Selected Abstracts from Other Physical Review Journals

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Precise measurement of the solar neutrino day-night and seasonal variation in Super-Kamiokande-I. M. B. Smy,[5] Y. Ashie,[1] S. Fukuda,[1] Y. Fukuda,[1] K. Ishihara,[1] Y. Itow,[1] Y. Koshio,[1] A. Minamino,[1] M. Miura,[1] S. Moriyama,[1] M. Nakahata,[1] T. Namba,[1] R. Nambu,[1] Y. Obayashi,[1] N. Sakurai,[1] M. Shiozawa,[1] Y. Suzuki,[1] H. Takeuchi,[1] Y. Takeuchi,[1] S. Yamada,[1] M. Ishitsuka,[2] T. Kajita,[2] K. Kaneyuki,[2] S. Nakayama,[2] A. Okada,[2] T. Ooyabu,[2] C. Saji,[2] S. Desai,[3] M. Earl,[3] E. Kearns,[3] M. D. Messier,[3] J. L. Stone,[3] L. R. Sulak,[3] C. W. Walter,[3] W. Wang,[3] M. Goldhaber,[4] T. Barszczak,[5] D. Casper,[5] W. Gajewski,[5] W. R. Kropp,[5] S. Mine,[5] D. W. Liu,[5] H. W. Sobel,[5] M. R. Vagins,[5] A. Gago,[6] K. S. Ganezer,[6] J. Hill,[6] W. E. Keig,[6] J. Y. Kim,[7] I. T. Lim,[7] R. W. Ellsworth,[8] S. Tasaka,[9] A. Kibayashi,[10] J. G. Learned,[10] S. Matsuno,[10] D. Takemori,[10] Y. Hayato,[11] A. K. Ichikawa,[11] T. Ishii,[11] J. 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The time variation of the elastic scattering rate of solar neutrinos with electrons in Super-Kamiokande-I was fit to the variations expected from active two-neutrino oscillations. The best fit in the large mixing angle solution has a mixing angle of $\tan^2\theta = 0.55$ and a mass squared difference of $\Delta m^2 = 6.3 \times 10^{-5}$ eV^2 between the two neutrino mass eigenstates. The fitted day-night asymmetry of $-1.8 \pm 1.6(\text{stat})^{+1.3}_{-1.2}(\text{syst})\%$ has improved statistical precision over previous measurements and agrees well with the expected asymmetry of -2.1%. [Phys. Rev. D **69**, 011104 (2004)]

$\Theta^+(1540)$ as a heptaquark with the overlap of a pion, a kaon, and a nucleon. P. Bicudo and G. M. Marques, *Dep. Física and CFIF, Instituto Superior Técnico, Av. Rovisco Pais, 1049-001 Lisboa, Portugal.* (Received 6 August 2003; revised manuscript received 17 November 2003; published 29 January 2004)

We study the very recently discovered $\Theta^+(1540)$ at SPring-8, at ITEP and at CLAS-Thomas Jefferson Lab. We apply the same RGM techniques that already explained with success the repulsive hard core of nucleon-nucleon, kaon-nucleon exotic scattering, and the attractive hard core present in pion-nucleon and pion-pion non-exotic scattering. We find that the $K-N$ repulsion excludes the Θ^+ as a $K-N$ s-wave pentaquark. We explore the Θ^+ as a heptaquark, equivalent to a $N+\pi+K$ Borromean bound state, with positive parity and total isospin $I=0$. We find that the kaon-nucleon repul-

sion is canceled by the attraction existing both in the pion-nucleon and pion-kaon channels. Although we are not yet able to bind the total three body system, we find that the Θ^+ may still be a heptaquark state. We conclude with predictions that can be tested experimentally. [Phys. Rev. D **69**, 011503 (2004)]

Anomalous specific heat in high-density QED and QCD. A. Ipp, A. Gerhold, and A. Rebhan, *Institut für Theoretische Physik, Technische Universität Wien, Wiedner Haupstr. 8-10, A-1040 Vienna, Austria.* (Received 9 September 2003; published 21 January 2004)

Long-range quasistatic gauge-boson interactions lead to anomalous (non-Fermi-liquid) behavior of the specific heat in the low-temperature limit of an electron or quark gas with a leading $T \ln T^{-1}$ term. We obtain perturbative results beyond the leading log approximation and find that dynamical screening gives rise to a low-temperature series involving also anomalous fractional powers $T^{(3+2n)/3}$. We determine their coefficients in perturbation theory up to and including order $T^{7/3}$ and compare with exact numerical results obtained in the large-N_f limit of QED and QCD. [Phys. Rev. D **69**, 011901 (2004)]

Antineutrinos from Earth: A reference model and its uncertainties. Fabio Mantovani,[1,2,3] Luigi Carmignani,[1,2] Gianni Fiorentini,[4,3] and Marcello Lissia[5,6] [1]*Dipartimento di Scienze della Terra, Università di Siena, I-53100 Siena, Italy,* [2]*Centro di GeoTecnologie CGT, I-52027 San Giovanni Valdarno, Italy,* [3]*Istituto Nazionale di Fisica Nucleare, Sezione di Ferrara, I-44100 Ferrara, Italy,* [4]*Dipartimento di Fisica, Università di Ferrara, I-44100 Ferrara, Italy,* [5]*Istituto Nazionale di Fisica Nucleare, Sezione di Cagliari, I-09042 Monserrato (CA), Italy,* [6]*Dipartimento di Fisica, Università di Cagliari, I-09042 Monserrato (CA), Italy.* (Received 12 September 2003; published 7 January 2004)

We predict geoneutrino fluxes in a reference model based on a detailed description of Earth's crust and mantle and using the best available information on the abundances of uranium, thorium, and potassium inside Earth's layers. We estimate the uncertainties of fluxes corresponding to the uncertainties of the element abundances. In addition to distance integrated fluxes, we also provide the differential fluxes as a function of distance from several sites of experimental interest. Event yields at several locations are estimated and their dependence on the neutrino oscillation parameters is discussed. At Kamioka we predict $N(\mathrm{U+Th})=35\pm6$ events for 10^{32} proton yr and 100% efficiency assuming $\sin^2(2\theta)=0.863$ and $\delta m^2=7.3\times10^{-5}$ eV^2. The maximal prediction is 55 events, obtained in a model with fully radiogenic production of the terrestrial heat flow. [Phys. Rev. D **69**, 013001 (2004)]

Extrinsic *CPT* violation in neutrino oscillations in matter. Magnus Jacobson and Tommy Ohlsson, *Division of Mathematical Physics, Department of Physics, Royal Institute of Technology (KTH) – Stockholm Center for Physics, Astronomy, and Biotechnology (SCFAB), Roslagstullsbacken 11, SE-106 91 Stockholm, Sweden.* (Received 18 September 2003; published 15 January 2004)

We investigate matter-induced (or extrinsic) *CPT* violation effects in neutrino oscillations in matter. Especially, we present approximate analytical formulas for the *CPT*-violating probability differences for three flavor neutrino oscillations in matter with an arbitrary matter density profile. Note that we assume that the *CPT* invariance theorem holds, which means that the *CPT* violation effects arise entirely because of the presence of matter. As special cases of matter density profiles, we consider constant and step-function matter density profiles, which are relevant for neutrino oscillation physics in accelerator and reactor long baseline experiments as well as neutrino factories. Finally, the implications of extrinsic *CPT* violation on neutrino oscillations in matter for several past, present, and future long baseline experiments are estimated. [Phys. Rev. D **69**, 013003 (2004)]

Neutrino mass parameters from Kamland, SNO, and other solar evidence. P. Aliani,[1,2] V. Antonelli,[1] M. Picariello,[1] and E. Torrente-Lujan[3] [1]*Dip. di Fisica, Univ. di Milano, and INFN Sez. Milano, Via Celoria 16, Milano, Italy,* [2]*Dept. Theoretical Physics, Univ. Libre de Bruxelles, Bruxelles, Belgium,* [3]*Dept. Fisica Teorica C-XI, Univ. Autonoma de Madrid, 28049 Madrid, Spain.* (Received 12 March 2003; published 27 January 2004)

An updated analysis of all available neutrino oscillation evidence in reactor (Kamland, first 145 days of data) and solar experiments (SK day and night spectra, global rates from Homestake, SAGE, and GALLEX) including the SNOCC and NC data is presented. In the framework of two active neutrino oscillations we determine the allowed regions in neutrino parameter space; we obtain, from the Kamland spectral shape and global signal, the following antineutrino best solution parameters: $\Delta m^2_{kl}=7.7\times10^{-5}$ eV^2, $\tan^2\theta_{kl}=0.98$. The overall effect of the measured observed ratio $R\sim0.6$ is that the large mixing angle (LMA) region remains the only one that is still favored. Combining Kamland and solar data and assuming *CPT* invariance, i.e., the same mass matrix for neutrinos and antineutrinos, we obtain the following antineutrino best solution parameters (LMAI solution): $\Delta m^2=7.1\times10^{-5}$ eV^2, $\tan^2\theta=0.47$. A second solution (LMAII) appears for values $\Delta m^2=1.5\times10^{-4}$ eV^2, $\tan^2\theta=0.48$. We determine additionally individual neutrino mixing parameters and their errors from fits to marginal likelihood distributions; the values are compatible with previous results. In both methods, χ^2 minimization and marginal likelihood, the combined analysis of solar and Kamland data concludes that maximal mixing is not favored at the $\sim3\sigma$ level at least. [Phys. Rev. D **69**, 013005 (2004)]

Implications of generalized Frampton-Glashow-Yanagida *Ansätze* on neutrino masses and lepton flavor mixing. Zhi-zhong Xing, *CCAST (World Laboratory), P.O. Box 8730, Beijing 100080, China, and Institute of High Energy Physics, Chinese Academy of Sciences, P.O. Box 918 (4), Beijing 100039, China.* (Received 22 September 2003; published 28 January 2004)

In the most minimal seesaw model with two heavy right-handed neutrinos, we generalize the Frampton-Glashow-Yanagida *Ansatz* for the 3×2 Dirac neutrino mass matrix and show that the determinant of the 3×3 light Majorana neutrino mass matrix M always

vanishes. Parametrizing M in terms of three neutrino masses, three lepton mixing angles, and three CP-violating phases, we examine all its possible one-zero textures with one vanishing mass eigenvalue. We find that three one-zero patterns of M with $m_1=0$ and four one-zero patterns of M with $m_3=0$ are compatible with current neutrino oscillation data. The implications of these phenomenological *Ansätze* on the neutrino mass spectrum and the neutrinoless double beta decay are also discussed. [Phys. Rev. D **69**, 013006 (2004)]

Kinematically complete analysis of the CLAS data on the proton structure function F_2 in a Regge-dual model. R. Fiore,[1] A. Flachi,[2] L. L. Jenkovszky,[3] A. I. Lengyel,[4] and V. K. Magas[3,5]
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The recently measured inclusive electron-proton cross section in the nucleon resonance region, performed with the CLAS detector at the Thomas Jefferson Laboratory, has provided new data for the nucleon structure function F_2 with previously unavailable precision. In this paper we propose a description of these experimental data based on a Regge-dual model for F_2. The basic inputs in the model are nonlinear complex Regge trajectories producing both isobar resonances and a smooth background. The model is tested against the experimental data, and the Q^2 dependence of the moments is calculated. The fitted model for the structure function (inclusive cross section) is a limiting case of the more general scattering amplitude equally applicable to deeply virtual Compton scattering. The connection between the two is discussed. [Phys. Rev. D **69**, 014004 (2004)]

High density effective theory confronts the Fermi liquid. Simon Hands, *Department of Physics, University of Wales Swansea, Singleton Park, Swansea SA2 8PP, United Kingdom.* (Received 7 October 2003; published 30 January 2004)

The high density effective theory recently introduced by Hong and Hsu to describe ultradense relativistic fermionic matter is used to calculate the tree-level forward scattering amplitude between two particles at the Fermi surface. While the direct term correctly reproduces that of the underlying gauge theory, the exchange term has the wrong sign. The physical consequences are discussed in the context of Landau's theoretical description of the Fermi liquid. [Phys. Rev. D **69**, 014020 (2004)]

Parton-hadron duality in unpolarized and polarized structure functions. N. Bianchi and A. Fantoni, *Laboratori Nazionali di Frascati dell'INFN, Via E. Fermi 40, 00044 Frascati (RM), Italy;* S. Liuti, *University of Virginia, Charlottesville, Virginia 22901, USA.* (Received 14 August 2003; published 28 January 2004)

We study the phenomenon of parton-hadron duality in both polarized and unpolarized electron proton scattering using the HERMES and the Jefferson Lab data, respectively. In both cases we extend a systematic perturbative QCD based analysis to the integrals of the structure functions in the resonance region. After subtracting target mass corrections and large x resummation effects, we extract the remaining power corrections up to order $1/Q^2$. We find a sizable suppression of these terms with respect to analyses using deep inelastic scattering data. The suppression appears consistently in both polarized and unpolarized data, except for the low Q^2 polarized data, where a large negative higher twist contribution remains. A similar trend is found by using phenomenological parametrizations of the data, which include nonperturbative type corrections. Possible scenarios generating this behavior are discussed. [Phys. Rev. D **69**, 014505 (2004)]

Lattice calculation of gluon screening masses. A. Nakamura and T. Saito, *Research Institute for Information Science and Education, Hiroshima University, Higashi-Hiroshima 739-8521, Japan;* S. Sakai, *Faculty of Education, Yamagata University, Yamagata 990-8560, Japan.* (Received 13 June 2003; published 29 January 2004)

We study $SU(3)$ gluon electric and magnetic masses at finite temperatures using quenched lattice QCD on a $20^2\times32\times6$ lattice. We focus on temperature regions between $T=T_c$ and $6T_c$, which are realized in BNL Relativistic Heavy Ion Collider and CERN Large Hadron Collider experiments. Stochastic quantization with a gauge-fixing term is employed to calculate gluon propagators. The temperature dependence of the electric mass is found to be consistent with the hard-thermal-loop perturbation, and the magnetic mass has finite values in the temperature region of interest. Both screening masses have little gauge parameter dependence. The behavior of the gluon propagators is very different in confinement or deconfinement physics. The short distance magnetic part behaves like a confined propagator even in the deconfinement phase. A simulation with a larger lattice, $32^2\times48\times6$, shows that the magnetic mass has a stronger finite size effect than the electric mass. [Phys. Rev. D **69**, 014506 (2004)]

Order from disorder in lattice QCD at high density. Barak Bringoltz, *School of Physics and Astronomy, Raymond and Beverly Sackler Faculty of Exact Sciences, Tel Aviv University, 69978 Tel Aviv, Israel.* (Received 17 August 2003; published 30 January 2004)

We investigate the properties of the ground state of strong coupling lattice QCD at finite density. Our starting point is the effective Hamiltonian for color singlet objects, which looks at lowest order as an antiferromagnet, and describes meson physics with a fixed baryon number background. We concentrate on uniform baryon number backgrounds (with the same baryon number on all sites), for which the ground state was extracted in an earlier work, and calculate the dispersion relations of the excitations. Two types of Goldstone boson emerge. The first, antiferromagnetic spin waves, obeys a linear dispersion relation. The others, ferromagnetic magnons, have energies that are quadratic in their momentum. These energies emerge only when fluctuations around the large-N_c ground state are taken into account, along the lines of ''order from disor-

der'' in frustrated magnetic systems. Unlike other spectrum calculations in order from disorder, we employ the Euclidean path integral. For comparison, we also present a Hamiltonian calculation using a generalized Holstein-Primakoff transformation. The latter can only be constructed for a subset of the cases we consider. [Phys. Rev. D **69**, 014508 (2004)]

Addendum to "Solar neutrino oscillation parameters after first KamLAND results". G. L. Fogli,[1] E. Lisi,[1] A. Marrone,[1] D. Montanino,[2] A. Palazzo,[1] and A. M. Rotunno[1] [1]*Dipartimento di Fisica and Sezione INFN di Bari, Via Amendola 173, 70126 Bari, Italy,* [2]*Dipartimento di Scienza dei Materiali and Sezione INFN di Lecce, Via Arnesano, 73100 Lecce, Italy.* (Received 6 August 2003; published 13 January 2004)

In a previous paper, we presented a three-flavor oscillation analysis of the solar neutrino measurements and of the first data from the KamLAND experiment, in terms of the relevant mass-mixing parameters ($\delta m^2, \theta_{12}, \theta_{13}$). The analysis, performed by including the terrestrial neutrino constraints coming from the CHOOZ (reactor), KEK-to-Kamioka (K2K, accelerator), and Super-Kamiokande (SK, atmospheric) experiments, provided a stringent upper limit on θ_{13}, namely, $\sin^2\theta_{13}<0.05$ at 3σ. We reexamine such an upper bound in light of a recent (although preliminary) reanalysis of atmospheric neutrino data performed by the SK Collaboration, which seems to shift the preferred value of the largest neutrino square mass difference Δm^2 downwards. By taking the results of the SK official reanalysis at face value, and by repeating the analysis of our previous paper with such new input, we find that the upper bound on θ_{13} is somewhat relaxed: $\sin^2\theta_{13}<0.067$ at 3σ. Related phenomenological issues are briefly discussed. [Phys. Rev. D **69**, 017301 (2004)]

Sensitivity to θ_{13} and δ in the decaying astrophysical neutrino scenario. John F. Beacom,[1] Nicole F. Bell,[1] Dan Hooper,[2] Sandip Pakvasa,[3] and Thomas J. Weiler[4] [1]*NASA/Fermilab Astrophysics Center, Fermi National Accelerator Laboratory, Batavia, Illinois 60510-0500, USA,* [2]*Denys Wilkinson Laboratory, Astrophysics Department, OX1 3RH Oxford, England,* [3]*Department of Physics and Astronomy, University of Hawaii, Honolulu, Hawaii 96822, USA,* [4]*Department of Physics and Astronomy, Vanderbilt University, Nashville, Tennessee 37235, USA.* (Received 23 September 2003; published 30 January 2004)

We have previously shown that the decay of high-energy neutrinos from distant astrophysical sources would be revealed by flavor ratios that deviate strongly from the $\phi_{\nu_e}:\phi_{\nu_\mu}:\phi_{\nu_\tau}=1:1:1$ expected from oscillations alone. Here we show that the deviations are significantly larger when the mixing angle θ_{13} and the *CP* phase δ are allowed to be nonzero. If neutrinos decay, this could allow measurement of θ_{13} and δ in IceCube and other near-term neutrino telescopes. [Phys. Rev. D **69**, 017303 (2004)]

Quantum dynamics and thermalization for out-of-equilibrium ϕ^4 theory. S. Juchem, W. Cassing, and C. Greiner, *Institut für Theoretische Physik, Universität Giessen, D-35392 Giessen, Germany.* (Received 29 July 2003; published 30 January 2004)

The quantum time evolution of ϕ^4-field theory for a spatially homogeneous system in 2+1 space-time dimensions is investigated numerically for out-of-equilibrium initial conditions on the basis of the Kadanoff-Baym equations including the tadpole and sunset self-energies. Whereas the tadpole self-energy yields a dynamical mass, the sunset self-energy is responsible for dissipation and an equilibration of the system. In particular we address the dynamics of the spectral (''off-shell'') distributions of the excited quantum modes and the different phases in the approach to equilibrium described by Kubo-Martin-Schwinger relations for thermal equilibrium states. The investigation explicitly demonstrates that the only translation invariant solutions representing the stationary fixed points of the coupled equation of motions are those of full thermal equilibrium. They agree with those extracted from the time integration of the Kadanoff-Baym equations for $t\to\infty$. Furthermore, a detailed comparison of the full quantum dynamics to more approximate and simple schemes such as that of a standard kinetic (on-shell) Boltzmann equation is performed. Our analysis shows that the consistent inclusion of the dynamical spectral function has a significant impact on relaxation phenomena. The different time scales that are involved in the dynamical quantum evolution towards a complete thermalized state are discussed in detail. We find that far off-shell $1\leftrightarrow 3$ processes are responsible for chemical equilibration, which is missed in the Boltzmann limit. Finally, we briefly address the case of (bare) massless fields. For sufficiently large couplings λ we observe the onset of Bose condensation, where our scheme within symmetric ϕ^4 theory breaks down. [Phys. Rev. D **69**, 025006 (2004)]

Reexamination of the ^{187}Re bound on the variation of fundamental couplings. Keith A. Olive,[1,2] Maxim Pospelov,[3] Yong-Zhong Qian,[2] Gérard Manhès,[4] Elisabeth Vangioni-Flam,[5] Alain Coc,[6] and Michel Cassé[5,7] [1]*Theoretical Physics Institute, School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455, USA,* [2]*School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455, USA,* [3]*Department of Physics and Astronomy, University of Victoria, PO Box 3055 STN CSC Victoria, British Columbia, Canada V8W 3P6,* [4]*Institut de Physique du Globe de Paris, Laboratoire de Géochimie et Cosmochimie, 75252 Paris CEDEX 05, France,* [5]*IAP, CNRS, 98 bis Bd Arago 75014 Paris, France,* [6]*CSNSM, IN2P3/CNRS/UPS, Bât 104, 91405 Orsay, France,* [7]*SAp, CEA, Orme des Merisiers, 91191 Gif/Yvette CEDEX, France.* (Received 11 September 2003; published 30 January 2004)

We reconsider the ^{187}Re bound on the variation of the fine-structure constant. We combine the meteoritic measurement with several present-day lab measurements to firmly establish the quantitative upper limit to the time variation over the age of the solar system. We find that the relative change of the fine-structure constant between its present value and α of $\sim$4.6 Gyr ago is consistent with zero, $\Delta\alpha/\alpha=[-8\pm 8\ (1\sigma)]\times 10^{-7}$. We also rederive this bound in models where all gauge and Yukawa couplings vary in an interdependent manner, as would be expected in unified theories. [Phys. Rev. D **69**, 027701 (2004)]