

Selected Abstracts from Physical Review D

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τ neutrino decays and big bang nucleosynthesis. Steen Hannestad, *Institute of Physics and Astronomy and Theoretical Astrophysics Center, University of Aarhus, DK-8000 Århus C, Denmark and Max-Planck-Institut für Physik, Föhringer Ring 6, 80805 München, Germany.* (Received 11 June 1997; published 21 January 1998)

We investigate the nonradiative decay during nucleosynthesis of a massive τ neutrino with a mass of 0.1–1 MeV into an electron neutrino and a scalar or pseudoscalar particle ϕ . The full Boltzmann equation is used and shown to give markedly different results than the usual nonrelativistic formalism for relativistic or semirelativistic neutrino decays. Indeed, the region we investigate is where the formalism that has previously been applied to solving this problem is expected to break down. We also compare the nucleosynthesis predictions from this scenario with results from the standard model and with some of the available observational determinations of the primordial abundances. It is found that for relativistic or semirelativistic decays the helium abundance can be significantly lowered without changing other light element abundances. Since a problem with the standard model of big bang nucleosynthesis is that helium appears to be overproduced, a decay of the type we discuss can be a possible solution. [S0556-2821(98)05204-7] [Phys. Rev. D **57**, 2213 (1998)]

Up-down asymmetry: A diagnostic for neutrino oscillations. John W. Flanagan, John G. Learned, and Sandip Pakvasa, *Department of Physics and Astronomy, University of Hawaii, Honolulu, Hawaii 96822.* (Received 26 September 1997; published 28 January 1998)

We propose a simple test of underground neutrino data to discriminate amongst neutrino oscillation models. It uses the asymmetry between downward-going events and upward-going events, for electron and muon events separately. Because of the symmetry of typical underground detectors, an asymmetry can be compared with calculations with little need for the intermediary of a simulation program. Furthermore, we show that the various oscillation scenarios give rise to dramatically differing trajectories of asymmetry versus energy for muons and electrons. This permits a clean distinction to be drawn between models. [S0556-2821(98)05053-6] [Phys. Rev. D **57**, 2649 (1998)]

Rho-omega mixing and the pion form factor in the timelike region. S. Gardner and H. B. O'Connell, *Department of Physics and Astronomy, University of Kentucky, Lexington, Kentucky 40506-0055.* (Received 18 July 1997; published 4 February 1998)

We determine the magnitude, phase, and s dependence of ρ - ω "mixing" in the pion form factor in the timelike region through fits to $e^+e^- \rightarrow \pi^+\pi^-$ data. The associated systematic errors in these

quantities, arising from the functional form used to fit the ρ resonance, are small. The systematic errors in the ρ mass and width, however, are larger than previously estimated. [S0556-2821(98)03105-1] [Phys. Rev. D **57**, 2716 (1998)]

How to extract the $P_{33}(1232)$ resonance contributions from the amplitudes $M_{1+}^{3/2}, E_{1+}^{3/2}, S_{1+}^{3/2}$ of pion electroproduction on nucleons. I. G. Aznauryan, *Yerevan Physics Institute, Alikhanian Brothers St. 2, Yerevan, 375036 Armenia.* (Received 5 August 1997; published 6 February 1998)

Within the dispersion relation approach, solutions of integral equations for the multipoles $M_{1+}^{3/2}, E_{1+}^{3/2}, S_{1+}^{3/2}$ are found at $0 \leq Q^2 \leq 3 \text{ GeV}^2$. These solutions should be used as input for the resonance and nonresonance contributions in the analyses of pion electroproduction data in the $P_{33}(1232)$ resonance region. It is shown that the traditional identification of the amplitude $M_{1+}^{3/2}$ (as well as the amplitudes $E_{1+}^{3/2}, S_{1+}^{3/2}$) with the $P_{33}(1232)$ resonance contribution is not right; there is a contribution in these amplitudes which has a nonresonance nature and is produced by rescattering effects in the diagrams corresponding to the nucleon and pion poles. This contribution is reproduced by the dispersion relations. Taking into account nonresonance contributions in the amplitudes $M_{1+}^{3/2}, E_{1+}^{3/2}$, the helicity amplitudes $A_p^{1/2}, A_p^{3/2}$ and the ratio $E2/M1$ for the $\gamma N \rightarrow P_{33}(1232)$ transition are extracted from experiment at $Q^2 = 0$. They are in good agreement with quark model predictions. [S0556-2821(98)04603-7] [Phys. Rev. D **57**, 2727 (1998)]

Photoproduction off nuclei: Particle and jet production. S. Roesler, *Universität Siegen, Fachbereich Physik, D-57068 Siegen, Germany*; R. Engel, *Universität Leipzig, Fachbereich Physik, D-04109 Leipzig, Germany and Universität Siegen, Fachbereich Physik, D-57068 Siegen, Germany*; J. Ranft, *Departamento de Física de Partículas, Universidade de Santiago de Compostela, E-15706 Santiago de Compostela, Spain.* (Received 20 November 1996; revised manuscript received 17 September 1997; published 23 January 1998)

High energy multiparticle photoproduction off nuclear targets is studied. The photon is assumed to interact in direct scattering processes or as a resolved $q\bar{q}$ state according to the generalized vector dominance model. In the description of resolved interactions multiple soft and hard processes in each $q\bar{q}$ -nucleon interaction are taken into consideration. The model, formulated within the framework of the two-component dual parton model, is shown to agree with hadron production data from real and weakly virtual photon-nucleus interactions. Differences between multiparticle production in photon-nucleus and hadron-nucleus interactions and features of jet production in photon-nucleus collisions at DESY HERA ener-

gies are discussed. [S0556-2821(98)01805-0] [Phys. Rev. D **57**, 2889 (1998)]

Using Drell-Yan processes to probe nucleon and meson structure functions. R. S. Bhalerao, *Theoretical Physics Group, Tata Institute of Fundamental Research, Homi Bhabha Road, Colaba, Mumbai 400 005, India*; J. T. Londergan, *Department of Physics and Nuclear Theory Center, Indiana University, Bloomington, Indiana 47408*. (Received 16 October 1997; published 22 January 1998)

We investigate how Drell-Yan processes can be used to measure the magnitude of flavor symmetry violation in the proton sea. We examine the utility of the following beams: protons, charged pions, and charged kaons. In each case we present an approximate expression for the Drell-Yan asymmetry. Using currently available parton distributions, we locate those kinematic regions which provide the greatest information on the quantity $d^p(x) - u^p(x)$. If sufficiently intense K^+ beams were available, they could provide an efficient measurement of this quantity. Finally we present and discuss sets of sum rules for the Drell-Yan processes. [S0556-2821(98)05205-9] [Phys. Rev. D **57**, 3065 (1998)]

Neutrino oscillations in a model with a source and detector Ken Kiers, *Department of Physics, Brookhaven National Laboratory, Upton, New York 11973-5000*; Nathan Weiss, *School of Physics and Astronomy, Tel Aviv University, Tel Aviv, Israel*; *Department of Particle Physics, Weizmann Institute, Rehovot, Israel*; and *Department of Physics and Astronomy, University of British Columbia, Vancouver, British Columbia, Canada V6T 1Z1*. (Received 15 October 1997; published 22 January 1998)

We study the oscillations of neutrinos in a model in which the neutrino is coupled to a localized, idealized source and detector. By varying the spatial and temporal resolution of the source and detector we are able to model the full range of source and detector types ranging from coherent to incoherent. We find that this approach is useful in understanding the interface between the quantum mechanical nature of neutrino oscillations on the one hand and the production and detection systems on the other hand. This method can easily be extended to study the oscillations of other particles such as the neutral K and B mesons. We find that this approach gives a reliable way to treat the various ambiguities which arise

when one examines the oscillations from a wave packet point of view. We demonstrate that the conventional oscillation formula is correct in the relativistic limit and that several recent claims of an extra factor of 2 in the oscillation length are incorrect. We also demonstrate *explicitly* that the oscillations of neutrinos which have separated spatially may be “revived” by a long coherent measurement. [S0556-2821(98)01005-4] [Phys. Rev. D **57**, 3091 (1998)]

Nucleon effects on the photon dispersion relations in matter. Juan Carlos D’Olivo, *Instituto de Ciencias Nucleares, Universidad Nacional Autónoma de México, Apartado Postal 70-543, 04510 México, D.F., México*; José F. Nieves, *Laboratory of Theoretical Physics, Department of Physics, P.O. Box 23343, University of Puerto Rico, Río Piedras, Puerto Rico 00931-3343*. (Received 25 September 1997; published 4 February 1998)

We calculate the nucleon contribution to the photon self-energy in a plasma, including the effect of the anomalous magnetic moment of the nucleons. General formulas for the transverse and longitudinal components of the self-energy are obtained and we give explicit results in various limits of physical interest. The formulas are relevant for the study of the photon dispersion relations and the dynamical susceptibility in a nuclear medium such as the core of a supernova, and has implications with regard to the recent suggestion that the Cherenkov process $\nu \rightarrow \nu\gamma$ can take place in such a system. [S0556-2821(98)04005-3] [Phys. Rev. D **57**, 3116 (1998)]

Analytic formula of the transition probability for a neutrino propagating through fluctuating matter. Kenji Hirota, *Department of Physics, Tohoku University, Sendai 980-77, Japan*. (Received 25 March 1997; published 28 January 1998)

In this paper we derive analytically the transition probability of a neutrino in fluctuating matter. The result justifies the numerical analysis previously known in some limit. In the case of the periodic density fluctuations both the parametric enhancement and suppression can occur depending on the situation. For a randomly fluctuating case the transition probability is enhanced in some range of the neutrino energy. [S0556-2821(98)02305-4] [Phys. Rev. D **57**, 3140 (1998)]