Selected Abstracts from Other Physical Review Journals

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Sterile neutrinos and supernova nucleosynthesis. David O. Caldwell, *Institute for Nuclear and Particle Astrophysics and Cosmology, and Department of Physics, University of California, Santa Barbara, California 93106;* George M. Fuller, *Department of Physics, University of California, San Diego, La Jolla, California 92093-0319;* Yong-Zhong Qian, *School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455.* (Received 12 October 1999; published 30 May 2000)

A light sterile neutrino species has been introduced to explain simultaneously the solar and atmospheric neutrino puzzles and the results of the LSND experiment, while providing for a hot component of dark matter. Employing this scheme of neutrino masses and mixings, we show how matter-enhanced active-sterile ($\nu_{\mu,\tau} \rightleftharpoons \nu_s$) neutrino transformation followed by active-active ($\nu_{\mu,\tau} \rightleftharpoons \nu_e$) neutrino transformation can solve robustly the neutron deficit problem encountered by models of *r*-process nucleosynthesis associated with neutrino-heated supernova ejecta. [Phys. Rev. D **61**, 123005 (2000)]

Three-flavor MSW solutions of the solar neutrino problem. G. L. Fogli,[1] E. Lisi,[1] D. Montanino,[2] and A. Palazzo,[1] [1]*Dipartimento di Fisica and Sezione INFN di Bari, Via Amendola 173, I-70126 Bari, Italy* [2]*Dipartimento di Scienza dei Materiali dell'Università di Lecce, Via Arnesano, Collegio Fiorini, I-73100 Lecce, Italy.* (Received 7 December 1999; published 26 May 2000)

We perform an updated phenomenological analysis of the Mikheyev-Smirnov-Wolfenstein (MSW) solutions of the solar neutrino problem, assuming oscillations between two and three neutrino families. The analysis includes the total rates of the Homestake, SAGE, GALLEX, Kamiokande and Super-Kamiokande experiments, as well as the day-night asymmetry and the 18-bin energy spectrum of Super-Kamiokande. Solutions are found at several values of the θ_{13} mixing angle. Among the most interesting features, we find that solar neutrino data alone put the constraint $\theta_{13} \lesssim 55° - 59°$ at 95% C.L., and that a fraction of the MSW solutions extends at and beyond maximal (ν_1, ν_2) mixing ($\theta_{12} \geqslant \pi/4$), especially if the neutrino square mass splitting is in its lower range ($m_2^2 - m_1^2 \sim 10^{-7}$ eV^2) and if θ_{13} is nonzero. In particular, bimaximal (or nearly bimaximal) mixing is possible for atmospheric and MSW solar neutrino oscillations within the stringent reactor bounds on θ_{13}. [Phys. Rev. D **62**, 013002 (2000)]

Mass matrix for atmospheric, solar, and LSND neutrino oscillations. James M. Gelb, *Department of Physics, University of Texas at Arlington, Arlington, Texas 76019;* S. P. Rosen, *United States Department of Energy, Germantown, Maryland 20874.* (Received 8 September 1999; published 30 May 2000)

We construct a mass matrix for the four neutrino flavors, three active and one sterile, needed to fit oscillations in all three neutrino experiments: atmospheric, solar, and LSND, simultaneously. It organizes the neutrinos into two doublets whose central values are about 1 eV apart, and whose splittings are of the order of 10^{-3} eV. Atmospheric neutrino oscillations are described as maximal mixing within the upper doublet, and solar as the same within the lower doublet. Then LSND is a weak transition from one doublet to the other. We comment on the Majorana versus Dirac nature of the active neutrinos and show that our mass matrix can be derived from an $S_2 \times S_2$ permutation symmetry plus an equal splitting rule. [Phys. Rev. D **62**, 013003 (2000)]

Long-baseline study of the leading neutrino oscillation at a neutrino factory. V. Barger,[1] S. Geer,[2] R. Raja,[2] and K. Whisnant,[3] [1]*Department of Physics, University of Wisconsin, Madison, Wisconsin 53706* [2]*Fermi National Accelerator Laboratory, P.O. Box 500, Batavia, Illinois 60510* [3]*Department of Physics and Astronomy, Iowa State University, Ames, Iowa 50011.* (Received 30 November 1999; published 5 June 2000)

Within the framework of three-flavor neutrino oscillations, we consider the physics potential of $\nu_e \rightarrow \nu_\mu$ appearance and $\nu_\mu \rightarrow \nu_\mu$ survival measurements at a neutrino factory for a leading oscillation scale $\delta m^2 \sim 3.5 \times 10^{-3}$ eV^2. Event rates are evaluated versus baseline and stored muon energy, and optimal values discussed. Over a sizable region of oscillation parameter space, matter effects would enable the sign of δm^2 to be determined from a comparison of $\nu_e \rightarrow \nu_\mu$ with $\bar{\nu}_e \rightarrow \bar{\nu}_\mu$ event rates and energy distributions. It is important, therefore, that both positive and negative muons can be stored in the ring. Measurements of the $\nu_\mu \rightarrow \nu_\mu$ survival spectrum could determine the magnitude of δm^2 and the leading oscillation amplitude with a precision of $\mathcal{O}$ (1%–2%). [Phys. Rev. D **62**, 013004 (2000)]

Four-neutrino oscillation solutions of the solar neutrino problem. C. Giunti, *INFN, Sez. di Torino, and Dip. di Fisica Teorica, Univ. di Torino, I–10125 Torino, Italy;* M. C. Gonzalez-Garcia and C. Peña-Garay, *Instituto de Física Corpuscular (IFIC) CSIC–Universidad de Valencia, Edificio Institutos de Paterna,Apartado 2085, 46071 Valencia, Spain.* (Received 12 January 2000; published 6 June 2000)

We present an analysis of the neutrino oscillation solutions of the solar neutrino problem in the framework of four-neutrino mixing where a sterile neutrino is added to the three standard ones. We perform a fit to the full data set corresponding to the 825-day Super-Kamiokande data sample as well as to chlorine, GALLEX, and

SAGE and Kamiokande experiments. In our analysis we use all measured total event rates as well as all Super-Kamiokande data on the zenith angle dependence and the recoil electron energy spectrum. We consider both transitions via the Mikheyev-Smirnov-Wolfenstein (MSW) mechanism as well as oscillations in vacuum (just-so) and find the allowed solutions for different values of the additional mixing angles. This framework permits transitions into active or sterile neutrinos controlled by the additional parameter $\cos^2(\vartheta_{23})\cos^2(\vartheta_{24})$ and contains as limiting cases the pure ν_e-active and ν_e-sterile neutrino oscillations. We discuss the maximum allowed values of this additional mixing parameter for the different solutions. As a particularity, we also show that for MSW transitions there are solutions at 99% C.L. at ϑ_{12} mixing angles greater than $\pi/4$ and that the best-fit point for the zenith angle distribution is in the second octant. [Phys. Rev. D **62**, 013005 (2000)]

Neutrino oscillation experiments and limits on lepton-number and lepton-flavor violating processes. Werner Rodejohann, *Lehrstuhl für Theoretische Physik III, Universität Dortmund, Otto–Hahn Strasse 4, 44221 Dortmund, Germany.* (Received 24 January 2000; published 9 June 2000)

Using a three neutrino framework we investigate bounds for the effective Majorana neutrino mass matrix. The mass measured in neutrinoless double beta decay is its (11) element. Lepton-number and -flavor violating processes sensitive to each element are considered and limits on branching ratios or cross sections are given. Those processes include $\mu^- e^+$ conversion, $K^+ \to \pi^- \mu^+ \mu^+$ or recently proposed high-energy scattering processes at DESY's HERA. Including all possible mass schemes, the three solar solutions and other allowed possibilities, there is a total of 80 mass matrices. The obtained indirect limits are up to 14 orders of magnitude more stringent than direct ones. It is investigated how neutrinoless double beta decay may judge between different mass and mixing schemes as well as solar solutions. Prospects for detecting processes depending on elements of the mass matrix are also discussed. [Phys. Rev. D **62**, 013011 (2000)]

New approach to background subtraction in low-energy neutrino experiments. Y.-F. Wang, L. Miller, and G. Gratta, *Physics Department, Stanford University, Stanford, California 94305.* (Received 18 February 2000; published 9 June 2000)

We discuss a new method to extract neutrino signals in low-energy experiments. In this scheme the symmetric nature of most backgrounds allows for direct cancellation from data. The application of this technique to the Palo Verde reactor neutrino oscillation experiment allows us to reduce the measurement errors on the antineutrino flux from $\sim 20\%$ to $\sim 10\%$. We expect this method to substantially improve the data quality in future low background experiments such as KamLAND and LENS. [Phys. Rev. D **62**, 013012 (2000)]

Generalized polarizabilities of the nucleon in chiral effective theories. Thomas R. Hemmert,[1] Barry R. Holstein,[1,2] Germar Knöchlein,[3] Dieter Drechsel,[3] [1]*Forschungszentrum Jülich, Institut für Kernphysik (Th), D-52425 Jülich, Germany* [2]*Department of Physics and Astronomy, University of Massachusetts, Amherst, Massachusetts 01003* [3]*Institut für Kernphysik, Johannes Gutenberg-Universität, D-55099 Mainz, Germany.* (Received 18 October 1999; published 30 May 2000)

Using the techniques of chiral effective field theories we evaluate the so called ''generalized polarizabilities,'' which characterize the structure dependent components in virtual Compton scattering off the nucleon as probed in the electron scattering reaction $eN \to e'N\gamma$. Results are given for both spin-dependent and spin-independent structure effects to $\mathcal{O}(p^3)$ in SU(2) heavy baryon chiral perturbation theory and to $\mathcal{O}(\epsilon^3)$ in the SU(2) ''small scale expansion.'' [Phys. Rev. D **62**, 014013 (2000)]

Spin dependence of massive lepton pair production in proton-proton collisions. Edmond L. Berger, *High Energy Physics Division, Argonne National Laboratory Argonne, Illinois 60439;* Lionel E. Gordon, *Jefferson Laboratory, Newport News, Virginia 23606 and Hampton University, Hampton, Virginia 23668;* Michael Klasen, *High Energy Physics Division, Argonne National Laboratory Argonne, Illinois 60439.* (Received 21 September 1999; published 30 May 2000)

We calculate the transverse momentum distribution for the production of massive lepton pairs in longitudinally polarized proton-proton reactions at collider energies within the context of perturbative quantum chromodynamics. For values of the transverse momentum Q_T greater than roughly half the pair mass Q, $Q_T > Q/2$, we show that the differential cross section is dominated by subprocesses initiated by incident gluons, provided that the polarized gluon density is not too small. Massive lepton-pair differential cross sections should be a good source of independent constraints on the polarized gluon density, free from the experimental and theoretical complications of photon isolation that beset studies of prompt photon production. We provide predictions for the spin-averaged and spin-dependent differential cross sections as a function of Q_T at energies relevant for the Relativistic Heavy Ion Collider at Brookhaven, and we compare these with predictions for real prompt photon production. [Phys. Rev. D **62**, 014014 (2000)]

Lambda polarization in polarized proton-proton collisions at BNL RHIC. C. Boros, *Department of Physics and Mathematical Physics, and Special Research Center for the Subatomic Structure of Matter, University of Adelaide, Adelaide 5005, Australia;* J. T. Londergan, *Department of Physics and Nuclear Theory Center, Indiana University, Bloomington, Indiana 47408;* A. W. Thomas, *Department of Physics and Mathematical Physics, and Special Research Center for the Subatomic Structure of Matter, University of Adelaide, Adelaide 5005, Australia.* (Received 8 February 2000; published 5 June 2000)

We discuss Λ polarization in inclusive proton-proton collisions, with one of the protons longitudinally polarized. The hyperfine interaction responsible for the Δ-N and Σ-Λ mass splittings gives rise to flavor asymmetric fragmentation functions and to sizable polarized non-strange fragmentation functions. We predict large positive Λ polarization in polarized inclusive proton-proton collisions at large rapidities of the produced Λ. The effect of Σ^0 and Σ^* decays

is also discussed. Forthcoming experiments at RHIC will be able to test our predictions. [Phys. Rev. D **62**, 014021 (2000)]

Mesonlike baryons and the spin-orbit puzzle. Nathan Isgur, *Jefferson Lab, 12000 Jefferson Avenue, Newport News, Virginia 23606.* (Received 8 October 1999; published 7 June 2000)

I describe a special class of mesonlike Λ_Q excited states and present evidence supporting the similarity of their spin-independent spectra to those of mesons. I then examine spin-dependent forces in these baryons, showing that the baryon spin-orbit puzzle is solved for them for the same reason spin-orbit forces are small for the analogous mesons: a fortuitous cancellation between large spin-orbit forces due to one-gluon exchange and equally large inverted spin-orbit forces due to Thomas precession in the confining potential. This solution provides a new perspective on spin-orbit forces in all baryons by showing that the three-body spin-orbit forces which were believed to be the origin of the baryon spin-orbit problem conspire in these states to become an essential part of this cancellation. [Phys. Rev. D **62**, 014025 (2000)]

Magnetic photon splitting: The *S*-matrix formulation in the Landau representation. Matthew G. Baring, *Laboratory for High Energy Astrophysics, Code 661, NASA Goddard Space Flight Center, Greenbelt, Maryland 20771.* (Received 7 October 1999; published 5 June 2000)

Calculations of reaction rates for the third-order QED process of photon splitting $\gamma \rightarrow \gamma\gamma$ in strong magnetic fields traditionally have employed either the effective Lagrangian method or variants of Schwinger's proper-time technique. Recently, Mentzel, Berg and Wunner presented an alternative derivation via an *S*-matrix formulation in the Landau representation. Advantages of such a formulation include the ability to compute rates near pair resonances above pair threshold. This paper presents new developments of the Landau representation formalism as applied to photon splitting, providing significant advances beyond the work of Mentzel, Berg, and Wunner by summing over the spin quantum numbers of the electron propagators, and analytically integrating over the component of momentum of the intermediate states that is parallel to the field. The ensuing tractable expressions for the scattering amplitudes are satisfyingly compact, and of an appearance familiar to *S*-matrix theory applications. Such developments can facilitate numerical computations of splitting considerably both below and above pair threshold. Specializations to two regimes of interest are obtained, namely the limit of highly supercritical fields and the domain where photon energies are far inferior to that for the threshold of single-photon pair creation. In particular, for the first time the low-frequency amplitudes are simply expressed in terms of the Γ function, its integral and its derivatives. In addition, the equivalence of the asymptotic forms in these two domains to extant results from effective Lagrangian or proper-time formulations is demonstrated. [Phys. Rev. D **62**, 016003 (2000)]

Maximal neutrino mixing from a minimal flavor symmetry. Alfredo Aranda and Christopher D. Carone, *Nuclear and Particle Theory Group, Department of Physics, College of William and Mary, Williamsburg, Virginia 23187-8795;* Richard F. Lebed, *Jefferson Lab, 12000 Jefferson Avenue, Newport News, Virginia 23606.* (Received 4 February 2000; published 12 June 2000)

We study a number of models, based on a non-Abelian discrete group, that successfully reproduce the simple and predictive Yukawa textures usually associated with U(2) theories of flavor. These models allow for solutions to the solar and atmospheric neutrino problems that do not require altering successful predictions for the charged fermions or introducing sterile neutrinos. Although Yukawa matrices are hierarchical in the models we consider, the mixing between second- and third-generation neutrinos is naturally large. We first present a quantitative analysis of a minimal model proposed in earlier work, consisting of a global fit to fermion masses and mixing angles, including the most important renormalization group effects. We then propose two new variant models: The first reproduces all important features of the $SU(5) \times U(2)$ unified theory with neither SU(5) nor U(2). The second demonstrates that discrete subgroups of SU(2) can be used in constructing viable supersymmetric theories of flavor without scalar universality even though SU(2) by itself cannot. [Phys. Rev. D **62**, 016009 (2000)]

Strange stars at finite magnetic field. Torun C. Phukon, *Department of Physics, Pandu College, Guwahati-781 012, India and Inter-University Centre for Astronomy and Astrophysics, Pune-4110 07, India.* (Received 14 September 1999; published 22 June 2000)

We study the properties of β-equilibrated electrically charged neutral quark-star matter at zero temperature and finite magnetic field, and derive the equation of state. The mass and radius of strange stars are constructed for absolutely stable three-flavor quark matter, where the energy per baryon number lies below the energy per baryon for ^{56}Fe. The effect of the magnetic field on the electrostatic potential of electrons inside and in close vicinity outside the quark surface of the star is studied. We find that the interior magnetic field $H \leqslant 10^{18}$ G does not change the mass and radius of the equilibrium star appreciably, but changes the interior structure of a star. Depending on the value of the crust potential and the electron chemical potential at the base of the nuclear crust, our studies show that the strong surface magnetic field $1.0 \times 10^{14} \leqslant H \leqslant 3.0 \times 10^{16}$ G leads to a considerable reduction of the electrostatic potential which is responsible for the tunneling of ions from the nuclear crust towards the quark surface. For those values of the magnetic fields, strange stars are unlikely to possess a thick nuclear crust. The magnetic field intensity lying outside this range does not have any effect on the crust mass. [Phys. Rev. D **62**, 023002 (2000)]