

Selected Abstracts from Other Physical Review Journals

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Bimaximal lepton flavor mixing matrix and neutrino oscillation.

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Recently, many authors showed that if the solar and atmospheric neutrino data are both described by maximal mixing vacuum oscillations at the relevant mass scale, then there exists a unique bimaximal lepton mixing matrix for three neutrino flavors. We construct the lepton mass matrices from the symmetry principle so that maximal mixings for the atmospheric and the solar neutrino vacuum oscillations are naturally generated. Although the hierarchical patterns of the lepton sector are quite different from each other, we show how two different mass matrices suggested in this work can be generated in a unified way. We also give comments on possible future tests of the bimaximal lepton mixing matrix. [S0556-2821(99)50109-4] [Phys. Rev. D **59**, 091302 (1999)]

Penetration of the Earth by ultrahigh energy neutrinos predicted by low x QCD.

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We calculate the cross sections for neutrino interactions with (isoscalar) nuclear targets in the energy domain all the way up to 10^{12} GeV. Small x QCD effects are included by using a unified BFKL-DGLAP formalism which embodies non-leading $\log 1/x$ contributions. The few free parameters which specify the input parton distributions are determined by fitting to DESY HERA deep inelastic data. The attenuation of neutrinos transversing the Earth at different nadir angles is calculated for a variety of energy spectra for neutrinos originating from different sources (from active galactic nuclei, gamma ray bursts, top-down models), as well as for atmospheric neutrinos. For this purpose we solve the transport equation which includes regeneration due to neutral current neutrino interactions, in addition to attenuation. [S0556-2821(99)01409-5] [Phys. Rev. D **59**, 093002 (1999)]

Tau neutrino fluxes from atmospheric charm.

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We present an evaluation of the atmospheric tau neutrino flux in the energy range between 10^2 and 10^6 GeV. The main source of tau neutrinos is from charmed particle production and decay. The $\nu_\tau N \rightarrow \tau X$ event rate for a detector with a water equivalent volume of 1 km^3 is on the order of 60–100 events per year for $E_\tau > 100$ GeV, reducing to 18 events above 1 TeV. Event rates for atmospheric muon neutrino oscillations to tau neutrinos are also evaluated. [S0556-2821(99)03409-8] [Phys. Rev. D **59**, 093003 (1999)]

Can lepton flavor violating interactions explain the LSND results?

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If the atmospheric and the solar neutrino problems are both explained by neutrino oscillations, and if there are only three light neutrinos, then all mass-squared differences between the neutrinos are known. In such a case, existing terrestrial neutrino oscillation experiments cannot be significantly affected by neutrino oscillations, but, in principle there could be an anomaly in the neutrino flux due to new neutrino interactions. We discuss how a non-standard muon decay $\mu^+ \rightarrow e^+ \bar{\nu}_e \nu_l$ would modify the neutrino production processes of these experiments. Since $SU(2)_L$ violation is small for new physics above the weak scale one can use related flavor-violating charged lepton processes to constrain these decays in a model independent way. We show that the upper bounds on $\mu \rightarrow 3e$, muonium-antimuonium conversion and $\tau \rightarrow \mu e e$ rule out any observable effect for the present experiments due to $\mu^+ \rightarrow e^+ \bar{\nu}_e \nu_l$ for $l=e, \mu, \tau$, respectively. Applying similar arguments to flavor-changing semi-leptonic reactions we exclude the possibility that the “oscillation signals” observed at LSND are due to flavor-changing interactions that conserve total lepton number. [S0556-2821(99)04409-4] [Phys. Rev. D **59**, 093005 (1999)]

Neutrino spin flavor precession in fluctuating solar magnetic fields.

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The effect of a random magnetic field in the convective zone of the Sun on resonant neutrino spin oscillations, i.e., transitions of the type $\nu_{eL} \rightarrow \bar{\nu}_{\mu R}$, is considered. The average survival probability and the expected experimental signals in the existing solar neutrino experiments are computed as a function of the level of the noise and

magnitude of a constant magnetic field in the convective zone. From comparison with observed detection rates we conclude that the RSFP solutions to the SNP with a negligible mixing angle are stable under the presence of low or moderate levels of noise. Detection rates, especially in the Homestake experiment, are however sensitive to large levels of noise. As a consequence, an upper limit on small scale magnetic fluctuations is obtained from the combined solar data: $\sqrt{\langle B^2 \rangle} < 140\text{--}200$ kG for the scale $L_0 \sim 1000$ km and transition moment $\mu = 10^{-11} \mu_B$. [S0556-2821(99)01509-X] [Phys. Rev. D **59**, 093006 (1999)]

Global three-neutrino vacuum oscillation fits to the solar and atmospheric anomalies. V. Barger, *Fermi National Accelerator Laboratory, Batavia, Illinois 60510 and Department of Physics, University of Wisconsin, Madison, Wisconsin 53706*; K. Whisnant, *Department of Physics and Astronomy, Iowa State University, Ames, Iowa 50011*. (Received 8 December 1998; published 6 April 1999)

We determine the three-neutrino mixing and mass parameters that are allowed by the solar and atmospheric neutrino data when vacuum oscillations are responsible for both phenomena. The global fit does not appreciably change the allowed regions for the parameters obtained from effective two-neutrino fits. We discuss how measurements of the solar electron energy spectrum below 6.5 GeV in Super-Kamiokande and seasonal variations in the Super-Kamiokande, ^{71}Ga , and BOREXINO experiments can distinguish the different solar vacuum solutions. [S0556-2821(99)09009-8] [Phys. Rev. D **59**, 093007 (1999)]

Gluon minijet production in nuclear collisions at high energies. Xiaofeng Guo, *Department of Physics and Astronomy, University of Kentucky, Lexington, Kentucky 40506 and Department of Physics, Columbia University, New York, New York 10027*. (Received 4 December 1998; published 5 April 1999)

We show explicitly that the leading soft gluon p_T distribution, predicted by Kovner, McLerran, and Weigert after solving classical Yang-Mills equations, can be understood in terms of conventional QCD perturbation theory. We also demonstrate that the key logarithm in their result represents the logarithm in DGLAP evolution equations. [S0556-2821(99)02609-0] [Phys. Rev. D **59**, 094017 (1999)]

Role of resonances in nonleptonic hyperon decays. B gra Borasoy and Barry R. Holstein, *Department of Physics and Astronomy, University of Massachusetts, Amherst, Massachusetts 01003*. (Received 16 October 1998; published 8 April 1999)

We examine the importance of resonances for the nonleptonic hyperon decays in the framework of chiral perturbation theory. Lower lying resonances are included in the effective theory. Integrating out the heavy degrees of freedom in the resonance saturation scheme generates higher order counterterms in the effective Lagrangian, providing an estimate of the pertinent coupling constants. A fit to the eight independent decay amplitudes that are not related by isospin symmetry is performed and reasonable agreement for both s and p waves is achieved. [S0556-2821(99)08609-9] [Phys. Rev. D **59**, 094025 (1999)]

Searching for cold spots in multipion systems. A. Bialas and K. Zalewski, *M. Smoluchowski Institute of Physics, Jagellonian University, Krak w Reymonta 4, 30-059 Krak w, Poland and the Institute of Nuclear Physics, Krak w ul. Kawory 26a, 30-055 Krak w, Poland*. (Received 27 October 1998; published 6 April 1999)

Local fluctuations of pion density in momentum space may lead to Bose-Einstein condensation. Conditions for this phenomenon to occur in high-energy collisions and possibilities of its experimental investigation are discussed. [S0556-2821(99)03309-3] [Phys. Rev. D **59**, 097502 (1999)]

Minimal seesaw model for atmospheric and solar neutrino oscillations. Ernest Ma, *Department of Physics, University of California, Riverside, California 92521*; D. P. Roy, *Department of Physics, University of Durham, Durham, DH1 3LE, United Kingdom and Tata Institute of Fundamental Research, Homi Bhabha Road, Bombay 400005, India*. (Received 1 December 1998; published 6 April 1999)

We present a minimal seesaw model based on an extension of the standard model (SM) which includes an additional $U(1)$, with gauge charge $B - \frac{3}{2}(L_\mu + L_\tau)$. The requirement of anomaly cancellation implies the existence of two right-handed singlet neutrinos, carrying this gauge charge, which have normal Dirac couplings to ν_μ and ν_τ but suppressed ones to ν_e . Assuming the $U(1)$ symmetry breaking scale to be $10^{12}\text{--}10^{16}$ GeV, this model can naturally account for the large (small) mixing solutions to the atmospheric (solar) neutrino oscillations. [S0556-2821(99)06809-5] [Phys. Rev. D **59**, 097702 (1999)]

Fermion damping in a fermion-scalar plasma. D. Boyanovsky,¹ H. J. de Vega,² D.-S. Lee,³ Y. J. Ng,⁴ and S.-Y. Wang,¹
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In this article we study the dynamics of fermions in a fermion-scalar plasma. We begin by obtaining the effective in-medium Dirac equation in real time which is fully renormalized and causal and leads to the initial value problem. For a heavy scalar we find the novel result that the decay of the scalar into fermion pairs in the medium leads to damping of the fermionic excitations and their in-medium propagation as quasiparticles. That is, the fermions acquire a width due to the decay of the heavier scalar in the medium. We find the damping rate to lowest order in the Yukawa coupling for arbitrary values of scalar and fermion masses, temperature and fermion momentum. An all-order expression for the damping rate in terms of the exact quasiparticle wave functions is established. A kinetic Boltzmann approach to the relaxation of the fermionic distribution function confirms the damping of fermionic excitations as a consequence of the induced decay of heavy scalars in the medium. A linearization of the Boltzmann equation near equilibrium clearly displays the relationship between the damping rate of fermionic mean fields and the fermion interaction rate to lowest order in the

Yukawa coupling directly in real time. [S0556-2821(99)07604-3] [Phys. Rev. D **59**, 105001 (1999)]

Relic neutrino asymmetry evolution from first principles. Nicole F. Bell, Raymond R. Volkas, and Yvonne Y. Y. Wong, *School of Physics, Research Centre for High Energy Physics, The University of Melbourne, Parkville 3052, Australia.* (Received 14 September 1998; published 14 April 1999)

The exact quantum kinetic equations for a two-flavor active-sterile neutrino system are used to provide a systematic derivation of approximate evolution equations for the relic neutrino asymmetry. An extension of the adiabatic approximation for matter-affected neutrino oscillations is developed which incorporates decoherence due to collisions. Exact and approximate expressions for the decoherence and repopulation functions are discussed. A first pass is made at an exact treatment of multi-flavor partially incoherent oscillations. [S0556-2821(99)04909-7] [Phys. Rev. D **59**, 113001 (1999)]

Note on the field theory of neutrino mixing. Kanji Fujii and Chikage Habe, *Department of Physics, Faculty of Science, Hokkaido University, Sapporo 060-0810, Japan;* Tetsuo Yabuki, *Rakunou Gakuen University, Ebetsu 069-0836, Japan.* (Received 25 June 1998; revised manuscript received 21 December 1998; published 16 April 1999)

The possibility of constructing the Hilbert space of definite flavor neutrino states, especially a one-flavor neutrino state, is investigated in the theory with flavor-mixing mass terms in the Lagrangian. Reviewing the work of Blasone and Vitiello in detail, we clarify that even if we construct the Hilbert space of a definite flavor neutrino, the oscillation probabilities of neutrinos derived according to the usual way include arbitrary mass parameters. We examine the structure of the flavor neutrino propagator and show that the physical poles of the propagator coincide with mass eigenvalues of the mass matrix in the Lagrangian irrespective of such arbitrary parameters. This gives a possible way of escaping the arbitrariness. [S0556-2821(99)03809-6] [Phys. Rev. D **59**, 113003 (1999)]

Lower energy consequences of an anomalous high-energy neutrino cross section. Haim Goldberg, *Department of Physics, Northeastern University, Boston, Massachusetts 02115;* T. J. Weiler, *Department of Physics & Astronomy, Vanderbilt University, Nashville, Tennessee 37235.* (Received 12 November 1998; published 20 April 1999)

A new strong interaction has been postulated for neutrinos above $\sim 10^{19}$ eV to explain the production of highest-energy cosmic-ray events. We derive a dispersion relation relating the hypothesized high-energy cross section to the lower-energy neutrino-nucleon elastic amplitude. Remarkably, we find that the real forward amplitude becomes anomalous seven orders of magnitude lower in energy than does the total cross section. We discuss possible measurable consequences of this early onset of new neutrino physics and conclude that a significantly enhanced elastic νN scattering rate may occur for the neutrino beams available at Fermilab and CERN. [S0556-2821(99)03709-1] [Phys. Rev. D **59**, 113005 (1999)]

Solar and atmospheric neutrino oscillations and lepton flavor violation in supersymmetric models with right-handed neutrinos. J. Hisano, *Theory Group, KEK, Oho 1-1, Tsukuba, Ibaraki 305-0801, Japan;* Daisuke Nomura, *Department of Physics, University of Tokyo, Tokyo 113-0033, Japan.* (Received 27 October 1998; published 16 April 1999)

Taking the solar and the atmospheric neutrino experiments into account we discuss the lepton flavor violating processes, such as $\tau \rightarrow \mu \gamma$ or $\mu \rightarrow e \gamma$, in the minimal supersymmetric standard model with right-handed neutrinos (MSSMRN) and the supersymmetric SU(5) grand unified theory with right-handed neutrinos [SU(5)RN]. The predicted branching ratio of $\mu \rightarrow e \gamma$ in the MSSMRN with the Mikheyev-Smirnov-Wolfenstein (MSW) large angle solution is so large that it goes beyond the current experimental bound if the second-generation right-handed Majorana mass M_{ν_2} is greater than $\sim 10^{13} (\sim 10^{14})$ GeV for $\tan \beta = 30(3)$. When we take the MSW small angle solution, the $\mu \rightarrow e \gamma$ rate is at most about 1/100 of that of the MSW large angle solution. The “just so” solution implies 10^{-5} of that of the MSW large angle solution. Also, in the SU(5)RN the large $\mu \rightarrow e \gamma$ rate naturally follows from the MSW large angle solution, and the predicted rate is beyond the current experimental bound if the typical right-handed Majorana mass M_N is larger than $\sim 10^{13} (\sim 10^{14})$ GeV for $\tan \beta = 30(3)$, similarly to the MSSMRN. We show the multimass insertion formulas and their applications to $\tau \rightarrow \mu \gamma$ and $\mu \rightarrow e \gamma$. [S0556-2821(99)03909-0] [Phys. Rev. D **59**, 116005 (1999)]

Admixture of disoriented chiral condensate domains. Ding-wei Huang, *Department of Physics, Chung Yuan Christian University, Chung-li, Taiwan.* (Received 10 September 1998; published 13 April 1999)

The probability distribution of a neutral pion fraction from mixed domains of different types is characterized. The effects of finite multiplicity and fluctuations are included. The implications on the production rates of Centauro and anti-Centauro events are discussed. The signal for the condensate is less dramatic as the average multiplicity decreases. [S0556-2821(99)06409-7] [Phys. Rev. D **59**, 117501 (1999)]

Effect of friction on disoriented chiral condensate formation. A. K. Chaudhuri, *Variable Energy Cyclotron Centre, 1/AF, Bidhan Nagar, Calcutta - 700 064, India.* (Received 27 August 1998; published 16 April 1999)

We investigate the effect of friction on the DCC domain formation. We solve the Newton equation of motion for the O(4) fields, with a quenched initial condition. The initial fields are randomly distributed in a Gaussian form. In a one-dimensional expansion, on the average, large DCC domains cannot be formed. However, in some particular orbits, large instabilities may occur. This possibility also greatly diminishes with the introduction of friction. But, if the friction is large, the system may be overdamped and then there is a possibility of large DCC domain formation in some events. [S0556-2821(99)03701-7] [Phys. Rev. D **59**, 117503 (1999)]