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.*

Strangelet spectra from type II supernovae. H. Vucetich, *Facultad de Ciencias Astronómicas e Geofísicas, Universidad Nacional de La Plata, Paseo del Bosque S/N, (1900) La Plata, Argentina;* J. E. Horvath, *Instituto Astronômico e Geofísico, Universidade de São Paulo, Avenida Miguel Stéfano 4200, Água Funda, 04301-904, São Paulo, Brasil.* (Received 5 September 1997; published 4 May 1998)

We study in this work the fate of strangelets injected as a contamination in the tail of a ''strange matter-driven'' supernova shock. A simple model for the fragmentation and braking of the strangelets, when they pass through the expanding oxygen shell is presented and solved to understand the reprocessing of this component. We find that the escaping spectrum is a scaled-down version of the one injected at the base of the oxygen shell. The supernova source is likely to produce low-energy particles of $A\sim 100-1000$ quite independently of the initial conditions. However, it is difficult that ultrarrelativistic strangelets (such as the hypothetical Centauro primaries) can have an origin in those explosive events.
[S0556-2821(98)00412-3] [Phys. Rev. D **57**, 5959 (1998)]

A depression before a bump in the highest energy cosmic ray spectrum. L. A. Anchordoqui, M. T. Dova, and L. N. Epele, *Departamento de Física, Universidad Nacional de La Plata, C.C. 67, (1900) La Plata, Argentina;* J. D. Swain, *Department of Physics, Northeastern University, Boston, Massachusetts 02115.* (Received 19 December 1997; published 18 May 1998)

We reexamine the interaction of ultrahigh energy nuclei with the microwave background radiation. We find that the giant dipole resonance leaves a new signature in the differential energy spectrum of iron sources located around 3 Mpc: A depression before a bump which is followed by the expected cutoff.
[S0556-2821(98)01812-8] [Phys. Rev. D **57**, 7103 (1998)]

Possible tomography of the Sun's magnetic field with solar neutrinos. João Pulido, *Centro de Física das Interacções Fundamentais, Instituto Superior Técnico, Av. Rovisco Pais, 1096 Lisboa Codex, Portugal.* (Received 1 December 1997; published 8 May 1998)

The data from solar neutrino experiments together with standard solar model predictions are used in order to derive the possible profile of the magnetic field inside the Sun, assuming the existence of a sizeable neutrino magnetic moment and the resonant spin flavor mechanism. The procedure is based on the relationship between resonance location and the energy-dependent neutrino suppression, so that a large neutrino suppression at a given energy is taken to be connected to a large magnetic field in a given region of the Sun. In this way it is found that the solar field must undergo a very sharp increase by a factor of at least 6–7 over a distance no longer than 7–10 % of the solar radius, decreasing gradually towards the surface. The range in which this sharp increase occurs is likely to be the bottom of the convective zone. There are also indications in favor of the downward slope being stronger at the start and more moderate on approaching the solar surface. Typical ranges for the magnetic moment are from a few times $10^{-13}\mu_B$ to its laboratory upper bounds while the mass square difference between neutrino flavours is $\Delta^2 m_{21}\simeq(0.6-1.9)\times 10^{-8}$ eV^2.
[S0556-2821(98)02712-X] [Phys. Rev. D **57**, 7108 (1998)]

Damping rate of plasmons and photons in a degenerate nonrelativistic plasma. M. A. Valle Basagoiti, *Departamento de Física Teórica, Universidad del País Vasco, Apartado 644, E-48080 Bilbao, Spain.* (Received 3 October 1997; published 8 May 1998)

A calculation is presented of the plasmon and photon damping rates in a dense nonrelativistic plasma at zero temperature, following the resummation program of Braaten and Pisarski. At small soft momentum k, the damping is dominated by $3\rightarrow 2$ scattering processes corresponding to double longitudinal Landau damping. The dampings are proportional to $(\alpha/v_F)^{3/2}\,k^2/m$, where v_F is the Fermi velocity. [S0556-2821(98)03212-3] [Phys. Rev. D **57**, 7618 (1998)]

Exact solutions for matter-enhanced neutrino oscillations. A. B. Balantekin, *Department of Physics, University of Wisconsin, Madison, Wisconsin 53706; Theory, University of Washington, Box 351550, Seattle, Washington 98195-1550; and Department of Astronomy, University of Washington, Box 351580, Seattle, Washington 98195-1580.* (Received 26 November 1997; published 5 May 1998)

The analogy between supersymmetric quantum mechanics and matter-enhanced neutrino oscillations is exploited to obtain exact solutions for a class of electron density profiles. This integrability condition is analogous to shape invariance in supersymmetric quantum mechanics. This method seems to be the most direct way to obtain the exact survival probabilities for a number of density profiles of interest, such as linear and exponential density profiles. The resulting neutrino amplitudes can also be utilized as comparison amplitudes for the uniform semiclassical treatment of neutrino propagation in arbitrary electron density profiles.
[S0556-2821(98)00613-4] [Phys. Rev. D **58**, 013001 (1998)]

Comparing and contrasting the $\nu_\mu\rightarrow\nu_\tau$ and $\nu_\mu\rightarrow\nu_s$ solutions to the atmospheric neutrino problem with SuperKamiokande data. R. Foot and R. R. Volkas, *School of Physics, Research Centre for High Energy Physics, The University of Melbourne, Parkville 3052, Australia;* O. Yasuda, *Department of Physics, Tokyo Metropolitan University, 1-1 Minami-Osawa Hachioji, Tokyo 192-03, Japan.* (Received 29 January 1998; published 19 May 1998)

The $\nu_\mu\rightarrow\nu_\tau$ and $\nu_\mu\rightarrow\nu_s$ solutions to the atmospheric neutrino problem are compared with SuperKamiokande data. The differences between these solutions due to matter effects in the Earth are

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calculated for the ratio of μ-like to e-like events and for up-down flux asymmetries. These quantities are chosen because they are relatively insensitive to theoretical uncertainties in the overall neutrino flux normalization and detection cross sections and efficiencies. A χ^2 analysis using these quantities is performed yielding 3σ ranges which are approximately given by (0.725–1.0, 4×10^{-4}–2×10^{-2} eV^2) and (0.74–1.0, 1×10^{-3}–2×10^{-2} eV^2) for ($\sin^2 2\theta,\Delta m^2$) for the $\nu_\mu\rightarrow\nu_\tau$ and $\nu_\mu\rightarrow\nu_s$ solutions, respectively. Values of Δm^2 smaller than about 2×10^{-3} eV^2 are disfavored for the $\nu_\mu\rightarrow\nu_s$ solution, suggesting that future long baseline experiments should see a positive signal if this scenario is the correct one. [S0556-2821(98)00913-8] [Phys. Rev. D **58**, 013006 (1998)]

Neutrino electron scattering and electroweak gauge structure: Future tests. O. G. Miranda, V. Semikoz, and José W. F. Valle, *Instituto de Física Corpuscular – C.S.I.C. Departament de Física Teòrica, Universitat de València 46100 Burjassot, València, Spain.* (Received 2 December 1997; published 20 May 1998)

Low-energy high-resolution neutrino-electron scattering experiments may play an important role in testing the gauge structure of the electroweak interaction. We propose the use of radioactive neutrino sources (e.g., ^{51}Cr) in underground experiments such as BOREXINO, HELLAZ, and LAMA. As an illustration, we display the sensitivity of these detectors in testing the possible existence of extra neutral gauge bosons, both in the framework of E_6 models and of models with left-right symmetry. [S0556-2821(98)01913-4] [Phys. Rev. D **58**, 013007 (1998)]

Neutrino interactions in hot and dense matter. Sanjay Reddy, Madappa Prakash, and James M. Lattimer, *Department of Physics & Astronomy, SUNY at Stony Brook, Stony Brook, New York 11794-3800.* (Received 10 October 1997; published 28 May 1998)

We study the charged and neutral current weak interaction rates relevant for the determination of neutrino opacities in dense matter found in supernovae and neutron stars. We establish an efficient formalism for calculating differential cross sections and mean free paths for interacting, asymmetric nuclear matter at arbitrary degeneracy. The formalism is valid for both charged and neutral current reactions. Strong interaction corrections are incorporated through the in-medium single particle energies at the relevant density and temperature. The effects of strong interactions on the weak interaction rates are investigated using both potential and effective field-theoretical models of matter. We investigate the relative importance of charged and neutral currents for different astrophysical situations, and also examine the influence of strangeness-bearing hyperons. Our findings show that the mean free paths are significantly altered by the effects of strong interactions and the multicomponent nature of dense matter. The opacities are then discussed in the context of the evolution of the core of a protoneutron star. [S0556-2821(98)02813-6] [Phys. Rev. D **58**, 013009 (1998)]

Supernova neutrinos in the light of flavor changing neutral currents. S. W. Mansour and T. K. Kuo, *Department of Physics, Purdue University, West Lafayette, Indiana 47907.* (Received 24 November 1997; published 5 June 1998)

We study the effect of including flavor changing neutral currents (FCNCs) in the analysis of the neutrino signal of a supernova burst. When we include the effect of the FCNCs which are beyond the standard model in the study of the MSW resonant conversion, we obtain dramatic changes in the $\Delta m^2-\sin^2 2\theta$ probability contours for neutrino detection. [S0556-2821(98)04313-6] [Phys. Rev. D **58**, 013012 (1998)]

Multiparticle production in small-x deep inelastic scattering and the nature of the Pomeron. A. Capella, A. Kaidalov, V. Neichitailo, and J. Tran Thanh Van, *Laboratoire de Physique Théorique et Hautes Energies, Université de Paris XI, Bâtiment 210, F-91405 Orsay Cedex, France.* (Received 15 December 1997; published 12 May 1998)

Properties of multiparticle final states produced in the central rapidity region of small-x deep inelastic scattering (DIS) are discussed. It is pointed out that these properties contain important information on the nature of the Pomeron—a Regge singularity used for the description of $\sigma^{(\mathrm{tot})}_{\gamma^* p}$ and of diffractive production in DIS. It is shown that models based on the universality of the Pomeron predict charged particle multiplicities in small-x DIS which are in good agreement with recent DESY HERA results. [S0556-2821(98)01113-8] [Phys. Rev. D **58**, 014002 (1998)]

Isospin-breaking effects in the extraction of isoscalar and isovector spectral functions from $e^+e^-\rightarrow$ hadrons. Kim Maltman, *Department of Mathematics and Statistics, York University, 4700 Keele Street, North York, Ontario, Canada M3J 1P3 and Special Research Center for the Subatomic Structure of Matter, University of Adelaide, Australia 5005.* (Received 16 October 1997; published 27 May 1998)

We investigate the problem of the extraction of the isovector and isoscalar spectral functions from data on $e^+e^-\rightarrow$ hadrons, in the presence of non-zero isospin breaking. It is shown that the conventional approach to extracting the isovector spectral function in the ρ resonance region, in which only the isoscalar contribution associated with $\omega\rightarrow\pi\pi$ is subtracted, fails to fully remove the effects of the isoscalar component of the electromagnetic current. The additional subtractions required to extract the pure isovector and isoscalar spectral functions are estimated using results from QCD sum rules. It is shown that the corrections are small ($\sim$2%) in the isovector case (though relevant to precision tests of the CVC hypothesis), but very large ($\sim$20%) in the case of the ω contribution to the isoscalar spectral function. The reason such a large effect is natural in the isoscalar channel is explained, and implications for other applications, such as the extraction of the sixth order chiral low-energy constant, Q, are discussed. [S0556-2821(98)02113-4] [Phys. Rev. D **58**, 014008 (1998)]

$1/N_c$ corrections to the hadronic matrix elements of Q_6 and Q_8 in $K\rightarrow\pi\pi$ decays. T. Hambye, G. O. Köhler, E. A. Paschos, and P. H. Soldan, *Institut für Physik, Universität Dortmund, D-44221 Dortmund, Germany;* W. A. Bardeen, *Fermilab, P.O. Box 500, Batavia, Illinois 60510.* (Received 13 February 1998; published 5 June 1998)

We calculate long-distance contributions to the amplitudes $A(K^0\rightarrow 2\pi,\ I)$ induced by the gluon and the electroweak penguin operators Q_6 and Q_8, respectively. We use the $1/N_c$ expansion within the effective chiral Lagrangian for pseudoscalar mesons. In

addition, we adopt a modified prescription for the identification of meson momenta in the chiral loop corrections in order to achieve a consistent matching to the short-distance part. Our approach leads to an explicit classification of the loop diagrams into nonfactorizable and factorizable, the scale dependence of the latter being absorbed in the low-energy coefficients of the effective theory. Along these lines we calculate the one-loop corrections to the $\mathcal{O}(p^0)$ term in the chiral expansion of both operators. In the numerical results, we obtain moderate corrections to $B_6^{(1/2)}$ and a substantial reduction of $B_8^{(3/2)}$. [S0556-2821(98)06013-5] [Phys. Rev. D **58**, 014017 (1998)]

The evolution of unpolarized singlet structure functions at small *x*. Johannes Blümlein, *DESY-Zeuthen, Platanenallee 6, D-15735 Zeuthen, Germany;* Andreas Vogt, *Institut für Theoretische Physik, Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany.* (Received 5 January 1998; published 10 June 1998)

A systematic study is performed of the impact of the various resummed small-x contributions to the anomalous dimensions and coefficient functions on the evolution of unpolarized structure functions in deep-inelastic scattering. The proton structure functions F_2^p and F_L^p as well as the photon structure function F_2^γ are considered together with the corresponding parton densities. The general analytic solution of the evolution equations in Mellin-N space is derived, and different approximate solutions are compared. Potential effects of less singular small-x terms in the anomalous dimension and coefficient functions are discussed. [S0556-2821(98)02413-8] [Phys. Rev. D **58**, 014020 (1998)]

Measurements of the rising photon-photon total cross section at the CERN LEP. M. M. Block, *Department of Physics, Northwestern University, Evanston, Illinois 60208;* E. M. Gregores and F. Halzen, *Department of Physics, University of Wisconsin, Madison, Wisconsin 53706;* G. Pancheri, *INFN—Laboratori Nazionali di Frascati, Frascati, Italy.* (Received 20 November 1997; published 4 June 1998)

Using vector meson dominance we calculate the $\gamma\gamma$ total cross section from data on pp, $p\overline{p}$ and γp total cross sections. Our result agrees with recent high energy measurements performed by the L3 experiment at the CERN LEP collider, not with the conflicting preliminary data obtained by OPAL. [S0556-2821(98)03813-2] [Phys. Rev. D **58**, 017503 (1998)]