Selected Abstracts from Physical Review D

Abstracts of papers published in **Physical Review D** *which may be of interest to our readers are printed here.*

Probing small-x parton densities in proton-proton(-nucleus) collisions in the very forward direction. Lyndon Alvero, John C. Collins, Mark Strikman, and J. J. Whitmore, *Physics Department, 104 Davey Lab, Pennsylvania State University, University Park, Pennsylvania 16802-6300.* (Received 5 November 1997; published 6 March 1998)

We present calculations of several pp scattering cross sections with potential applications at the CERN LHC. Significantly large rates for the momentum fraction x, as low as 10^{-7}, are obtained, allowing for possible extraction of quark and gluon densities in the proton and nuclei down to these small x values provided a detector with good acceptance at maximal rapidities is used. [S0556-2821(98)01409-X] [Phys. Rev. D **57**, 4063 (1998)]

New baryons in the $\Delta\eta$ and $\Delta\omega$ channels. Simon Capstick, *Supercomputer Computations Research Institute and Department of Physics, Florida State University, Tallahassee, Florida 32306;* W. Roberts, *Department of Physics, Old Dominion University, Norfolk, Virginia 23529 and Thomas Jefferson National Accelerator Facility, 12000 Jefferson Avenue, Newport News, Virginia 23606.* (Received 28 August 1997; revised manuscript received 9 January 1998; published 3 March 1998)

The decays of excited nonstrange baryons into the final states $\Delta\eta$ and $\Delta\omega$ are examined in a relativized quark pair creation model. The wave functions and parameters of the model are fixed by previous calculations of $N\pi$ and $N\pi\pi$, etc., decays through various quasi-two-body channels including $N\eta$ and $N\omega$. Our results show that the combination of thresholds just below the region of interest and the isospin selectivity of these channels should allow the confirmation of several weakly established Δ baryons and the discovery of new Δ baryons in pion and photoproduction of these final states. [S0556-2821(98)01609-9] [Phys. Rev. D **57**, 4301 (1998)]

Next-to-leading order QCD corrections to inclusive-hadron photoproduction in polarized lepton-proton collisions. D. de Florian and W. Vogelsang, *Theory Division, CERN, CH-1211 Geneva 23, Switzerland.* (Received 8 December 1997; published 5 March 1998)

We calculate the next-to-leading order QCD corrections to the ''direct'' part of the spin-dependent cross section for single-inclusive charged-hadron photoproduction. This process could be studied experimentally in future polarized fixed-target lepton-nucleon experiments, but also at the DESY ep collider HERA after an upgrade to both beams being polarized. We present a brief numerical evaluation of our results by studying the K-factors and the scale dependence of the next-to-leading order cross section. [S0556-2821(98)02209-7] [Phys. Rev. D **57**, 4376 (1998)]

Interplay of gravitation and linear superposition of different mass eigenstates. D. V. Ahluwalia, *Physics (P-25) Division, Mail Stop H-846, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 and Global Power Division, ANSER, S-800, 1215 Jefferson Davis Highway, Arlington, Virginia 22202;* C. Burgard, *CERN, PPE, CH-1211 Geneva 23, Switzerland.* (Received 5 March 1996; revised manuscript received 31 October 1997; published 3 March 1998)

The interplay of gravitation and the quantum-mechanical principle of linear superposition induces a new set of neutrino oscillation phases. These ensure that the flavor-oscillation clocks, inherent in the phenomenon of neutrino oscillations, redshift precisely as required by Einstein's theory of gravitation. The physical observability of these phases in the context of the solar neutrino anomaly, type-II supernova, and certain atomic systems is briefly discussed. [S0556-2821(98)00808-X] [Phys. Rev. D **57**, 4724 (1998)]

Recent results of the neutrino mass squared measurements and the coherent neutrino–cold-dark-matter interaction. R. Horvat, *Ruđer Bošković Institute, P.O. Box 10001 Zagreb, Croatia.* (Received 27 January 1997; revised manuscript received 18 November 1997; published 6 March 1998)

It is argued that external coherent potentials for neutrinos in the electronvolts range would give a detectable modification of the electron spectrum in tritium beta decay. We show that such very large potentials may be obtained from a novel long-range interaction between neutrinos and galactic baryonic and/or nonbaryonic matter if the new force is mediated by massless vector particles. [S0556-2821(98)00508-6] [Phys. Rev. D **57**, 5236 (1998)]

Supersymmetric resolution of solar and atmospheric neutrino puzzles. M. Drees,[1] S. Pakvasa,[2] X. Tata,[2] and T. ter Veldhuis[2] [1]*APCTP, 207-43 Cheongryangri-dong, Seoul 130-012, Korea* [2]*Department of Physics and Astronomy, University of Hawaii, Honolulu, Hawaii 96822* (Received 16 December 1997; published 10 April 1998)

Renormalizable lepton number violating interactions that break R parity can induce a Majorana mass for neutrinos. Based on this, we show that it is possible to obtain a phenomenologically viable neutrino mass matrix that can accommodate atmospheric neutrino data via ν_μ-ν_τ mixing and the solar neutrino data via either the large or small angle MSW effect. We argue that such a mass matrix could result from an approximate discrete symmetry of the superpotential that forbids renormalizable baryon number violating couplings. [S0556-2821(98)50309-8] [Phys. Rev. D **57**, 5335 (1998)]

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Extraction of light quark masses from sum rule analyses of axial vector and vector current Ward identities. Tanmoy Bhattacharya and Rajan Gupta, *Group T-8, Mail Stop B-285, Los Alamos National Laboratory, Los Alamos, New Mexico 87545;* Kim Maltman, *Department of Mathematics and Statistics, York University, 4700 Keele Street, North York, Ontario, Canada M3J 1P3 and Special Research Centre for the Subatomic Structure of Matter, University of Adelaide, Adelaide, Australia 5005.* (Received 23 April 1998; published 18 March 1998)

In light of recent lattice results for the light quark masses m_s and m_u+m_d, we reexamine the use of sum rules in the extraction of these quantities, and discuss a number of potential problems with existing analyses. The most important issue is that of the overall normalization of the hadronic spectral functions relevant to the sum rule analyses. We explain why previous treatments, which fix this normalization by assuming complete resonance dominance of the continuum threshold region, can potentially overestimate the resonance contributions to spectral integrals by factors as large as ~ 5. We propose an alternate method of normalization based on an understanding of the role of resonances in chiral perturbation theory which avoids this problem. The second important uncertainty we consider relates to the physical content of the assumed location s_0 of the onset of duality with perturbative QCD. We find that the extracted quark masses depend very sensitively on this parameter. We show that the assumption of duality imposes very severe constraints on the shape of the relevant spectral function in the dual region and present rigorous lower bounds for m_u+m_d as a function of s_0 based on a combination of these constraints and the requirement of positivity of $\rho_5(s)$. In the extractions of m_s, we find that the conventional choice of the value of s_0 is not physical. For a more reasonable choice of s_0, we are not able to find a solution that is stable with respect to variations of the Borel transform parameter. This problem can, unfortunately, be overcome only if the hadronic spectral function is determined up to significantly larger values of s than is currently possible. Finally, we also estimate the error associated with the convergence of perturbative QCD expressions used in the sum rule analyses. Our conclusion is that, taking all of these issues into account, the resulting sum rule estimates for both m_u+m_d and m_s could easily have uncertainties as large as a factor of 2, which would make them compatible with the low estimates obtained from lattice QCD. [S0556-2821(98)00209-4] [Phys. Rev. D **57**, 5455 (1998)]

Instantons and polarized structure functions. N. I. Kochelev, *Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research, RU-141980 Dubna, Moscow region, Russia.* (Received 3 December 1997; published 8 April 1998)

The contribution of the quark-quark and quark-gluon interactions induced by instantons to the valence quark and proton spin-dependent structure functions $g_1(x,Q^2)$ is estimated within the instanton liquid model for a QCD vacuum. It is shown that this interaction leads to a rather large violation of the Ellis-Jaffe sum rule. [S0556-2821(98)04409-9] [Phys. Rev. D **57**, 5539 (1998)]

Temperature dependence of η and η' masses. Jamal Jalilian-Marian, *Nuclear Science Division, Lawrence Berkeley National Laboratory, Berkeley, California 94720;* Bayram Tekin, *School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455.* (Received 5 December 1997; published 3 April 1998)

We investigate the temperature dependence of η and η' masses due to scatterings from thermal pions in a heat bath using the nonlinear sigma model. We show that mass shifts of η and η' and the shift in the mixing angle are negligible. [S0556-2821(98)06609-0] [Phys. Rev. D **57**, 5593 (1998)]

Majoron emitting neutrinoless double beta decay in the electroweak chiral gauge extensions. F. Pisano, *Departamento de Física, Universidade Federal do Paraná, 81531-990, Curitiba, PR, Brazil;* S. Shelly, Sharma *Departamento de Física, Universidade Estadual de Londrina, 86051-970, Londrina, PR, Brazil.* (Received 29 July 1997; published 3 April 1998)

Fundamental mechanisms for Majoron emitting neutrinoless double beta decay in $SU(3)_C \otimes G_W \otimes U(1)$ models, for electroweak flavor chiral extensions, $G_W = SU(3)_L$ and $SU(4)_L$ are pointed out. Both kinds of known Majoron emitting processes, charged Majoron emitting where the massless Nambu-Goldstone boson itself carries lepton charge, $L=-2$, and the ordinary Majoron emitting where the boson has a small mass, are found possible. [S0556-2821(98)03809-0] [Phys. Rev. D **57**, 5670 (1998)]

Compton scattering and the spin structure of the nucleon at low energies. Thomas R. Hemmert,[1] Barry R. Holstein,[2] Joachim Kambor,[3] and Germar Knöchlein[4] [1]*Theory Division, TRIUMF, 4004 Wesbrook Mall, Vancouver, British Columbia, Canada V6T 2A3* [2]*Department of Physics and Astronomy, University of Massachusetts, Amherst, Massachusetts 01003* [3]*Theoretische Physik, Universität Zürich, CH-8057 Zürich, Switzerland* [4]*Institut für Kernphysik, Johannes Gutenberg-Universität, D-55099 Mainz, Germany.* (Received 1 October 1997; published 27 March 1998)

We analyze polarized Compton scattering which provides information on the spin-structure of the nucleon. For scattering processes with photon energies up to 100 MeV the spin-structure dependence can be encoded into four independent parameters—the so-called spin-polarizabilities γ_i, $i=1,\ldots,4$, of the nucleon, which we calculate within the framework of the ''small scale expansion'' in SU(2) baryon chiral perturbation theory. Specific application is made to ''forward'' and ''backward'' spin-polarizabilities. [S0556-2821(98)01109-6] [Phys. Rev. D **57**, 5746 (1998)]

Chiral symmetry and the nucleon structure functions. M. Wakamatsu and T. Kubota, *Department of Physics, Faculty of Science, Osaka University, Toyonaka, Osaka 560, Japan.* (Received 21 August 1997; published 31 March 1998)

The flavor asymmetry of the sea quark distribution as well as the unexpectedly small quark spin fraction of the nucleon are two outstanding discoveries recently made in the physics of deep-inelastic structure functions. We evaluate here the corresponding quark distribution functions within the framework of the chiral quark soliton model, which is an effective quark model of baryons maximally incorporating the most important feature of low-energy QCD, i.e.,

chiral symmetry and its spontaneous breakdown. It is shown that the model can explain qualitative features of the abovementioned nucleon structure functions within a single framework, thereby disclosing the importance of chiral symmetry in the physics of high-energy deep-inelastic scattering. [S0556-2821(98)02909-9] [Phys. Rev. D **57**, 5755 (1998)]

Solar neutrinos and grand unification. K. S. Babu, *Institute for Advanced Study, School of Natural Sciences, Princeton, New Jersey 08540;* Q. Y. Liu, *Scuola Internazionale Superiore di Studi Avanzati, I-34013 Trieste, Italy;* A. Yu. Smirnov, *Institute for Advanced Study, School of Natural Sciences, Princeton, New Jersey 08540 and International Centre for Theoretical Physics, I-34100 Trieste, Italy.* (Received 28 July 1997; published 16 March 1998)

We consider the grand unification (GU) scenario for neutrino masses which is based on the seesaw mechanism with the mass of the heaviest right handed (RH) neutrino at the GU-scale: $M_3 \sim \Lambda_{GU}$, and on the quark-lepton symmetry for fermions from the third generation. The scenario predicts for the light neutrinos $m_3 \sim (2-4)\times 10^{-3}$ eV and $m_2 \sim (0.3-3)\times 10^{-5}$ eV (in the case of a *linear mass hierarchy* of the RH neutrinos or/and in the presence of the Planck scale suppressed non-renormalizable operators). It also predicts large $\nu_e - \nu_\mu$ mixing: $\sin^2 2\theta_{e\mu} \gtrsim 0.2$. In this scenario the solar neutrinos ($\nu_\odot$) undergo both the $\nu_e \to \nu_\tau$ resonance conversion in the Sun and substantial $\nu_e \to \nu_\mu$ vacuum oscillations on the way from the Sun to the Earth. The interplay of both effects enlarges the range of neutrino parameters which solves the $\nu_\odot$-problem. In particular, the $\nu_e - \nu_\tau$ mixing angle can be as small as the corresponding quark mixing: $\sin^2 2\theta_{e\tau} \geqslant (2-5)\times 10^{-4}$. The scenario predicts a peculiar (oscillatory) distortion of the boron neutrino energy spectrum and seasonal variations of signals. Manifestations of these effects in the Super-Kamiokande and SNO experiments are studied. [S0556-2821(98)00709-7] [Phys. Rev. D **57**, 5825 (1998)]

Neutrino masses and mixings in a universal seesaw mass matrix model. Yoshio Koide, *Department of Physics, University of Shizuoka, 395 Yada, Shizuoka 422, Japan.* (Received 29 July 1997; published 26 March 1998)

Neutrino masses and mixings are investigated on the basis of a universal seesaw mass matrix model, in which quark (except for the top quark) and charged lepton mass matrices M_f and the neutrino mass matrix M_ν are given by $M_f \simeq m_L M_F^{-1} m_R$ and $M_\nu \simeq m_L M_F^{-1} m_L^T$ $(F=N)$, respectively. For a simple model which can successfully describe quark masses and mixings, we find that the observed neutrino data (except for the solar neutrino data) are favorable to the intermediate mass scales $O(m_R)=10^{11}$ GeV and $O(M_F)=10^{13}$ GeV together with $O(m_L)=10^2$ GeV. In spite of the largeness of $O(m_R)$, the observed top-quark mass can be consistently understood from the would-be seesaw mass matrix with these mass scales.
[S0556-2821(98)03209-3] [Phys. Rev. D **57**, 5836 (1998)]

***CP* violation in neutrinoless double beta decay and neutrino oscillation.** T. Fukuyama and K. Matsuda, *Department of Physics, Ritsumeikan University, Kusatsu, Shiga, 525 Japan;* H. Nishiura, *Department of General Education, Junior College of Osaka Institute of Technology, Asahi-ku, Osaka, 535 Japan.* (Received 14 November 1997; published 1 April 1998)

Taking possible CP violations into account, we discuss constraints on lepton mixing angles obtained from neutrinoless double beta decay and from neutrino oscillation for three flavor Majorana neutrinos. From the CHORUS oscillation experiment, combined with the data from neutrinoless double beta decay, we show that the large angle solution for θ_{23} is improbable if the neutrino mass m_3 of the third generation is a candidate for hot dark matter. [S0556-2821(98)04909-1] [Phys. Rev. D **57**, 5844 (1998)]

Interference fragmentation functions and valence quark spin distributions in the nucleon. R. L. Jaffe, *Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 and RIKEN BNL Research Center, Brookhaven National Laboratory, Upton, New York 11973;* Xuemin Jin and Jian Tang, *Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139.* (Received 3 November 1997; revised manuscript received 23 January 1998; published 31 March 1998)

We explore further applications of the twist-two quark interference fragmentation functions introduced earlier. We show that semi-inclusive production of two pions in the current fragmentation region in deep inelastic scattering of a longitudinally polarized electron on a longitudinally polarized nucleon can provide a probe of the valence quark spin (or helicity difference) distribution in the nucleon. [S0556-2821(98)01009-1] [Phys. Rev. D **57**, 5920 (1998)]