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.*

Mass signature of supernova ν_μ and ν_τ neutrinos in SuperKamiokande. J. F. Beacom and P. Vogel, *Department of Physics, California Institute of Technology, Pasadena, California 91125.* (Received 25 February 1998; published 7 August 1998)

The ν_μ and ν_τ neutrinos (and their antiparticles) from a Galactic core-collapse supernova can be observed in a water-Čerenkov detector by the neutral-current excitation of ^{16}O. The number of events expected is several times greater than from neutral-current scattering on electrons. The observation of this signal would be a strong test that these neutrinos are produced in core-collapse supernovae, and with the right characteristics. In this paper, this signal is used as the basis for a technique of neutrino mass determination from a future Galactic supernova. The masses of the ν_μ and ν_τ neutrinos can either be measured or limited by their delay relative to the $\bar{\nu}_e$ neutrinos. By comparing to the high-statistics $\bar{\nu}_e$ data instead of the theoretical expectation, much of the model dependence is canceled. Numerical results are presented for a future supernova at 10 kpc as seen in the SuperKamiokande detector. Under reasonable assumptions, and in the presence of the expected counting statistics, ν_μ and ν_τ masses down to about 50 eV can be simply and robustly determined. The signal used here is more sensitive to small neutrino masses than the signal based on neutrino-electron scattering. [S0556-2821(98)00619-5] [Phys. Rev. D **58**, 053010 (1998)]

Quantifying uncertainties in primordial nucleosynthesis without Monte Carlo simulations. G. Fiorentini,[1] E. Lisi,[2] S. Sarkar,[3] and F. L. Villante,[1] [1]*Dipartimento di Fisica and Sezione INFN di Ferrara, Via del Paradiso 12, I-44100 Ferrara, Italy* [2]*Dipartimento di Fisica and Sezione INFN di Bari, Via Amendola 173, I-70126 Bari, Italy* [3]*Theoretical Physics, University of Oxford, 1 Keble Road, Oxford OX1 3NP, United Kingdom.* (Received 16 March 1998; published 21 August 1998)

We present a simple method for determining the (correlated) uncertainties of the light element abundances expected from big bang nucleosynthesis, which avoids the need for lengthy Monte Carlo simulations. Our approach helps to clarify the role of the different nuclear reactions contributing to a particular elemental abundance and makes it easy to implement energy-independent changes in the measured reaction rates. As an application, we demonstrate how this method simplifies the statistical estimation of the nucleon-to-photon ratio through comparison of the standard BBN predictions with the observationally inferred abundances.
[S0556-2821(98)05018-8] [Phys. Rev. D **58**, 063506 (1998)]

Radiative neutrino mass matrix for three active plus one sterile species. Naveen Gaur,[1] Ambar Ghosal,[2] Ernest Ma,[3] and Probir Roy,[4] [1]*Department of Physics and Astrophysics, University of Delhi, Delhi 110 007, India* [2]*Mehta Research Institute, Chhatnag Road, Jhusi, Allahabad 211 019, India* [3]*Department of Physics, University of California, Riverside, California 92521* [4]*Tata Institute of Fundamental Research, Mumbai 400 005, India.* (Received 4 June 1998; published 26 August 1998)

A simple unifying mass matrix is presented for the three active and one sterile neutrinos ν_e, ν_μ, ν_τ, and ν_s, using an extension of the radiative mechanism proposed some time ago by Zee. The total neutrino-oscillation data are explained by the scheme $\nu_e \leftrightarrow \nu_s$ (solar), $\nu_\mu \leftrightarrow \nu_\tau$ (atmospheric) and $\nu_e \leftrightarrow \nu_\mu$ (LSND). We obtain the interesting approximate relationship $(\Delta m^2)_{\rm atm} \simeq 2[(\Delta m^2)_{\rm solar}(\Delta m^2)_{\rm LSND}]^{1/2}$ which is well satisfied by the data. [S0556-2821(98)50119-1] [Phys. Rev. D **58**, 071301 (1998)]

Cosmological nucleosynthesis and active-sterile neutrino oscillations with small mass differences: The nonresonant case. D. P. Kirilova, *Teoretisk Astrofysik Center, Juliane Maries Vej 30, DK-2100, Copenhagen and Copenhagen University, Niels Bohr Institute, Blegdamsvej 17, DK-2100, Copenhagen, Denmark;* M. V. Chizhov, *Centre for Space Research and Technologies, Faculty of Physics, University of Sofia, 1164 Sofia, Bulgaria.* (Received 3 September 1997; published 31 August 1998)

We study the nonresonant oscillations between left-handed electron neutrinos ν_e and nonthermalized sterile neutrinos ν_s in the early Universe plasma. The case when ν_s do not thermalize until 2 MeV and the oscillations become effective after ν_e decoupling is discussed. As far as for this model the rates of the expansion of the Universe, neutrino oscillations, and neutrino interactions with the medium may be comparable, we have analyzed the kinetic equations for the neutrino density matrix, accounting *simultaneously* for these processes. The evolution of neutrino ensembles was described numerically by integrating the kinetic equations for the neutrino density matrix in *momentum* space for small mass differences $\delta m^2 \leqslant 10^{-7}$ eV^2. This approach allowed us to study precisely the evolution of the neutrino number densities, energy spectrum distortion, and the asymmetry between neutrinos and antineutrinos due to oscillations for each momentum mode. We have performed a complete numerical analysis for the full range of the oscillations parameters of the model of the influence of the nonequilibrium $\nu_e \leftrightarrow \nu_s$ oscillations on the primordial production of ^{4}He. The exact kinetic approach enabled us to calculate the effects of neutrino population depletion, the distortion of the neutrino spectrum, and the generation of neutrino-antineutrino asymmetry on the kinetics of neutron-to-proton transitions during the primordial nucleosynthesis epoch and correspondingly on cosmological ^{4}He production. It was shown that the neutrino population depletion and spectrum distortion play an important role. The asymmetry effect, in case the lepton asymmetry is accepted initially equal to the baryon one, is proved to be negligible for the discussed range of δm^2. Constant helium contours in the δm^2-ϑ plane were calculated. Thanks to the exact kinetic approach more precise cosmological constraints on the mixing pa-

 © 1998 The American Physical Society

rameters were obtained. [S0556-2821(98)04115-0] [Phys. Rev. D **58**, 073004 (1998)]

Comparison of $\nu_\mu \leftrightarrow \nu_\tau$ and $\nu_\mu \leftrightarrow \nu_s$ oscillations as solutions of the atmospheric neutrino problem. Paolo Lipari and Maurizio Lusignoli, *Dipartimento di Fisica, Università di Roma ''la Sapienza,'' and I.N.F.N., Sezione di Roma, P. A. Moro 2, I-00185 Roma, Italy.* (Received 25 March 1998; published 1 September 1998)

The simplest explanation for the atmospheric neutrino anomaly is the transition of muon neutrinos and antineutrinos into states of different flavor. Data from the reactor experiment CHOOZ, and the measurement of the energy and angle distribution of electronlike events at Super-Kamiokande put strong constraints on ν_μ-ν_e mixing, but the transitions $\nu_\mu \rightarrow \nu_\tau$ and $\nu_\mu \rightarrow \nu_s$ are viable possibilities. If the muon neutrinos are mixed with a singlet sterile state, the energy and zenith angle dependence of the oscillation probability is modified by matter effects that are important for $E_\nu/|\Delta m^2| \gtrsim 10^3$ GeV/eV^2. We confront the theoretical predictions with existing data on contained events and neutrino-induced upward-going muons. [S0556-2821(98)00319-1] [Phys. Rev. D **58**, 073005 (1998)]

Strange decays of nonstrange baryons. Simon Capstick, *Supercomputer Computations Research Institute and Department of Physics, Florida State University, Tallahassee, Florida 32306;* W. Roberts, *Department of Physics, Old Dominion University, Norfolk, Virginia 23529 and Thomas Jefferson National Accelerator Facility, 12000 Jefferson Avenue, Newport News, Virginia 23606.* (Received 29 April 1998; published 9 September 1998)

The strong decays of excited nonstrange baryons into the final states ΛK, ΣK, and for the first time into $\Lambda(1405)K$, $\Lambda(1520)K$, $\Sigma(1385)K$, ΛK^*, and ΣK^*, are examined in a relativized quark pair creation model. The wave functions and parameters of the model are fixed by previous calculations of $N\pi$ and $N\pi\pi$, etc., decays. Our results show that it should be possible to discover several new negative parity excited baryons and confirm the discovery of several others by analyzing these final states in kaon production experiments. We also establish clear predictions for the relative strengths of certain states to decay to $\Lambda(1405)K$ and $\Lambda(1520)K$, which can be tested to determine if a three-quark model of the $\Lambda(1405)K$ is valid. Our results compare favorably with the results of partial wave analyses of the limited existing data for the ΛK and ΣK channels. We do not find large ΣK decay amplitudes for a substantial group of predicted and weakly established negative-parity states, in contrast to the only previous work to consider decays of these states into the strange final states ΛK and ΣK. [S0556-2821(98)03919-8] [Phys. Rev. D **58**, 074011 (1998)]

Lattice calculation of the strangeness magnetic moment of the nucleon. S. J. Dong and K. F. Liu, *Department of Physics and Astronomy, University of Kentucky, Lexington, Kentucky 40506;* A. G. Williams, *Special Research Center for the Subatomic Structure of Matter and Department of Physics and Mathematical Physics, University of Adelaide, 5005 Australia.* (Received 22 December 1997; published 2 September 1998)

We report on a lattice QCD calculation of the strangeness magnetic moment of the nucleon. Our result is $G_M^s(0) = -0.36 \pm 0.20$. The sea contributions from the u and d quarks are about 80% larger. However, they cancel to a large extent due to their electric charges, resulting in a smaller net sea contribution of $-0.097 \pm 0.037 \mu_N$ to the nucleon magnetic moment. As far as the neutron to proton magnetic moment ratio is concerned, this sea contribution tends to cancel out the cloud-quark effect from the Z graphs and results in a ratio of -0.68 ± 0.04 which is close to the SU(6) relation and the experiment. The strangeness Sachs electric mean-square radius $\langle r_s^2 \rangle_E$ is found to be small and negative. [S0556-2821(98)01817-7] [Phys. Rev. D **58**, 074504 (1998)]

Optimized perturbation theory at finite temperature. S. Chiku, *Institute of Physics, University of Tsukuba, Tsukuba, Ibaraki 305, Japan and Yukawa Institute for Theoretical Physics, Kyoto University, Kyoto 606, Japan;* T. Hatsuda, *Institute of Physics, University of Tsukuba, Tsukuba, Ibaraki 305, Japan and Physics Department, Kyoto University, Kyoto 606, Japan.* (Received 3 March 1998; published 20 August 1998)

An optimized perturbation theory (OPT) at finite temperature T, which resums higher order terms in the naive perturbation, is developed in $O(N)$ ϕ^4 theory. It is proved that (i) the renormalization of the ultraviolet divergences can be carried out systematically in any given order of OPT and (ii) the Nambu-Goldstone theorem is satisfied for arbitrary N and for any given order of OPT. The method is applied for the $O(4)$ σ model to study the soft modes associated with the chiral transition in quantum chromodynamics. Threshold enhancement of the spectral functions at finite T in the scalar and pseudoscalar channels is shown to be a typical signal of the chiral transition. [S0556-2821(98)04617-7] [Phys. Rev. D **58**, 076001 (1998)]

$\pi\Lambda$ scattering phase shifts and CP violation in $\Xi \rightarrow \pi\Lambda$ decay. A. N. Kamal, *Theoretical Physics Institute and Department of Physics, University of Alberta, Edmonton, Alberta, Canada T6G 2J1.* (Received 20 January 1998; published 31 August 1998)

CP-violating signals in weak $\Xi \rightarrow \pi\Lambda$ decay require the knowledge of $\pi\Lambda$ S- and P-wave scattering phases at m_Ξ center-of-mass energy. We have calculated these phases in baryon chiral perturbation theory with the ground-state Σ in s and u channels and $\frac{3}{2}^+$ $\Sigma(1385)$ in the u channel. We do not treat the baryons as heavy. We find $\delta_S = 1.2°$ and $\delta_P = -1.7°$ with the central value of the strong coupling parameter D. We also investigate the variation of the scattering phases as functions of the parameter D. We compare this result with previous calculations, and discuss its relevance to CP-asymmetry parameters. [S0556-2821(98)07717-0] [Phys. Rev. D **58**, 077501 (1998)]

Three flavor neutrino oscillation analysis of the SuperKamiokande atmospheric neutrino data. Osamu Yasuda, *Department of Physics, Tokyo Metropolitan University, Minami-Osawa, Hachioji,*

Tokyo 192-0397, Japan. (Received 27 April 1998; published 14 September 1998)

SuperKamiokande atmospheric neutrino data for 535 days are analyzed in the framework of three flavor oscillations with mass hierarchy. It is shown that the best fit point is very close to the pure maximal $\nu_\mu \leftrightarrow \nu_\tau$ case and $\Delta m^2 \simeq 7\times 10^{-3}$ eV^2. The allowed region at 90% C.L. is given and the implications to the long baseline experiments are briefly discussed.
[S0556-2821(98)50619-4] [Phys. Rev. D **58**, 091301 (1998)]

Partons in phase space. David A. Brown and Paweł Danielewicz, *National Superconducting Cyclotron Laboratory and Department of Physics and Astronomy, Michigan State University, East Lansing, Michigan 48824.* (Received 6 February 1998; published 14 September 1998)

Within QED, we examine several issues related to constructing a parton-model-based QCD transport theory. We rewrite the QED analog of the parton model, the Weizsäcker-Williams approximation, entirely in terms of phase-space quantities and we study the phase-space photon and electron densities created by a classical point charge. We find that the densities take a distinctive ''source-propagator'' form. This form does not arise in a conventional derivation of the semiclassical transport equations because of the overuse of the gradient approximation. We do not apply the gradient approximation and so derive the phase-space analog of the generalized fluctuation-dissipation theorem. Together, this theorem and the expression for the phase-space particle self-energies give a set of coupled phase-space evolution equations. We illustrate how these evolution equations can be used perturbatively or to derive semiclassical transport equations. Our work relies on phase-space propagators and sources, so we describe them in detail when calculating the photon and electron phase-space densities. We use these tools to discuss the shape of a nucleon's parton cloud.
[S0556-2821(98)08019-9] [Phys. Rev. D **58**, 094003 (1998)]