

## Selected Abstracts from Other Physical Review Journals

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**String spreading on a black hole horizon.** A. L. Larsen, *Physics Department, University of Odense, Campusvej 55, 5230 Odense M, Denmark*; A. Nicolaidis, *Theoretical Physics Department, University of Thessaloniki, 54006 Thessaloniki, Greece*. (Received 17 December 1998; published 14 June 1999)

The phenomenon of string spreading on the black hole horizon, as originally discussed by Susskind, is considered in the *exact* curved Schwarzschild background. We consider an oscillating macroscopic string encircling the black hole and contracting towards the horizon. We then compute the angular and radial spreading of the string, as seen by a static observer at spatial infinity using fixed finite resolution time. Within our case study we find that there is indeed a spreading of the string in the angular direction, such that the string eventually covers the whole horizon. However, regarding the radial direction, we find that Lorentz-contraction suppresses the radial string spreading. [S0556-2821(99)03414-1] [*Phys. Rev. D* **60**, 024012 (1999)]

**$U(2)$  and maximal mixing of  $\nu_\mu$ .** Lawrence J. Hall and Neal Weiner, *Department of Physics, University of California, Berkeley, California 94720 and Theoretical Physics Group, Ernest Orlando Lawrence Berkeley National Laboratory, University of California, Berkeley, California 94720*. (Received 20 November 1998; published 29 June 1999)

A  $U(2)$  flavor symmetry can successfully describe charged fermion masses and mixings, and suppress SUSY FCNC processes, making it a viable candidate for a theory of flavor. We show that a direct application of this  $U(2)$  flavor symmetry automatically predicts a mixing of  $45^\circ$  for  $\nu_\mu \Rightarrow \nu_s$ , where  $\nu_s$  is a light, right-handed state. The introduction of an additional flavor symmetry acting on the right-handed neutrinos makes the model phenomenologically viable, explaining the solar neutrino deficit as well as the atmospheric neutrino anomaly, while giving a potential hot dark matter candidate and retaining the theory's predictivity in the quark sector. [S0556-2821(99)04509-9] [*Phys. Rev. D* **60**, 033005 (1999)]

**Bounds and implications of neutrino magnetic moments from atmospheric neutrino data.** Sin Kyu Kang, *School of Physics, Korea Institute for Advanced Study, Seoul 130-012, Korea*; Jihn E. Kim, *School of Physics, Korea Institute for Advanced Study, Seoul 130-012, Korea and Department of Physics and Center for Theoretical Physics, Seoul National University, Seoul 151-742, Korea*; Jae Sik Lee, *School of Physics, Korea Institute for Advanced Study, Seoul 130-012, Korea*. (Received 11 January 1999; published 8 July 1999)

The neutral current effects of the future high statistics atmospheric neutrino data can be used to distinguish the mechanisms between a  $\nu_\mu$  oscillation to a tau neutrino or to a sterile neutrino. However, if neutrinos possess large diagonal and/or transition magnetic moments, the neutrino magnetic moments can contribute to the neutral current effects which can be studied by the single  $\pi^0$  production events in the Super-K data. This effect should be included in the future analyses of atmospheric data in the determination of  $\nu_\mu$  to tau or sterile neutrino oscillation. [S0556-2821(99)01215-1] [*Phys. Rev. D* **60**, 033008 (1999)]

**Small- $x$   $F_2$  structure function of a nucleus including multiple Pomeron exchanges.** Yuri V. Kovchegov, *School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455*. (Received 13 January 1999; published 25 June 1999)

We derive an equation determining the small- $x$  evolution of the  $F_2$  structure function of a large nucleus which includes all multiple Pomeron exchanges in the leading logarithmic approximation using Mueller's dipole model. We show that in the double leading logarithmic limit this evolution equation reduces to the Gribov-Levin-Ryskin equation. [S0556-2821(99)04013-8] [*Phys. Rev. D* **60**, 034008 (1999)]

**Propagation of gluons from a nonperturbative evolution equation in axial gauges.** Klaus Geiger, *Physics Department, Brookhaven National Laboratory, Upton, New York 11973*. (Received 10 February 1999; published 2 July 1999)

We derive a nonperturbative evolution equation for the gluon propagator in axial gauges based on the framework of Wetterich's formulation of the exact renormalization group. We obtain asymptotic solutions to this equation in the ultraviolet and infrared limits. [S0556-2821(99)06113-5] [*Phys. Rev. D* **60**, 034012 (1999)]

**Nucleon magnetic moments beyond the perturbative chiral regime.** Derek B. Leinweber, Ding H. Lu, and Anthony W. Thomas, *Department of Physics and Mathematical Physics and Special Research Centre for the Subatomic Structure of Matter, University of Adelaide, Australia 5005*. (Received 7 October 1998; revised manuscript received 8 March 1999; published 7 July 1999)

The quark mass dependence of nucleon magnetic moments is explored over a wide range. Quark masses currently accessible to lattice QCD, which lie beyond the regime of chiral perturbation theory ( $\chi$ PT), are accessed via the cloudy bag model (CBM). The latter reproduces the leading nonanalytic behavior of  $\chi$ PT, while modeling the internal structure of the hadron under investigation. We find that the predictions of the CBM are succinctly described by the simple formula  $\mu_N(m_\pi) = \mu_N^{(0)}/(1 + \alpha m_\pi + \beta m_\pi^2)$ , which reproduces the lattice data, as well as the leading nonanalytic behavior of  $\chi$ PT. As this form also incorporates the anticipated Dirac moment behavior in the limit  $m_\pi \rightarrow \infty$ , it constitutes a powerful method for extrapolating lattice results to the physical mass regime. [S0556-2821(99)02415-7] [Phys. Rev. D **60**, 034014 (1999)]

**Survey of heavy-meson observables.** M. A. Ivanov, *Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research, 141980 Dubna, Russia*; Yu. L. Kalinovsky, *Laboratory of Computing Techniques and Automation, Joint Institute for Nuclear Research, 141980 Dubna, Russia*; C. D. Roberts, *Physics Division, Building 203, Argonne National Laboratory, Argonne, Illinois 60439-4843*. (Received 23 December 1998; published 7 July 1999)

We employ a Dyson-Schwinger equation model to effect a unified and uniformly accurate description of light- and heavy-meson observables, which we characterize by heavy-meson leptonic decays, semileptonic heavy-to-heavy and heavy-to-light transitions,  $B \rightarrow D^*$ ,  $D$ ,  $\rho$ ,  $\pi$ ;  $D \rightarrow K^*$ ,  $K$ ,  $\pi$ , radiative and strong decays,  $B_{(s)}^* \rightarrow B_{(s)} \gamma$ ;  $D_{(s)}^* \rightarrow D_{(s)} \gamma$ ,  $D\pi$ , and the rare  $B \rightarrow K^* \gamma$  flavor-changing neutral-current process. We elucidate the heavy-quark limit of these processes and, using a model-independent mass formula valid for all nonsinglet pseudoscalar mesons, demonstrate that their mass rises linearly with the mass of their heaviest constituent. In our numerical calculations we eschew a heavy-quark expansion and rely instead on the observation that the dressed  $c, b$ -quark mass functions are well approximated by a constant, interpreted as their constituent mass: we find  $\hat{M}_c = 1.32$  GeV and  $\hat{M}_b = 4.65$  GeV. The calculated heavy-meson leptonic decay constants and transition form factors are a necessary element in the experimental determination of CKM matrix elements. The results also show that this framework, as employed hitherto, is able to describe vector meson polarization observables well. [S0556-2821(99)08013-3] [Phys. Rev. D **60**, 034018 (1999)]

**Four light neutrinos in the singular seesaw mechanism with Abelian flavor symmetry.** Chun Liu, *Korea Institute for Advanced Study, 207-43 Chungryangri-dong, Dongdaemun-ku, Seoul 130-012, Korea*; Jeonghyeon Song, *Center for Theoretical Physics, Seoul National University, Seoul 151-742, Korea*. (Received 7 April 1999; published 12 July 1999)

The four light neutrino scenario, which explains the atmosphere, solar and LSND neutrino experiments, is studied in the framework of the seesaw mechanism. By taking both the Dirac and Majorana mass matrices of neutrinos to be singular, the four neutrino mass spectrum consisting of two almost degenerate pairs separated by a

mass gap  $\sim 1$  eV is naturally generated. Moreover, the right-handed neutrino Majorana mass can be at the  $\sim 10^{14}$  GeV scale unlike in the usual singular seesaw mechanism. Abelian flavor symmetry is used to produce the required neutrino mass pattern. A specific example of the flavor charge assignment is provided to show that maximal mixings between the  $\nu_\mu - \nu_\tau$  and  $\nu_e - \nu_s$  are respectively attributed to the atmosphere and solar neutrino anomalies while small mixing between two pairs to the LSND results. The implications to the other fermion masses are also discussed. [S0556-2821(99)06015-4] [Phys. Rev. D **60**, 036002 (1999)]

**Constraints on the variation of the fine structure constant from big bang nucleosynthesis.** L. Bergström, S. Iğuri, and H. Rubinstein, *Department of Physics, Stockholm University, Box 6730, S-113 85 Stockholm, Sweden*. (Received 10 February 1999; published 13 July 1999)

We put bounds on the variation of the value of the fine structure constant  $\alpha$ , at the time of big bang nucleosynthesis. We study carefully all light elements up to  ${}^7\text{Li}$ . We correct a previous upper limit on  $|\Delta\alpha/\alpha|$  estimated from  ${}^4\text{He}$  primordial abundance and we find interesting new potential limits (depending on the value of the baryon-to-photon ratio) from  ${}^7\text{Li}$ , whose production is governed to a large extent by Coulomb barriers. The presently unclear observational situation concerning the primordial abundances precludes a better limit than  $|\Delta\alpha/\alpha| \lesssim 2 \times 10^{-2}$ , two orders of magnitude less restrictive than previous bounds. In fact, each of the (mutually exclusive) scenarios of standard big bang nucleosynthesis proposed, one based on a high value of the measured deuterium primordial abundance and one based on a low value, may describe some aspects of data better if a change in  $\alpha$  of this magnitude is assumed. [S0556-2821(99)04414-8] [Phys. Rev. D **60**, 045005 (1999)]

**Balloon measurements of cosmic ray muon spectra in the atmosphere along with those of primary protons and helium nuclei over midlatitude.** R. Bellotti, F. Cafagna, M. Circella, and C. N. De Marzo, *Dipartimento di Fisica dell'Università di Bari and INFN-Sezione di Bari, Via Amendola 173, I-70126 Bari, Italy*; R. L. Golden and S. J. Stochaj, *Particle Astrophysics Laboratory, New Mexico State University, Las Cruces, New Mexico 88003*; M. P. De Pascale, A. Morselli, and P. Picozza, *Dipartimento di Fisica dell'Università di Roma "Tor Vergata" and INFN-Sezione di Roma II, Via Carnevale 15, I-00173 Rome, Italy*; S. A. Stephens, *Tata Institute of Fundamental Research, Bombay 400 005, India*; M. Hof, W. Menn, and M. Simon, *Universität Siegen, D-57068 Siegen, Germany*; J. W. Mitchell, J. F. Ormes, and R. E. Streitmatter, *NASA Goddard Space Flight Center, Greenbelt, Maryland 20771*; N. Finetti, C. Grimani, P. Papini, S. Piccardi, and P. Spillantini, *Dipartimento di Fisica dell'Università di Firenze and INFN-Sezione di Firenze, Largo Enrico Fermi 2, I-50125 Florence, Italy*; G. Basini and M. Ricci, *INFN Laboratori Nazionali di Frascati, Via Enrico Fermi 40, I-00044 Frascati, Italy*. (Received 30 November 1998; published 14 July 1999)

We report here the measurements of the energy spectra of atmospheric muons and of the parent cosmic ray primary proton and helium nuclei in a single experiment. These were carried out using the MASS superconducting spectrometer in a balloon flight experiment in 1991. The relevance of these results to the atmospheric neutrino anomaly is emphasized. In particular, this approach allows uncertainties caused by the level of solar modulation, the geomagnetic cut-off of the primaries and possible experimental systematics, to be decoupled in the comparison of calculated fluxes of muons to measured muon fluxes. The muon observations cover the momentum and depth ranges of 0.3–40 GeV/c and 5–886 g/cm<sup>2</sup>, respectively. A comparison of these results with those obtained in a previous experiment by the same collaboration using a similar apparatus allows us to search for differences due to the different experimental conditions at low energy and to check for the overall normalization between the two measurements. The proton and helium primary measurements cover the rigidity range from 3 to 100 GV, in which both the solar modulation and the geomagnetic cut-off affect the energy spectra at low energies. From the observed low-energy helium spectrum, the geomagnetic transmission function at mid-latitude has been determined.  
[S0556-2821(99)07513-X] [Phys. Rev. D **60**, 052002 (1999)]

**New variables for neutrino oscillation diagnostics at SuperKamiokande and the Sudbury Neutrino Observatory.** Debasish Majumdar and Amitava Raychaudhuri, *Department of Physics, University of Calcutta, 92 Acharya Prafulla Chandra Road, Calcutta 700 009, India.* (Received 25 January 1999; published 23 July 1999)

The SuperKamiokande Collaboration has presented results on the observation of solar neutrinos. The Sudbury Neutrino Observatory (SNO) is also expected to go on-line in the near future. We propose several new variables, insensitive to the absolute flux of the initial

solar neutrino beam, which probe the shape of the observed spectrum at these experiments and can sensitively signal neutrino oscillations. One class of such variables involves normalized moments of the distributions recorded at the two facilities while another variable, specific to SNO, depends on the integrated charged and neutral current signals. The utility of these variables in the context of supernova neutrinos, both from the collapse epoch and the post-bounce era, is also emphasized. It is shown that, notwithstanding the imprecise nature of the information about the initial neutrino spectra from a supernova, oscillations can be detected using these variables and it will be possible to distinguish between the alternatives of oscillation to a sequential neutrino *vis-à-vis* that to a sterile neutrino. [S0556-2821(99)06013-0] [Phys. Rev. D **60**, 053001 (1999)]

**Gluon field of a fast moving nucleus and the effective Lagrangian for QCD at high energy.** Ph. Hägler,<sup>1</sup> R. Kirschner,<sup>2</sup> A. Schäfer,<sup>1</sup> L. Szymanowski,<sup>1</sup> <sup>1</sup>*Institut für Theoretische Physik, Universität Regensburg, D-93040 Regensburg, Germany* <sup>2</sup>*Institut für Theoretische Physik, Universität Leipzig, D-04109 Leipzig, Germany.* (Received 26 February 1999; published 23 July 1999)

Starting from the effective Lagrangian for QCD at high energy we calculate the lowest perturbative contributions to the potential of a relativistic nucleus and compare our results to those derived by Kovchegov [see Y.V. Kovchegov, Phys. Rev. D **55**, 5445 (1997)]. The results differ already at order  $g^3$  which can be traced to the fact that the meaning of the underlying gluon fields is different. (The effective gluon field we use is a gauge-invariant object.) Both approaches should therefore be seen as alternatives, the relative merits of which have to be judged by their phenomenological success. [S0556-2821(99)01715-4] [Phys. Rev. D **60**, 054006 (1999)]