear realization of chiral symmetry. [Phys. Rev. D **63**, 054024 (2001)]

Sigma-term physics in the perturbative chiral quark model. V. E. Lyubovitskij,^{1,2} Th. Gutsche,¹ Amand Faessler,¹ and E. G. Drukarev,³ ¹*Institut für Theoretische Physik, Universität Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen, Germany*, ²*Department of Physics, Tomsk State University, 634050 Tomsk, Russia*, ³*Petersburg Nuclear Physics Institute, Gatchina, 188350 St. Petersburg, Russia*. (Received 29 September 2000; published 7 February 2001)

We apply the perturbative chiral quark model at one loop to analyze meson-baryon sigma terms. Analytic expressions for these quantities are obtained in terms of fundamental parameters of low-energy pion-nucleon physics (weak pion decay constant, axial nucleon coupling, strong pion-nucleon form factor) and of only one model parameter (radius of the nucleonic three-quark core). Our result for the πN sigma term $\sigma_{\pi N} \approx 45$ MeV is in good agreement with the value deduced by Gasser, Leutwyler, and Sainio using dispersion-relation techniques and exploiting the chiral symmetry constraints. [Phys. Rev. D **63**, 054026 (2001)]

“Neutrinoless double beta decay” at a neutrino factory. W. Rodejohann, *Lehrstuhl für Theoretische Physik III, Universität Dortmund, Otto-Hahn Str. 4, 44221 Dortmund, Germany*; K. Zuber, *Lehrstuhl für Experimentelle Physik IV, Universität Dortmund, Otto-Hahn Str. 4, 44221 Dortmund, Germany*. (Received 21 July 2000; published 9 February 2001)

We examine the prospects of detecting an analogous process of neutrinoless double beta decay at a neutrino factory from a high energy muon storage ring. Limits from CERN LEP experiments, neutrinoless double beta decay as well as from global fits have to be incorporated and they severely restrict the results. We investigate what limits on light and heavy effective Majorana neutrino masses can be obtained and compare them with existing ones. Contributions from right-handed neutrinos and purely right-handed interactions are also discussed. We also comment on conspiracy in the mixing matrix, which might reduce the results within orders of magnitude. However, other “new physics” contributions to the same final state might produce large event numbers. [Phys. Rev. D **63**, 054031 (2001)]

Bethe-Salpeter equation for diquarks in color-flavor locked phase of cold dense QCD. V. A. Miransky, *Bogolyubov Institute for Theoretical Physics, 252143 Kiev, Ukraine and Research Center for Nuclear Physics, Osaka University, Osaka 567-0047, Japan*; I. A. Shovkovy, *Physics Department, University of Cincinnati, Cincinnati, Ohio 45221-0011 and School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455*; L. C. R. Wijewardhana, *Physics Department, University of Cincinnati, Cincinnati, Ohio 45221-0011 and Institute of Fundamental Studies, Kandy, Sri Lanka*. (Received 17 September 2000; published 5 February 2001)

The Bethe-Salpeter equations for diquarks with the quantum numbers of the Nambu-Goldstone bosons are analyzed in the color-

flavor locked phase of cold dense QCD with three quark flavors. The decay constants and the velocities of the Nambu-Goldstone bosons are calculated in the Pagels-Stokar approximation. It is also shown that, in contrast with the case of dense QCD with two flavors, there are no massive radial excitations with quantum numbers of the Nambu-Goldstone bosons in the color-flavor locked phase. The role of the Meissner effect in the pairing dynamics of diquarks is explained. [Phys. Rev. D **63**, 056005 (2001)]

Alternative method to obtain the quark polarization of the nucleon. G. Igo, *Department of Physics and Astronomy, UCLA, Los Angeles, California 90095*. (Received 6 October 2000; published 5 February 2001)

An alternate method is described to extract the quark contribution to the spin of the nucleon directly from the first moment of the deuteron structure function g_1^d . It is obtained without recourse to the use of input on the nucleon wave function from hyperon decays involving the flavor symmetry parameters F and D . The result for the quark polarization of the nucleon, $\Delta\Sigma_N$, is in good agreement with the values of the singlet axial vector current matrix element, a_0 , obtained from recent next-to-leading order analyses of current proton, neutron and deuteron data. [Phys. Rev. D **63**, 057501 (2001)]

Approximately self-consistent resummations for the thermodynamics of the quark-gluon plasma: Entropy and density. J.-P. Blaizot, *Service de Physique Théorique, CE Saclay, F-91191 Gif-sur-Yvette, France*; E. Iancu, *Theory Division, CERN, CH-1211 Geneva 23, Switzerland*; A. Rebhan, *Institut für Theoretische Physik, Technische Universität Wien, Wiedner Hauptstraße 8-10/136, A-1040 Vienna, Austria*. (Received 1 May 2000; published 2 February 2001)

We propose a gauge-invariant and manifestly UV finite resummation of the physics of hard thermal or dense loops (HTL-HDL) in the thermodynamics of the quark-gluon plasma. The starting point is a simple, effectively one-loop expression for the entropy or the quark density which is derived from the fully self-consistent two-loop skeleton approximation to the free energy, but subject to further approximations, whose quality is tested in a scalar toy model. In contrast with the direct HTL-HDL resummation of the one-loop free energy, in our approach both the leading-order (LO) and the next-to-leading order (NLO) effects of interactions are correctly reproduced and arise from kinematical regimes where the HTL-HDL are justifiable approximations. The LO effects are entirely due to the (asymptotic) thermal masses of the hard particles. The NLO ones receive contributions both from soft excitations, as described by the HTL-HDL propagators, and from corrections to the dispersion relation of the hard excitations, as given by HTL-HDL perturbation theory. The numerical evaluations of our final expressions

show very good agreement with lattice data for zero-density QCD, for temperatures above twice the transition temperature. [Phys. Rev. D **63**, 065003 (2001)]

Fourth-order self-energy of a neutron star due to massive neutrino exchange. Brian Woodahl and Ephraim Fischbach, *Physics Department, Purdue University, West Lafayette, Indiana 47907*. (Received 27 October 2000; published 12 February 2001)

We calculate the self-energy of a neutron star to fourth-order in the Fermi constant G_F , arising from neutrino exchange to one loop. We assume the neutron star is comprised entirely of neutrons and use the low-energy Lagrangian describing the interaction between neutrons and massive Dirac neutrinos. The calculation presented here derives from a more rigorous formalism than that used in previous work on the four-body self-energy, and consequently the results differ slightly. We have determined that the fourth-order self-energy, like the recently calculated second-order self-energy, is positive and dependent on the neutron-neutron hard core radius. Importantly, we also show that the fourth-order contribution is greater than the second order. We further demonstrate that, in contrast with the recently calculated vacuum energy shift in which the neutron field is taken to be external, the four-body self-energy decreases in magnitude as the neutrino mass is increased. This decrease of the self-energy as the neutrino mass increases was also the case in the second-order self-energy. The implications of these new findings are discussed. [Phys. Rev. D **63**, 065006 (2001)]

Bethe-Salpeter approach for the P_{33} elastic pion-nucleon scattering in heavy baryon chiral perturbation theory. J. Nieves and E. Ruiz Arriola, *Departamento de Física Moderna, Universidad de Granada, E-18071 Granada, Spain*. (Received 2 August 2000; published 22 February 2001)

Heavy baryon chiral perturbation theory (HBChPT) to leading order provides a kernel to solve the Bethe-Salpeter equation for the P_{33} [$\Delta(1232)$ -channel] π - N system, in the infinite nucleon mass limit. Crossed Born terms include, when iterated within the Bethe-Salpeter equation, both *all* one- and *some* two-pion intermediate states, hence preserving elastic unitarity below the two-pion production threshold. This suggests searching for a solution with the help of dispersion relations and suitable subtraction constants, when all in-elasticities are explicitly neglected. The solution allows for a successful description of the experimental phase shift from threshold up to $\sqrt{s}=1500$ MeV in terms of four subtraction constants. Next-to-leading order HBChPT calculations are also used to estimate the unknown subtraction constants which appear in the solution. Large discrepancies are encountered which can be traced to the slow convergence rate of HBChPT. [Phys. Rev. D **63**, 076001 (2001)]