Selected Abstracts from Other Physical Review Journals

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Polarization in hadronic Λ hyperon production and chiral-odd twist-3 distribution. Y. Kanazawa and Yuji Koike, *Department of Physics, Niigata University, Ikarashi, Niigata 950-2181, Japan.* (Received 3 April 2001; published 11 July 2001)

Polarization of the Λ hyperon produced with a large transverse momentum in unpolarized nucleon-nucleon collisions is analyzed in the framework of QCD factorization. We focus on the mechanism in which the soft-gluon component of the chiral-odd spin-independent twist-3 quark distribution $E_F(x,x)$ becomes a source of the polarized quark fragmenting into the polarized Λ. Our simple model estimate for this contribution indicates that it gives rise to a significant Λ polarization at large x_F. This is in parallel with the observation that the soft gluon pole mechanism gives rise to a large single transverse spin asymmetry in pion production at $x_F \to 1$. [Phys. Rev. D **64**, 034019 (2001)]

Nucleon-nucleon bremsstrahlung of axions and pseudoscalar particles from neutron-star matter. Naoki Iwamoto, *Department of Physics and Astronomy, The University of Toledo, Toledo, Ohio 43606-3390 and Department of Advanced Materials Science, Faculty of Engineering, Kagawa University, Takamatsu, Kagawa 761-0396, Japan.* (Received 16 February 2001; published 26 July 2001)

The energy-loss rates of degenerate neutron-star matter due to thermal bremsstrahlung of pseudoscalar particles and axions via neutron-proton collisions together with the mean-free path and the energy spectrum from neutron-neutron, neutron-proton, and neutron-neutron processes are calculated. Analytic expressions for these quantities are obtained in the general case where the pseudoscalar particle couples to the proton and neutron with different strengths and the protons and the neutrons have different Fermi momenta. These rates are compared with those of other authors. [Phys. Rev. D **64**, 043002 (2001)]

Strange quark stars within the Nambu–Jona-Lasinio model. M. Hanauske,[1] L. M. Satarov,[1,2] I. N. Mishustin,[1,2,3] H. Stöcker,[1] and W. Greiner,[1] [1]*Institut für Theoretische Physik, J. W. Goethe–Universität, D-60054 Frankfurt, Germany,* [2]*The Kurchatov Institute, 123182 Moscow, Russia,* [3]*The Niels Bohr Institute, DK-2100 Copenhagen O, Denmark.* (Received 16 January 2001; published 30 July 2001)

We investigate the properties of charge-neutral β-equilibrium cold quark matter within the Nambu–Jona-Lasinio model. The calculations are carried out for different ratios of coupling constants characterizing the vector and scalar 4-fermion interaction $\xi \equiv G_V/G_S$. It is shown that for $\xi < 0.4$ matter is self-bound and for $\xi < 0.65$ it has a first order phase transition of the liquid-gas type. The Gibbs conditions in the mixed phase are applied for the case of two chemical potentials associated with the baryon number and electric charge. The characteristics of the quark stars are calculated for $\xi = 0$, 0.5, and 1. It is found that the phase transition leads to a strong density variation at the surface of these stars. For $\xi = 1$ the properties of quark stars show behaviors typical for neutron stars. At $\xi \gtrsim 0.4$ the stars near to the maximum mass have a large admixture of strange quarks in their interiors. [Phys. Rev. D **64**, 043005 (2001)]

Standard model neutrinos as warm dark matter. Gian F. Giudice,[1] Edward W. Kolb,[2] Antonio Riotto,[3] Dmitry V. Semikoz,[4,5] and Igor I. Tkachev,[1,5] [1]*CERN Theory Division, CH-1211 Geneva 23, Switzerland,* [2]*NASA/Fermilab Astrophysics Center, Fermi National Accelerator Laboratory, Batavia, Illinois 60510-0500 and Department of Astronomy and Astrophysics, Enrico Fermi Institute, The University of Chicago, Chicago, Illinois 60637-1433,* [3]*Scuola Normale Superiore, Piazza dei Cavalieri 7, I-56126 Pisa, Italy,* [4]*Max Planck Insitut für Physik, Föhringer Ring 6, 80805 München, Germany,* [5]*Institute for Nuclear Research of the Academy of Sciences of Russia, Moscow 117312, Russia.* (Received 22 December 2000; published 27 July 2001)

Standard model neutrinos are not usually considered plausible dark matter candidates because the usual treatment of their decoupling in the early universe implies that their mass must be sufficiently small to make them ''hot'' dark matter. In this paper we show that decoupling of standard model neutrinos in low reheat models may result in neutrino densities very much less than usually assumed, and thus their mass may be in the keV range. Standard model neutrinos may therefore be warm dark matter candidates. [Phys. Rev. D **64**, 043512 (2001)]

Two-loop self-energy and multiple scattering at finite temperature. J. I. Kapusta, *School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455;* S. M. H. Wong, *Department of Physics, Ohio State University, Columbus, Ohio 43210.* (Received 5 March 2001; published 20 July 2001)

One- and two-loop self-energies are worked out explicitly for a heavy scalar field interacting weakly with a light self-interacting scalar field at finite temperature. The ring or daisy diagrams and a

set of necklace diagrams can be summed simultaneously. This simple model serves to illustrate the connection between multiloop self-energy diagrams and multiple scattering in a medium. [Phys. Rev. D **64**, 045008 (2001)]

Spontaneous parity violation in QCD at finite temperature: On the inapplicability of the Vafa-Witten theorem. Thomas D. Cohen, *Department of Physics, University of Maryland, College Park, Maryland 20742-4111.* (Received 30 January 2001; published 30 July 2001)

The generalization of the Vafa-Witten theorem, ruling out parity violation to QCD at finite temperature is considered. It is shown that this generalization of the theorem rules out Lorentz-invariant parity violating operators from spontaneously acquiring vacuum expectation values. However, it does not rule out Lorentz-noninvariant parity-violating operators from acquiring expectation values. Other situations, where the theorem is inapplicable, are also discussed. [Phys. Rev. D **64**, 047704 (2001)]

Relativistic corrections to the electromagnetic polarizabilities of compound systems. R. N. Lee and A. I. Milstein, *Budker Institute of Nuclear Physics, 630090 Novosibirsk, Russia;* M. Schumacher, *Zweites Physikalisches Institut, Universität Göttingen, D-37073 Göttingen, Germany.* (Received 4 February 2001; published 20 August 2001)

The low-energy amplitude of Compton scattering on the bound state of two charged particles of arbitrary masses, charges, and spins is obtained. A case in which the bound state exists due to electromagnetic interaction is considered. The term, proportional to ω^2, is obtained taking into account the first relativistic correction. It is shown that the complete result for this correction differs essentially from the commonly used term $\Delta\alpha$, proportional to the rms charge radius of the system. We propose that the same situation can take place in the more complicated case of hadrons. [Phys. Rev. A **64**, 032507 (2001)]

Improved measurement of the $\bar{d}/\bar{u}$ asymmetry in the nucleon sea. R. S. Towell,[1,6] P. L. McGaughey,[6] T. C. Awes,[9] M. E. Beddo,[8] M. L. Brooks,[6] C. N. Brown,[3] J. D. Bush,[1] T. A. Carey,[6] T. H. Chang,[8] W. E. Cooper,[3] C. A. Gagliardi,[10] G. T. Garvey,[6] D. F. Geesaman,[2] E. A. Hawker,[10,6] X. C. He,[4] L. D. Isenhower,[1] D. M. Kaplan,[5] S. B. Kaufman,[2] P. N. Kirk,[7] D. D. Koetke,[11] G. Kyle,[8] D. M. Lee,[6] W. M. Lee,[4] M. J. Leitch,[6] N. Makins,[2] J. M. Moss,[6] B. A. Mueller,[2] P. M. Nord,[11] V. Papavassiliou,[8] B. K. Park,[6] J. C. Peng,[6] G. Petitt,[4] P. E. Reimer,[6,2] M. E. Sadler,[1] W. E. Sondheim,[6] P. W. Stankus,[9] T. N. Thompson,[6] R. E. Tribble,[10] M. A. Vasiliev,[10] Y. C. Wang,[7] Z. F. Wang,[7] J. C. Webb,[8] J. L. Willis,[1] D. K. Wise,[1] and G. R. Young[9] (FNAL E866/NuSea Collaboration), [1]*Abilene Christian University, Abilene, Texas 79699,* [2]*Argonne National Laboratory, Argonne, Illinois 60439,* [3]*Fermi National Accelerator Laboratory, Batavia, Illinois 60510,* [4]*Georgia State University, Atlanta, Georgia 30303,* [5]*Illinois Institute of Technology, Chicago, Illinois 60616,* [6]*Los Alamos National Laboratory, Los Alamos, New Mexico 87545,* [7]*Louisiana State University, Baton Rouge, Louisiana 70803,* [8]*New Mexico State University, Las Cruces, New Mexico 88003,* [9]*Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831,* [10]*Texas A & M University, College Station, Texas 77843,* [11]*Valparaiso University, Valparaiso, Indiana 46383.* (Received 14 March 2001; published 10 August 2001)

Measurements of the ratio of Drell-Yan yields from an 800 GeV/c proton beam incident on liquid hydrogen and deuterium targets are reported. Approximately 360 000 Drell-Yan muon pairs remained after all cuts on the data. From these data, the ratio of down antiquark ($\bar{d}$) to up ($\bar{u}$) antiquark distributions in the proton sea is determined over a wide range in Bjorken-x. These results confirm previous measurements by E866 and extend them to lower x. From these data, $(\bar{d}-\bar{u})$ and $\int(\bar{d}-\bar{u})dx$ are evaluated for $0.015<x<0.35$. These results are compared with parametrizations of various parton distribution functions, models and experimental results from NA51, NMC and HERMES. [Phys. Rev. D **64**, 052002 (2001)]

Discrete flavor symmetries and mass matrix textures. M. S. Berger and Kim Siyeon, *Physics Department, Indiana University, Bloomington, Indiana 47405.* (Received 31 May 2000; revised manuscript received 22 March 2001; published 1 August 2001)

We show how introducing discrete Abelian flavor symmetries can produce texture zeros in the fermion mass matrices, while preserving the correct relationships with the low-energy data on quark and lepton masses. We outline a procedure for defining texture zeros as suppressed entries in Yukawa matrices. These texture zeros can account for the coexistence of the observed large mixing in atmospheric neutrino oscillations with a hierarchy in the neutrino masses, and offer the possibility of alignment of the quark and squark mass matrices, thus giving a solution to the supersymmetric flavor problem. A requirement that the flavor symmetry commutes with the $SU(5)$ grand unified group can be used to explain the lepton mass hierarchies as well as the neutrino parameters, including the large mixing observed in the atmospheric neutrino data. We present one such model that yields a large atmospheric neutrino mixing angle, as well as a solar neutrino mixing angle of order $\lambda \simeq 0.22$. [Phys. Rev. D **64**, 053006 (2001)]

Measuring atmospheric neutrino oscillations with neutrino telescopes. Ivone F. M. Albuquerque, *Department of Astronomy & Space Sciences Laboratory, University of California, Berkeley, California 94720;* George F. Smoot, *Department of Physics, Lawrence Berkeley National Laboratory & Space Sciences Laboratory, University of California, Berkeley, California 94720.* (Received 29 March 2001; published 8 August 2001)

Neutrino telescopes with large detection volumes can demonstrate whether the current indications of neutrino oscillation are correct or if a better description can be achieved with nonstandard

alternatives. Observations of contained muons produced by atmospheric neutrinos can better constrain the allowed region for oscillations or determine the relevant parameters of nonstandard models. We analyze the possibility of neutrino telescopes measuring atmospheric neutrino oscillations. We suggest adjustments to improve this potential. An addition of four densely instrumented strings to the AMANDA II detector makes oscillation observations feasible. Such a configuration is competitive with current and proposed experiments. [Phys. Rev. D **64**, 053008 (2001)]

Majorana neutrinos, neutrino mass spectrum, *CP* violation, and neutrinoless double β decay: The three-neutrino mixing case. S. M. Bilenky, *Joint Institute for Nuclear Research, Dubna, Russia and Scuola Internazionale Superiore di Studi Avanzati, I-34014 Trieste, Italy;* S. Pascoli and S. T. Petcov, *Scuola Internazionale Superiore di Studi Avanzati, I-34014 Trieste, Italy and Istituto Nazionale di Fisica Nucleare, Sezione di Trieste, I-34014 Trieste, Italy.* (Received 20 February 2001; published 10 August 2001)

Assuming three-neutrino mixing and massive Majorana neutrinos, we study the implications of the neutrino oscillation solutions of the solar and atmospheric neutrino problems and of the results of the CHOOZ experiment for the predictions of the effective Majorana mass in neutrinoless double-beta $[(\beta\beta)_{0\nu}]$ decay, $|\langle m\rangle|$. The general case of CP nonconservation is investigated. The predicted values of $|\langle m\rangle|$, which determine the magnitude of the $(\beta\beta)_{0\nu}$-decay rate, depend strongly on the type of neutrino mass spectrum and on the solution of the solar neutrino problem, as well as on the values of the two Majorana CP-violating phases, present in the lepton mixing matrix. We find that (i) $|\langle m\rangle| \lesssim 0.02$ eV for a hierarchical neutrino mass spectrum, (ii) $|\langle m\rangle| \lesssim 0.09$ eV if the spectrum is of the inverted hierarchy type, and (iii) $|\langle m\rangle| \leqslant m$ in the case of three quasidegenerate neutrinos, $m > 0$ being the common neutrino mass scale which is limited by the bounds from the ^{3}H β-decay experiments, $m < 2.5$ eV. The indicated maximal values of $|\langle m\rangle|$ are reached in cases (i), (ii), and (iii), respectively, for the large mixing angle (LMA) MSW solution, the small mixing angle (SMA) MSW solution, and for all current solutions of the solar neutrino problem. If CP invariance holds, $|\langle m\rangle|$ is very sensitive to the values of the relative CP parities of the massive Majorana neutrinos. The cases of neutrino mass spectra which interpolate between the hierarchical or inverted hierarchy type and the quasidegenerate one are also studied. The observation of the $(\beta\beta)_{0\nu}$ decay with a rate corresponding to $|\langle m\rangle| \gtrsim 0.02$ eV can provide unique information on the neutrino mass spectrum. Combined with information on the lightest neutrino mass or the type of neutrino mass spectrum, it can give also information on the CP violation in the lepton sector and, if CP invariance holds, on the relative CP parities of the massive Majorana neutrinos. [Phys. Rev. D **64**, 053010 (2001)]

Comparison of 3-dimensional and 1-dimensional schemes in the calculation of atmospheric neutrinos. M. Honda and T. Kajita, *Institute for Cosmic Ray Research, University of Tokyo, Kashiwa 277-8582, Japan;* K. Kasahara, *Department of Electronic Information Systems, Shibaura Institute of Technology, Fukasaku, Ohmiya 330-8570, Japan;* S. Midorikawa, *Faculty of Engineering, Aomori University, Aomori 030-0943, Japan.* (Received 30 March 2001; published 10 August 2001)

A 3-dimensional calculation of atmospheric neutrino flux is presented, and the results are compared with those of a 1-dimensional calculation. In this study, the interaction and propagation of particles is treated in a 3-dimensional way including the curvature of charged particles due to the geomagnetic field, which is assumed to be a dipole field. The purpose of this paper is limited to the comparison of calculation schemes. The updated flux value with a new interaction model and primary flux model will be reported in a separate paper. Except for nearly horizontal directions, the flux is very similar to the result of 1-dimensional calculations. However, for near-horizontal directions an enhancement of the neutrino flux is seen even at energies as high as 1 GeV. The production height of neutrinos is lower than the prediction of the 1-dimensional calculation for near-horizontal directions, and is a little higher for near-vertical directions. However, the difference is not evident except for near-horizontal directions. [Phys. Rev. D **64**, 053011 (2001)]

Lepton flavor violating *Z* decays in the Zee model. Ambar Ghosal and Yoshio Koide, *Department of Physics, University of Shizuoka, 52-1 Yada, Shizuoka 422-8526, Japan;* Hideo Fusaoka, *Department of Physics, Aichi Medical University, Nagakute, Aichi 480-1195, Japan.* (Received 12 April 2001; published 10 August 2001)

We calculate lepton flavor violating (LFV) Z decays $Z \to e_i^{\pm} e_j^{\mp}$ $(i,j = e,\mu,\tau; i \neq j)$ in the Zee model keeping in mind the radiative leptonic decays $e_i \to e_j \gamma$ $(i = \mu,\tau; j = e,\mu; i \neq j)$, μ decay, and the anomalous muon magnetic moment (μAMM). We investigate three different cases of Zee f_{ij} coupling: (A) $f_{e\mu}^2 = f_{\mu\tau}^2 = f_{\tau e}^2$, (B) $f_{e\mu}^2 \gg f_{\tau e}^2 \gg f_{\mu\tau}^2$, and (C) $f_{\mu\tau}^2 \gg f_{e\mu}^2 \gg f_{\tau e}^2$, subject to the neutrino phenomenology. Interestingly, we find that, although case (C) satisfies the large excess value of the μAMM, it is unable to explain the solar neutrino experimental result, whereas case (B) satisfies the bimaximal neutrino mixing scenario, but in contrast with the results of μAMM experiments. We also find that, of all three cases, case (C) gives rise to the largest contribution to the ratio $B(Z \to e^{\pm}\tau^{\mp})/B(Z \to \mu^{\pm}\mu^{\mp}) \simeq 10^{-8}$, which is still two orders less than the value accessible to be probed by future linear colliders, whereas, for the other two cases, this ratio is too low to be observed even in the near future for all possible LFV Z decay modes. [Phys. Rev. D **64**, 053012 (2001)]

Quark-hadron duality in structure functions. Nathan Isgur,[1] Sabine Jeschonnek,[1] W. Melnitchouk,[1,2] and J. W. Van Orden,[1,3] [1]*Jefferson Lab, 12000 Jefferson Avenue, Newport News, Virginia 23606,* [2]*Special Research Centre for the Subatomic Structure of Matter, Adelaide University, Adelaide 5005, Australia,* [3]*Department of Physics, Old Dominion University, Norfolk, Virginia 23529.* (Received 3 April 2001; published 6 August 2001)

While quark-hadron duality is well established experimentally, the current theoretical understanding of this important phenomenon is quite limited. To expose the essential features of the dynamics behind duality, we use a simple model in which the hadronic spec-

trum consists of narrow resonances made of valence quarks. We qualitatively reproduce the features of duality as seen in electron scattering data within our model. We show that in order to observe duality, it is essential to use the appropriate scaling variable and scaling function. In addition to its great intrinsic interest in connecting the quark-gluon and hadronic pictures, an understanding of quark-hadron duality could lead to important benefits in extending the applicability of scaling into previously inaccessible regions. [Phys. Rev. D **64**, 054005 (2001)]

Nonsinglet structure function of the ^{3}He-^{3}H system and divergence of the Gottfried integral. V. Guzey, A. W. Thomas, and K. Tsushima, *Department of Physics and Mathematical Physics and Special Research Centre for the Subatomic Structure of Matter (CSSM), Adelaide University, Adelaide 5005, Australia;* K. Saito, *Tohoku College of Pharmacy, Sendai 981-8558, Japan;* M. Strikman, *The Pennsylvania State University, University Park, Pennsylvania 16802.* (Received 1 March 2001; published 10 August 2001)

We study shadowing and antishadowing corrections to the flavor nonsinglet structure function $F_2^{^3\mathrm{He}}-F_2^{^3\mathrm{H}}$ and show that the difference between the one-particle density distributions of ^{3}He and ^{3}H plays an important role at very small x. We find that the flavor nonsinglet structure function in these mirror nuclei is enhanced at small x by nuclear shadowing, which increases the nuclear Gottfried integral, integrated from 10^{-4} to 3, by 15–41 %. When integrated from zero, the Gottfried integral is divergent for these mirror nuclei. It seems likely that, as a consequence of charge symmetry breaking, this may also apply to the proton-neutron system. [Phys. Rev. D **64**, 054503 (2001)]

Broken *R* parity, top squark decays, and neutrino physics. D. Restrepo, W. Porod, and J. W. F. Valle, *Inst. de Física Corpuscular (IFIC), CSIC – Universita de València, Edificio Institutos de Paterna, Apartado de Correos 22085, E-46071, València, Spain.* (Received 5 April 2001; published 13 August 2001)

We discuss the phenomenology of the lightest top squark in models where *R* parity is broken by bilinear superpotential terms. In this class of models we consider scenarios where the *R*-parity breaking two-body decay $\tilde{t}_1\to\tau^+ b$ competes with the leading three-body decays such as $\tilde{t}_1\to W^+ b\,\tilde{\chi}_1^0$. We demonstrate that the *R*-parity violating decay can be sizable and in some parts of the parameter space even the dominant one. Moreover we discuss the expectations for $\tilde{t}_1\to\mu^+ b$ and $\tilde{t}_1\to e^+ b$. The recent results from solar and atmospheric neutrinos suggest that these are as important as the $\tau^+ b$ mode. The $\tilde{t}_1\to l^+ b$ decays are of particular interest for hadron colliders, as they may allow a full mass reconstruction of the lighter top squark. Moreover these decay modes allow cross checks on the neutrino mixing angle involved in the solar neutrino puzzle complementary to those possible using neutralino decays. For the so-called small mixing angle solution $\tilde{t}_1\to e^+ b$ should be negligible, while for the large mixing angle type solutions all $\tilde{t}_1\to l^+ b$ decays should have comparable magnitude. [Phys. Rev. D **64**, 055011 (2001)]

Remark on neutrino masses and oscillations in an $SU(3)_L\times U(1)_N$ model with the radiative mechanism. Teruyuki Kitabayashi, *Accelerator Engineering Center, Mitsubishi Electric System & Service Engineering Co. Ltd., 2-8-8 Umezono, Tsukuba, Ibaraki 305-0045, Japan.* (Received 17 March 2001; published 31 July 2001)

We have discussed how neutrino masses and oscillations are radiatively generated in an $SU(3)_L\times U(1)_N$ gauge model with a symmetry based on L_e-L_μ-L_τ ($\equiv L'$). The model is characterized by lepton triplets $\psi^i=(\nu^i,l^{-i},E^{-i})$, where E^{-i} are negatively charged heavy leptons, an $SU(3)_L$ triplet Higgs scalar ξ, and a singlet Higgs scalar k^{++}. These Higgs scalars can be interpreted as a Zee and Zee-Babu scalar for radiative mechanisms. We have demonstrated that the mass hierarchy of $\Delta m^2_{\mathrm{atm}}\gg\Delta m^2_{\odot}$ arises as a consequence of the dynamical hierarchy between L'-conserving one-loop effects and L'-violating two-loop effects, where L' is broken softly in the Higgs potential, and that our model is relevant to yield a quasi-vacuum solution for the solar neutrino problem. [Phys. Rev. D **64**, 057301 (2001)]