

## Selected Abstracts from Other Physical Review Journals

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**Spectroscopic studies in open quantum systems.** I. Rotter,<sup>1</sup> E. Persson,<sup>2</sup> K. Pichugin,<sup>3</sup> and P. Seba,<sup>3,4</sup> <sup>1</sup>*Max-Planck-Institut für Physik komplexer Systeme, D-01187 Dresden, Germany* <sup>2</sup>*Institut für Theoretische Physik, Technische Universität Wien, A-1040 Wien, Austria* <sup>3</sup>*Institute of Physics, Czech Academy of Sciences, Cukrovarnická 10, Prague, Czech Republic* <sup>4</sup>*Department of Physics, Pedagogical University, Hradec Kralove, Czech Republic.* (Received 14 February 2000)

The Hamiltonian  $\mathcal{H}$  of an open quantum system is non-Hermitian. Its complex eigenvalues  $\mathcal{E}_R$  are the poles of the  $S$  matrix and provide both the energies and widths of the states. We illustrate the interplay between  $\text{Re}(\mathcal{H})$  and  $\text{Im}(\mathcal{H})$  by means of the different interference phenomena between two neighboring resonance states. Level repulsion may occur along the real or imaginary axis (the latter is called resonance trapping). In any case, the eigenvalues of the two states avoid crossing in the complex plane. We then calculate the poles of the  $S$  matrix and the corresponding wave functions for a rectangular microwave resonator with a scatterer as a function of the area of the resonator as well as of the degree of opening to a waveguide. The calculations are performed by using the method of exterior complex scaling.  $\text{Re}(\mathcal{H})$  and  $\text{Im}(\mathcal{H})$  cause changes in the structure of the wave functions which are permanent, as a rule. The resonance picture obtained from the microwave resonator shows all the characteristic features known from the study of many-body systems in spite of the absence of two-body forces. The effects arising from the interplay between resonance trapping and level repulsion along the real axis are not involved in the statistical theory (random matrix theory). [Phys. Rev. E **62**, 450 (2000)]

**Size of the dark side of the solar neutrino parameter space.** M. C. Gonzalez-Garcia and C. Peña-Garay, *Instituto de Física Corpuscular – C.S.I.C., Departamento de Física Teòrica, Universitat de València, Edificio Institutos de Paterna, Apt. 2085, 46071 València, Spain.* (Received 28 February 2000; published 27 June 2000)

We present an analysis of the MSW neutrino oscillation solutions of the solar neutrino problem in the framework of two-neutrino mixing in the enlarged parameter space  $(\Delta m^2, \tan^2 \theta)$  with  $\theta \in (0, \pi/2)$ . Recently, it was pointed out that the allowed region of parameters from a fit to the measured total rates can extend to values  $\theta \geq \pi/4$  (the so-called “dark side”) when higher confidence levels are allowed. The purpose of this Rapid Communication is to reanalyze the problem, including all the solar neutrino data available, to discuss the dependence on the statistical criteria in the determination of the C.L. of the “dark side” and to extract the corresponding limits on the largest mixing allowed by the data. Our results show that when the Super-Kamiokande data on the zenith angle distribution of events and the spectrum information are in-

cluded, the regions extend more into the second octant. [Phys. Rev. D **62**, 031301 (2000)]

**Energy spectra, altitude profiles, and charge ratios of atmospheric muons.** S. Coutu, J. J. Beatty, and M. A. DuVernois, *Departments of Physics and of Astronomy and Astrophysics, 104 Davey Laboratory, The Pennsylvania State University, University Park, Pennsylvania 16802*; S. W. Barwick and E. Schneider, *Department of Physics, University of California at Irvine, Irvine, California 92717*; A. Bhattacharyya, C. R. Bower, and J. A. Musser, *Department of Physics, Swain Hall West, Indiana University, Bloomington, Indiana 47405*; A. Labrador, D. Müller, S. P. Swordy, and E. Torbet, *Enrico Fermi Institute and Department of Physics, 933 E. 56<sup>th</sup> St., University of Chicago, Chicago, Illinois 60637*; C. Chaput, S. McKee, G. Tarlé, and A. D. Tomasch, *Department of Physics, Randall Laboratory, University of Michigan, 500 E. University, Ann Arbor, Michigan 48109-1120*; S. L. Nutter, *Department of Physical Sciences, Eastern New Mexico University, Portales, New Mexico 88130*; G. A. deNolfo, *Department of Physics, Washington University, St. Louis, Missouri 63130.* (Received 30 December 1999; published 28 June 2000)

We present a new measurement of air shower muons made during atmospheric ascent of the High Energy Antimatter Telescope balloon experiment. The muon charge ratio  $\mu^+/\mu^-$  is presented as a function of atmospheric depth in the momentum interval 0.3–0.9 GeV/c. The differential  $\mu^-$  momentum spectra are presented between 0.3 and  $\sim 50$  GeV/c at atmospheric depths between 13 and 960 g/cm<sup>2</sup>. We compare our measurements with other recent data and with Monte Carlo calculations of the same type as those used in predicting atmospheric neutrino fluxes. We find that our measured  $\mu^-$  fluxes are smaller than the predictions by as much as 70% at shallow atmospheric depths, by  $\sim 20\%$  at the depth of shower maximum, and are in good agreement with the predictions at greater depths. We explore the consequences of this on the question of atmospheric neutrino production. [Phys. Rev. D **62**, 032001 (2000)]

**Simultaneous observation of families and accompanied air showers at Mt. Chacaltaya. II. Study of the hadronic component in air showers.** C. Aguirre,<sup>1</sup> H. Aoki,<sup>2</sup> K. Hashimoto,<sup>3</sup> K. Honda,<sup>4</sup> N. Inoue,<sup>5</sup> N. Kawasumi,<sup>3</sup> Y. Maeda,<sup>6</sup> N. Martinic,<sup>1</sup> T. Matano,<sup>7</sup> N. Ohmori,<sup>6</sup> A. Ohsawa,<sup>8</sup> K. Shinozaki,<sup>5</sup> M. Tamada,<sup>9</sup> R. Ticona,<sup>1</sup> and I. Tsushima,<sup>3</sup> <sup>1</sup>*Instituto de Investigaciones Físicas, Universidad Mayor de San Andrés, La Paz, Bolivia* <sup>2</sup>*Faculty of Science, Soka University, Hachioji, Tokyo, 192-8577 Japan* <sup>3</sup>*Faculty of Education, Yamanashi University, Kofu, 400-8510 Japan* <sup>4</sup>*Faculty of Engineering, Yamanashi University, Kofu,*

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An experimental setup of an air shower array, hadron calorimeter, and emulsion chamber is being carried out at Mt. Chacaltaya (5200 m, Bolivia), in order to study the hadron interaction and the primary cosmic rays in the energy region exceeding  $10^{15}$  eV. The number of hadrons in the air shower, detected by the hadron calorimeter, is discussed mainly in this paper. A comparison with the simulation shows that the number of hadrons in the air shower is not compatible with that of the simulation, indicating that the Feynman scaling law is violated more strongly than the one assumed in the simulation at  $10^{16}$  eV. The average mass number of the primary cosmic rays, estimated from the distribution of the number of hadrons, is  $\langle \ln A \rangle = 2.8 \pm 0.5$  at  $10^{16}$  eV. [Phys. Rev. D **62**, 032003 (2000)]

**Measurement of the flux of atmospheric muons with the CAPRICE94 apparatus.** M. Boezio, P. Carlson, T. Francke, and N. Weber, *Royal Institute of Technology (KTH), S-104 05 Stockholm, Sweden*; M. Suffert, *Centre des Recherches Nucléaires, BP20, F-67037 Strasbourg-Cedex, France*; M. Hof, W. Menn, and M. Simon, *Universität Siegen, 57068 Siegen, Germany*; S. A. Stephens, *Tata Institute of Fundamental Research, Bombay 400 005, India*; R. Bellotti, F. Cafagna, M. Circella, and C. De Marzo, *Dipartimento di Fisica dell'Università and Sezione INFN di Bari, Via Amendola 173, I-70126 Bari, Italy*; N. Finetti, P. Papini, S. Piccardi, and P. Spillantini, *Dipartimento di Fisica dell'Università and Sezione INFN di Firenze, Largo Enrico Fermi 2, I-50125 Firenze, Italy*; M. Ricci, *Laboratori Nazionali INFN, Via Enrico Fermi 40, CP 13, I-00044 Frascati, Italy*; M. Casolino, M. P. De Pascale, A. Morselli, P. Picozza, and R. Sparvoli, *Dipartimento di Fisica dell'Università and Sezione INFN di Roma, Tor Vergata, Via della Ricerca Scientifica 1, I-00133 Roma, Italy*; G. Barbiellini, P. Schiavon, A. Vacchi, and N. Zampa, *Dipartimento di Fisica dell'Università and Sezione INFN di Trieste, Via A. Valerio 2, I-34147 Trieste, Italy*; C. Grimaldi, *Istituto di Fisica dell'Università di Urbino, I-61029 Urbino, Italy*; J. W. Mitchell, J. F. Ormes, and R. E. Streitmatter, *Code 661, NASA/Goddard Space Flight Center, Greenbelt, Maryland 20771*; U. Bravar, R. L. Golden, and S. J. Stochaj, *Box 3-PAL, New Mexico State University, Las Cruces, New Mexico 88003*. (Received 2 February 2000; published 12 July 2000)

A new measurement of the momentum spectra of both positive and negative muons as a function of atmospheric depth was made by the balloon-borne experiment CAPRICE94. The data were collected during ground runs in Lynn Lake on 19 and 20 July 1994 and during the balloon flight on 8 and 9 August 1994. We present results that cover the momentum intervals 0.3–40 GeV/c for  $\mu^-$  and 0.3–2 GeV/c for  $\mu^+$ , for atmospheric depths from 3.3 to 1000 g/cm<sup>2</sup>, respectively. Good agreement is found with previous measurements for high momenta, while at momenta below 1 GeV/c we find latitude dependent geomagnetic effects. These measurements are important cross-checks for the simulations carried out to calcu-

late the atmospheric neutrino fluxes and to understand the observed atmospheric neutrino anomaly. [Phys. Rev. D **62**, 032007 (2000)]

**CP violation effect in long-baseline neutrino oscillation in the four-neutrino model.** Toshihiko Hattori, *Institute of Theoretical Physics, University of Tokushima, Tokushima 770-8502, Japan*; Tsutomu Hasuike, *Department of Physics, Anan College of Technology, Anan 774-0017, Japan*; Seiichi Wakaizumi, *School of Medical Sciences, University of Tokushima, Tokushima 770-8509, Japan*. (Received 31 January 2000; published 12 July 2000)

We investigate CP-violation effects in long-baseline neutrino oscillations in the four-neutrino model with a mass scheme of the two nearly degenerate pairs separated by the order of 1 eV, by using the data from the solar neutrino deficit, the atmospheric neutrino anomaly, and the LSND experiments along with other accelerator and reactor experiments. By using the most general parametrization of the mixing matrix with six angles and six phases, we show that a genuine CP-violation effect could attain as large as 0.3 for  $\Delta P(\nu_\mu \rightarrow \nu_\tau) \equiv P(\nu_\mu \rightarrow \nu_\tau) - P(\bar{\nu}_\mu \rightarrow \bar{\nu}_\tau)$  and that the matter effect is negligibly small such as at most 0.01 for  $\Delta P(\nu_\mu \rightarrow \nu_\tau)$  for  $\Delta m^2 = (1-5) \times 10^{-3}$  eV<sup>2</sup>, which is the mass-squared difference relevant to the long-baseline oscillation. [Phys. Rev. D **62**, 033006 (2000)]

**Identifying the neutrino mass spectrum from a supernova neutrino burst.** Amol S. Dighe, *Theory Division, CERN, CH-1211 Geneva 23, Switzerland*; Alexei Yu. Smirnov, *The Abdus Salam International Center for Theoretical Physics, 34100 Trieste, Italy and Institute of Nuclear Research, RAS, Moscow, Russia*. (Received 31 January 2000; published 12 July 2000)

We study the role that the future detection of the neutrino burst from a galactic supernova can play in the reconstruction of the neutrino mass spectrum. We consider all possible  $3\nu$  mass and flavor spectra which describe the solar and atmospheric neutrino data. For each of these spectra we find the observable effects of the supernova neutrino conversions both in the matter of the star and the Earth. We show that studies of the electron neutrino and antineutrino spectra as well as observations of the neutral current effects from supernova will allow us (i) to identify the solar neutrino solution, (ii) to determine the type of mass hierarchy (normal or inverted) and (iii) to probe the mixing  $|U_{e3}|^2$  to values as low as  $10^{-4}$ – $10^{-3}$ . [Phys. Rev. D **62**, 033007 (2000)]

**Nucleon anapole moment and parity-violating ep scattering.** Shi-Lin Zhu,<sup>1</sup> S. J. Puglia,<sup>1</sup> B. R. Holstein,<sup>3</sup> and M. J. Ramsey-Musolf,<sup>1,2</sup> <sup>1</sup>Department of Physics, University of Connecticut, Storrs, Connecticut 06269 <sup>2</sup>Theory Group, Thomas Jefferson National Laboratory, Newport News, Virginia 23606 <sup>3</sup>Department of Physics and Astronomy, University of Massachusetts, Amherst, Massachusetts 01003. (Received 29 February 2000; published 12 July 2000)

Parity-violating (PV) interactions among quarks in the nucleon induce a PV  $\gamma NN$  coupling, or anapole moment (AM). We compute electroweak gauge-independent contributions to the AM through  $\mathcal{O}(1/\Lambda_\chi^2)$  in chiral perturbation theory. We estimate short-distance PV effects using resonance saturation. The AM contributions to PV electron-proton scattering slightly enhance the axial vector radiative corrections,  $R_A^P$ , over the scale implied by the standard model when weak quark-quark interactions are neglected. We estimate the theoretical uncertainty associated with the AM contributions to  $R_A^P$  to be large, and discuss the implications for the interpretation PV of  $ep$  scattering. [Phys. Rev. D **62**, 033008 (2000)]

**Does the quark-gluon plasma contain stable hadronic bubbles?** Gregers Neergaard and Jes Madsen, *Institute of Physics and Astronomy, University of Aarhus, DK-8000 Århus C, Denmark*. (Received 15 September 1999; published 7 July 2000)

We calculate the thermodynamic potential of bubbles of hadrons embedded in a quark-gluon plasma, and of droplets of quark-gluon plasma embedded in a hadron phase. This is a generalization of our previous results to the case of nonzero chemical potentials. As in the zero chemical potential case, we find that a quark-gluon plasma in thermodynamic equilibrium may contain stable bubbles of hadrons of radius  $R \approx 1$  fm. The calculations are performed within the MIT bag model, using an improved multiple reflection expansion. The results are of relevance for neutron star phenomenology and for ultrarelativistic heavy ion collisions. [Phys. Rev. D **62**, 034005 (2000)]

**Debye screening and the Meissner effect in a two-flavor color superconductor.** Dirk H. Rischke, *RIKEN-BNL Research Center, Brookhaven National Laboratory, Upton, New York 11973*. (Received 24 January 2000; published 7 July 2000)

I compute the gluon self-energy in a color superconductor with two flavors of massless quarks, where condensation of Cooper pairs breaks  $SU(3)_c$  to  $SU(2)_c$ . At zero temperature, there is neither Debye screening nor a Meissner effect for the three gluons of the unbroken  $SU(2)_c$  subgroup. The remaining five gluons attain an electric as well as a magnetic mass. For temperatures approaching the critical temperature for the onset of color superconductivity, or for gluon momenta much larger than the color-superconducting gap, the self-energy assumes the form given by the standard hard-dense loop approximation. The gluon self-energy determines the coefficient of the kinetic term in the effective low-energy theory for the condensate fields. [Phys. Rev. D **62**, 034007 (2000)]

**Bose symmetry interference effects of  $4\pi$  final states.** Jie Chen and Xue-Qian Li, *CCAST (World Laboratory), P.O. Box 8730, Beijing 100080, China; Department of Physics, Nankai University, Tianjin 300071, China; and Institute of High Energy Physics, Academia Sinica, P.O. Box 918(4), Beijing 100039, China; Bing-Song Zou, CCAST (World Laboratory), P.O. Box 8730, Beijing 100080, China and Institute of High Energy Physics, Academia Sinica, P.O.*

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We analyze the relative branching ratios of  $4\pi$  final states  $\pi^+\pi^-\pi^+\pi^-$ ,  $\pi^+\pi^-\pi^0\pi^0$ , and  $\pi^0\pi^0\pi^0\pi^0$ , from various resonances with  $J^{PC}=0^{++}$ ,  $0^{-+}$ ,  $2^{++}$ . We find that in some cases the interference effects due to Bose symmetry make their ratios obviously different from the naive counting values without these effects. The results allow an accurate estimate of the  $4\pi$  branching ratios of relevant resonances when only one (or two) modes are measured in a given experiment. [Phys. Rev. D **62**, 034011 (2000)]

**Dense QCD: Overhauser or BCS pairing?** Byung-Yoon Park,<sup>1,2</sup> Mannque Rho,<sup>1,3</sup> Andreas Wirzba,<sup>4,5</sup> Ismail Zahed,<sup>1,4</sup> <sup>1</sup>*School of Physics, Korea Institute for Advanced Study, Seoul 130-012, Korea* <sup>2</sup>*Department of Physics, Chungnam National University, Taejeon 305-764, Korea* <sup>3</sup>*Service de Physique Théorique, CE Saclay, 91191 Gif-sur-Yvette, France* <sup>4</sup>*Department of Physics and Astronomy, SUNY-Stony Brook, New York 11794* <sup>5</sup>*FZ Jülich, Institut für Kernphysik (Theorie), D-52425 Jülich, Germany*. (Received 15 October 1999; published 12 July 2000)

We discuss the Overhauser effect (particle-hole pairing) versus the BCS effect (particle-particle or hole-hole pairing) in QCD at large quark density. In weak coupling and to leading logarithm accuracy, the pairing energies can be estimated exactly. For a small number of colors, the BCS effect overtakes the Overhauser effect, while for a large number of colors the opposite takes place, in agreement with a recent renormalization group argument. In strong coupling with large pairing energies, the Overhauser effect may be dominant for any number of colors, suggesting that QCD may crystallize into an insulator at a few times nuclear matter density, a situation reminiscent of dense Skyrmions. The Overhauser effect is dominant in QCD in 1+1 dimensions, although susceptible to quantum effects. It is sensitive to temperature in all dimensions. [Phys. Rev. D **62**, 034015 (2000)]

**Stochastic treatment of disoriented chiral condensates within a Langevin description.** Zhe Xu and Carsten Greiner, *Institut für Theoretische Physik, Justus-Liebig-Universität Giessen, D-35392 Giessen, Germany*. (Received 8 November 1999; published 12 July 2000)

Applying a microscopically motivated semiclassical Langevin description of the linear sigma model we investigate for various different scenarios the stochastic evolution of a disoriented chiral condensate (DCC) in a rapidly expanding system. Some particular emphasis is put on the numerical realization of colored noise in order to treat the underlying dissipative and non-Markovian stochastic equations of motion. A comparison with an approximate Markovian (i.e., instantaneous) treatment of dissipation and noise will be made in order to identify the possible influence of memory effects in the evolution of the chiral order parameter. Assuming a standard Rayleigh cooling term to simulate a  $D$ -dimensional scaling expansion we present the probability distribution in the low momentum pion number stemming from the relaxing zero mode component of the chiral field. The best DCC signal is expected for

initial conditions centered around  $\langle\sigma\rangle\approx 0$  as would be the case of effective light “pions” close to the phase transition. By choosing appropriate idealized global parameters for the expansion our findings show that an experimentally feasible DCC, if it does exist in nature, has to be a rare event with some finite probability following a nontrivial and non-Poissonian distribution on an event by event basis. DCCs might then be identified experimentally by inspecting higher order factorial cumulants  $\theta_m$  ( $m\geq 3$ ) in the sampled distribution. [Phys. Rev. D **62**, 036012 (2000)]

#### Modification of Z boson properties in the quark-gluon plasma.

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We calculate the change in the effective mass and width of a Z boson in the environment of a quark-gluon plasma under the conditions expected in Pb-Pb collisions at the CERN LHC. The change in width is predicted to be only about 1 MeV at a temperature of 1 GeV, compared to the natural width of  $2490\pm 7$  MeV. The mass shift is even smaller. Hence no observable effects are to be expected. [Phys. Rev. D **62**, 037301 (2000)]

**Supernova relic neutrino background.** M. Kaplinghat, *Department of Physics, The Ohio State University, Columbus, Ohio 43210 and Department of Astronomy and Astrophysics, University of Chicago, Chicago, Illinois 60637*; G. Steigman and T. P. Walker, *Department of Physics, The Ohio State University, Columbus, Ohio 43210 and Department of Astronomy, The Ohio State University, Columbus, Ohio 43210*. (Received 20 December 1999; published 5 July 2000)

An upper bound to the supernova relic neutrino background from all past type II supernovae is obtained using observations of the universal metal enrichment history. We show that an unambiguous detection of these relic neutrinos by the SuperKamiokande detector is unlikely. We also analyze the event rate in the Sudbury Neutrino Observatory (where coincident neutrons from  $\bar{\nu}_e D \rightarrow n n e^+$  might enhance background rejection), and arrive at the same conclusion. If the relic neutrino flux should be observed to exceed our upper bound and if the observations of the metal enrichment history (for  $z < 1$ ) are not in considerable error, then either the type II supernova rate does not track the metal enrichment history or some mechanism may be responsible for transforming  $\bar{\nu}_{\mu,\tau} \rightarrow \bar{\nu}_e$ . [Phys. Rev. D **62**, 043001 (2000)]

**Infrared behavior of the gluon propagator on a large volume lattice.** Frédéric D. R. Bonnet, Patrick O. Bowman, Derek B. Leinweber, and Anthony G. Williams, *Special Research Centre for the Subatomic Structure of Matter and The Department of Physics and Mathematical Physics, University of Adelaide, Adelaide SA 5005, Australia*. (Received 22 February 2000; published 14 July 2000)

The first calculation of the gluon propagator using an  $\mathcal{O}(a^2)$  improved action with the corresponding  $\mathcal{O}(a^2)$  improved Landau gauge fixing condition is presented. The gluon propagator obtained from the improved action and improved Landau gauge condition is

compared with earlier unimproved results on similar physical lattice volumes of  $3.2^3 \times 6.4$  fm<sup>4</sup>. We find agreement between the improved propagator calculated on a coarse lattice with lattice spacing  $a=0.35$  fm and the unimproved propagator calculated on a fine lattice with spacing  $a=0.10$  fm. This motivates us to calculate the gluon propagator on a coarse large-volume lattice  $5.6^3 \times 11.2$  fm<sup>4</sup>. The infrared behavior of previous studies is confirmed in this work. The gluon propagator is enhanced at intermediate momenta and suppressed at infrared momenta. Therefore the observed infrared suppression of the Landau gauge gluon propagator is not a finite volume effect. [Phys. Rev. D **62**, 051501 (2000)]

#### Symplectic symmetry of the neutrino mass and the seesaw mechanism.

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We investigate the algebraic structure of the most general neutrino mass Hamiltonian and place the seesaw mechanism in an algebraic framework. We show that this Hamiltonian can be written in terms of the generators of an Sp(4) algebra. The Pauli-Gürsey transformation is an SU(2) rotation which is embedded in this Sp(4) group. This SU(2) also generates the seesaw mechanism. [Phys. Rev. D **62**, 053002 (2000)]

**Neutrino oscillations in an SO(10) supersymmetric grand unified theory with U(2)×U(1)<sup>n</sup> family symmetry.** T. Blažek, *Department of Physics and Astronomy, Northwestern University, Evanston, Illinois 60208*; S. Raby and K. Tobe, *Department of Physics, The Ohio State University, 174 W. 18th Ave., Columbus, Ohio 43210*. (Received 23 December 1999; published 14 July 2000)

In a previous paper we analyzed fermion masses (focusing on neutrino masses and mixing angles) in an SO(10) SUSY GUT with U(2)×U(1)<sup>n</sup> family symmetry. The model is “natural” containing all operators in the Lagrangian consistent with the states and their charges. With minimal family symmetry breaking vacuum expectation values (VEVs) the model is also predictive giving a unique solution to atmospheric (with maximal  $\nu_\mu \rightarrow \nu_\tau$  mixing) and solar (with SMA MSW  $\nu_e \rightarrow \nu_s$  mixing) neutrino oscillations. In this paper we analyze the case of general family breaking VEVs. We now find several new solutions for three, four, and five neutrinos. For three neutrinos we now obtain SMA MSW, LMA MSW, or vacuum oscillation solutions for solar neutrinos. In all three cases the atmospheric data are described by maximal  $\nu_\mu \rightarrow \nu_\tau$  mixing. In the four and five neutrino cases, in addition to fitting atmospheric and solar data as before, we are now able to fit LSND data. All this is obtained with the additional parameters coming from the family symmetry breaking VEVs, providing only minor changes in the charged fermion fits. [Phys. Rev. D **62**, 055001 (2000)]