

Selected Abstracts from Physical Review D

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Tests of electron flavor conservation with the Sudbury Neutrino Observatory. John N. Bahcall, *Institute for Advanced Study, Princeton, New Jersey 08540* Eligio Lisi *Institute for Advanced Study, Princeton, New Jersey 08540* and Istituto Nazionale di Fisica Nucleare, Sezione di Bari, Italy. (Received 17 May 1996)

We analyze tests of electron flavor conservation that can be performed at the Sudbury Neutrino Observatory (SNO). These tests, which utilize ^8B solar neutrinos interacting with deuterium, measure (1) the shape of the recoil electron spectrum in charged-current (CC) interactions (the CC spectrum shape), and (2) the ratio of the number of charged-current to neutral current (NC) events (the CC/NC ratio). We determine standard model predictions for the CC spectral shape and for the CC/NC ratio, together with realistic estimates of their errors and the correlations between errors. We consider systematic uncertainties in the standard neutrino spectrum and in the charged-current and neutral current cross sections, the SNO energy resolution and absolute energy scale, and the SNO detection efficiencies. Assuming that either matter-enhanced or vacuum neutrino oscillations solve the solar neutrino problems, we calculate the confidence levels with which electron flavor nonconservation can be detected using either the CC spectrum shape or the CC/NC ratio, or both. If the SNO detector works as expected, the neutrino oscillation solutions that best fit the results of the four operating solar neutrino experiments can be distinguished unambiguously from the standard predictions of electron flavor conservation. [S0556-2821(96)00221-4] [Phys. Rev. D **54**, 5417 (1996)]

Non-Abelian Weizsäcker-Williams field and a two-dimensional effective color charge density for a very large nucleus. Yuri V. Kovchegov, *Physics Department, Columbia University, New York, New York 10027*. (Received 30 May 1996)

We consider a very large ultrarelativistic nucleus. Assuming a simple model of the nucleus and weak coupling we find a classical solution for the gluon field of the nucleus and construct the two-dimensional color charge density for McLerran-Venugopalan model out of it. We prove that the density of states distribution, as a function of color charge density, is Gaussian, confirming the assumption made by McLerran and Venugopalan. [S0556-2821(96)01721-3] [Phys. Rev. D **54**, 5463 (1996)]

$\pi N\sigma$ term, $\overline{ss}$ in the nucleon, and the scalar form factor: A lattice study. S. J. Dong, J.-F. Lagae, and K. F. Liu, *Department of Physics and Astronomy, University of Kentucky, Lexington, Kentucky 40506*. (Received 2 July 1996)

We report on a lattice QCD calculation of the $\pi N\sigma$ term, the scalar form factor, and $\langle N|\overline{ss}|N\rangle$. The disconnected insertion part of $\sigma_{\pi N}$ is found to be 1.8 ± 0.1 times larger than the connected insertion contribution. The q^2 dependence of $\sigma_{\pi N}(q^2)$ is about the same

as $G_E(q^2)$ of the proton so that $\sigma_{\pi N}(2m_\pi^2) - \sigma_{\pi N}(0) = 6.6 \pm 0.6$ MeV. The ratio $y = \langle N|\overline{ss}|N\rangle / \langle N|\overline{uu} + \overline{dd}|N\rangle = 0.36 \pm 0.03$. Both results favor a $\sigma_{\pi N} \sim 53$ MeV, slightly larger than our direct calculation of $\sigma_{\pi N} = 49.7 \pm 2.6$ MeV. We also compute F_s and D_s and find that the agreement with those from the octet baryon mass splittings crucially depends on the inclusion of the large disconnected insertion. Finally, we give our result for the $KN\sigma$ term. [S0556-2821(96)04521-3] [Phys. Rev. D **54**, 5496 (1996)]

Nucleons at finite temperature. M. Kacir and I. Zahed, *Department of Physics, State University of New York at Stony Brook, Stony Brook, New York 11794-3800*. (Received 18 March 1996)

The nucleon mass shift is calculated using chiral counting arguments and a virial expansion, without and with the Δ . At all temperatures, the mass shift and damping rate are dominated by the Δ . Our results are compared with the empirical analysis of Leutwyler and Smilga, as well as results from heavy baryon chiral perturbation theory in the large N_c (number of color) limit. We show that unitarity implies that the concepts of thermal shifts are process dependent. [S0556-2821(96)03317-6] [Phys. Rev. D **54**, 5536 (1996)]

Color-octet contributions to J/ψ hadroproduction at fixed target energies. Sourendu Gupta and K. Sridhar, *Theory Group, Tata Institute of Fundamental Research, Homi Bhabha Road, Bombay 400005, India*. (Received 31 January 1996)

We investigate the integrated cross section for forward J/ψ production in proton-proton and pion-proton collisions at center-of-mass energies up to 60 GeV. We find that color-octet contributions to the cross section are crucially important, and their inclusion produces a very good description of the data. Since the values of non-perturbative matrix elements are fixed by other experiments, these predictions are parameter-free. [S0556-2821(96)01021-1] [Phys. Rev. D **54**, 5545 (1996)]

Z scaling in hadron-hadron collisions at high energies. I. Zborovský, *Nuclear Physics Institute, Academy of Sciences of the Czech Republic; Řež, Czech Republic*; Yu. A. Panebratsev, M. V. Tokarev, and G. P. Škoro, *Laboratory of High Energies, Joint Institute for Nuclear Research, 141980, Dubna, Moscow Region, Russia*. (Received 14 June 1996)

New scaling, z scaling, in the inclusive particle production (charged hadrons, $\pi^\pm$, $K^\pm$, γ) in pp or $p\bar{p}$ collisions is predicted. The scaling function $H(z)$ is expressed via the inclusive cross section of particle production $Ed^3\sigma/dq^3$ and the particle multiplicity density $dN/d\eta$ at pseudorapidity $\eta=0$. The dependence of $H(z)$

on the scaling variable $z = \sqrt{s_x}/[\Delta M \cdot dN(0)/d\eta]$, the center-of-mass energy $\sqrt{s}$, and the detection angle θ is investigated. The symmetry properties of the scaling function $H(z)$ are found. It is shown that for the secondary particle momenta $q > 0.4$ GeV/c, $H(z)$ is independent of $\sqrt{s}$ and θ in a wide kinematic range of particle production. The available experimental data confirm the universality of the $H(z)$ function. Some predictions for $H(z)$ concerning $\pi^\pm$, $K^\pm$, and γ using the HJING Monte Carlo code have been made. The obtained results can be of interest for future experiments at BNL RHIC and CERN LHC. [S0556-2821(96)05621-4] [Phys. Rev. D **54**, 5548 (1996)]

Composition of primary cosmic rays beyond the “knee” from emulsion chamber observations. C. G. S. Costa and F. Halzen *Department of Physics, University of Wisconsin, Madison, Wisconsin 53706*; J. Bellandi, *Instituto de Física Gleb Wataghin, UNICAMP, Campinas, São Paulo 13083-970, Brazil*; C. Salles, *Department of Materials Science and Engineering, University of Wisconsin, Madison, Wisconsin 53706*. (Received 23 February 1996)

We show that the simplest assumptions for the dynamics of particle production allow us to understand the fluxes of hadrons and photons at mountain altitudes as well as the structure of individual events. The analysis requires a heavy nuclear component of primary cosmic rays above the “knee” in the spectrum with an average mass number $\langle A \rangle = 7.3 \pm 0.9$. [S0556-2821(96)05221-6] [Phys. Rev. D **54**, 5558 (1996)]

Comparison of atmospheric neutrino flux calculations at low energies. T. K. Gaisser,¹ M. Honda,² K. Kasahara,³ H. Lee,⁴ S. Midorikawa,⁵ V. Naumov,⁶ and Todor Stanev¹, ¹*Bartol Research Institute, University of Delaware, Newark, Delaware 19716* ²*Institute for Cosmic Ray Research, University of Tokyo, Tanashi, Tokyo 188, Japan* ³*Faculty of Engineering, Kanagawa University, Yokohama 221, Japan* ⁴*Department of Physics, Chungnam National University, Daejeon 305-764, Korea* ⁵*Faculty of Engineering, Aomori University, Aomori 030, Japan* ⁶*Instituto Nazionale de Fisica Nucleare, Sezione di Firenze, Firenze I-50125, Italy*. (Received 28 May 1996)

We compare several different calculations of the atmospheric neutrino flux in the energy range relevant for contained neutrino interactions, and we identify the major sources of difference among the calculations. We find nothing that would affect the predicted ratio of ν_e/ν_μ , which is nearly the same in all calculations. Significant differences in normalization arise primarily from different treatments of pion production by interactions of protons in the atmosphere. Different assumptions about the primary spectrum and treatments of the geomagnetic field are also of some importance. [S0556-2821(96)04621-8] [Phys. Rev. D **54**, 5578 (1996)]

Radiative seesaw mechanism at the weak scale. Zhijian Tao, *Theory Division, Institute of High Energy Physics, Academia Sinica, Beijing 100039, China*. (Received 2 May 1996)

We investigate an alternative seesaw mechanism for neutrino mass generation. The neutrino mass is generated at the loop level but the basic concept of the usual seesaw mechanism is kept. One simple model is constructed to show how this mechanism is realized. The applications of this seesaw mechanism at weak scale to cosmology and neutrino physics are discussed. [S0556-2821(96)02521-0] [Phys. Rev. D **54**, 5693 (1996)]

Lattice computations of small- x parton distributions in a model of parton densities in very large nuclei. Rajiv V. Gavai, *Theoretical Physics Institute, University of Minnesota, Minneapolis, Minnesota 55455*; Raju Venugopalan, *Institute for Nuclear Theory, University of Washington, Seattle, Washington 98195-1550*. (Received 16 May 1996)

Using weak coupling methods McLerran and Venugopalan expressed the parton distributions in large nuclei as correlation functions of a two-dimensional Euclidean field theory. The theory has the dimensionful coupling $g^2\mu$, where $\mu^2 \sim A^{1/3}$ is the valence quark color charge squared per unit area. We use a lattice regularization to investigate these correlation functions both analytically and numerically for the simplified case of SU(2) gauge theory. In weak coupling ($g^2\mu L \ll 5$), where L is the transverse size of the nucleus, the numerical results agree with the *analytic* lattice weak coupling results. For $g^2\mu L \gg 5$, no solutions exist at $O(a^4)$ where a is the lattice spacing. This suggests an ill-defined infrared behavior for the two-dimensional theory. A recent proposal of Jalilian-Marian, Kovner, McLerran, and Weigert for an *analytic* solution of the classical problem is discussed briefly. [S0556-2821(96)01221-0] [Phys. Rev. D **54**, 5795 (1996)]

Heavy quark solitons in the Nambu–Jona-Lasinio model. L. Gamberg, H. Weigel, U. Zückert, and H. Reinhardt, *Institute for Theoretical Physics, Tübingen University, Auf der Morgenstelle 14, D-72076 Tübingen, Germany*. (Received 24 April 1996)

The Nambu–Jona-Lasinio (NJL) model is extended to incorporate heavy quark spin symmetry. In this model baryons containing one heavy quark are analyzed as bound states of light baryons, represented as chiral solitons, and mesons containing one heavy quark. From related studies in Skyrme-type models, the ground-state heavy baryon is known to arise for the heavy meson in a P -wave configuration. In the limit of an infinitely large quark mass the heavy meson wave function is sharply peaked at the center of the chiral soliton. Therefore, the bound state equation reduces to an eigenvalue problem for the coefficients of the operators contained in the most general P -wave ansatz for the heavy meson. Within the NJL model a novel feature arises from the coupling of the heavy meson to the various light quark states. In this respect conceptual differences to Skyrme-model calculations are discovered: The strongest bound state is given by a heavy meson configuration, which is completely decoupled from the grand spin zero channel of the light quarks. [S0556-2821(96)03521-7] [Phys. Rev. D **54**, 5812 (1996)]