Selected Abstracts from Other Physical Review Journals

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Emission of polarized photons from unpolarized electrons moving in crystals. V. M. Strakhovenko, *Budker Institute of Nuclear Physics, 630090 Novosibirsk, Russia.* (Received 20 February 2003; revised manuscript received 17 July 2003; published 10 October 2003)

Radiation emitted by unpolarized high-energy electrons penetrating crystals may be linearly polarized. This occurs when the particle velocity makes an angle with respect to some major crystal axis that is appreciably larger than the axial-channeling angle. For such an orientation, a complete description of spectral and polarization characteristics of the radiation is derived. At planar channeling, a nonperturbative contribution to the probability of the process appears to be caused by the plane field, and we must solve exactly a one-dimensional mechanical problem. For that, the approximate form of the actual plane potential is suggested which provides a precise fit for any crystal plane and an analytical solution to the motion problem. In a practical case, we must consider electron-photon showers developing in sufficiently thick crystals. For the first time, to our knowledge, this development is described taking into account the polarization of photons. We discuss qualitative features of the phenomenon, present results of numerical calculations for thin and thick crystals, and evaluate the possibility of the use of differently oriented crystals in a polarized hard-photon source. [Phys. Rev. A **68**, 042901 (2003)]

Asymmetric neutrino emission due to neutrino-nucleon scatterings in supernova magnetic fields. Shin'ichiro Ando, *Department of Physics, School of Science, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan.* (Received 15 March 2003; published 9 September 2003)

We derive the cross section of neutrino-nucleon scatterings in supernova magnetic fields, including weak-magnetism and recoil corrections. Since the weak interaction violates parity, the scattering cross section depends asymmetrically on the directions of the neutrino momenta with respect to the magnetic field; the origin of pulsar kicks may be explained by the mechanism. An asymmetric neutrino emission (a drift flux) due to neutrino-nucleon scattering is absent at the leading level of $O(\mu_B B/T)$, where μ_B is the nucleon magneton, B is the magnetic field strength, and T is the matter temperature at a neutrino sphere. This is because at this level the drift flux of the neutrinos is exactly canceled by that of the antineutrinos. Hence, the relevant asymmetry in the neutrino emission is suppressed by a much smaller coefficient of $O(\mu_B B/m)$, where m is the nucleon mass; a detailed form of the relevant drift flux is also derived from the scattering cross section, using a simple diffusion approximation. It appears that the asymmetric neutrino emission is too small to induce the observed pulsar kicks. However, we note the fact that the drift flux is proportional to the deviation of the neutrino distribution function from the value of thermal equilibrium at the neutrino sphere. Since the deviation can be large for nonelectron neutrinos, it is expected that there occurs a cancellation between the deviation and the small suppression factor of $O(\mu_B B/m)$. Using a simple parametrization, we show that the drift flux due to neutrino-nucleon scattering may be comparable to the leading term due to beta processes with nucleons, which has been estimated to give a relevant kick velocity when the magnetic field is as strong as 10^{15}–10^{16} G. [Phys. Rev. D **68**, 063002 (2003)]

Are direct photons a clean signal of a thermalized quark-gluon plasma? D. Boyanovsky and H. J. de Vega, *Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh, Pennsylvania 15260, USA, and LPTHE, Université Pierre et Marie Curie (Paris VI) et Denis Diderot (Paris VII), Tour 16, Premiere Étage, 4 place Jussieu, 75252 Paris Cedex 05, France.* (Received 20 May 2003; published 23 September 2003)

Direct photon production from a quark-gluon plasma (QGP) in thermal equilibrium is studied directly in real time. In contrast with the usual S-matrix calculations, the real time approach is valid for a QGP that formed and reached local thermal equilibrium a short time after a collision and of finite lifetime ($\sim$10–20 fm/c as expected at BNL RHIC or CERN LHC). We point out that during such a finite QGP lifetime the spectrum of emitted photons carries information on the initial state. There is an inherent ambiguity in separating the virtual from the observable photons during the transient evolution of the QGP. We propose a real time formulation to extract the photon yield which includes the initial stage of formation of the QGP parametrized by an effective time scale of formation Γ^{-1}. This formulation coincides with the S-matrix approach in the infinite lifetime limit. It allows us to separate the virtual cloud as well as the observable photons emitted during the preequilibrium stage from the yield during the QGP lifetime. We find that the lowest order contribution $O(\alpha_{em})$ which does *not* contribute to the S-matrix approach, is of the same order of or larger than the S-matrix contribution during the lifetime of the QGP for a typical formation time $\sim$1 fm/c. The yield for momenta $\gtrsim$3 GeV/c features a power law fall-off $\sim T^3\Gamma^2/k^5$ and is larger than that obtained with the S-matrix for momenta $\geqslant$4 GeV/c. We provide a comprehensive numerical comparison between the real time and S-matrix yields and study the dynamics of the build-up of the photon cloud and the different contributions to the radiative energy loss. The reliability of the current estimates on photon emission as well as theoretical uncertainties on the details of the initial state are discussed. [Phys. Rev. D **68**, 065018 (2003)]

Chiral symmetry breaking solutions for QCD in the truncated Coulomb gauge. P. J. A. Bicudo, *Grupo Teórico de Altas Energias (GTAE), Centro de Física das Interacções Fundamentais (CFIF),*

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In this paper we study the powerlike confining potentials r^{α}. The region of allowed α's is identified, the mass-gap equation is constructed for an arbitrary α and solved for several values of the latter, and the vacuum energy and the chiral condensate are calculated. The question of replica solutions to the mass-gap equation for such potentials is addressed, and it is demonstrated that the number of replicas is infinite for any α, as a consequence of the peculiar behavior of the quark self-energy in the infrared domain. [Phys. Rev. D **68**, 065021 (2003)]

Photodisintegration of deuterium and big bang nucleosynthesis. K. Y. Hara, H. Utsunomiya, S. Goko, H. Akimune, T. Yamagata, and M. Ohta, *Department of Physics, Konan University, Okamoto 8-9-1, Higashinada, Kobe 658-8501, Japan;* H. Toyokawa, K. Kudo, A. Uritani, and Y. Shibata, *National Institute of Advanced Industrial Science and Technology (AIST), 1-1-1 Umezono, Tsukuba, Ibaraki 305-8568, Japan;* Y.-W. Lui, *Cyclotron Institute, Texas A & M University, College Station, Texas 77843, USA;* H. Ohgaki, *Institute of Advanced Energy, Kyoto University, Gokanosho, Uji, Kyoto 611-0011, Japan.* (Received 27 April 2003; revised manuscript received 24 June 2003; published 8 October 2003)

Photodisintegration cross sections were measured for deuterium with Laser-Compton scattering γ beams at seven energies near threshold. Combined with the preceding data, $R(E)=N_a\sigma v$ for the $p(n,\gamma)$D reaction is for the first time evaluated based on experimental data with 6% uncertainty in the energy region relevant to the big bang nucleosynthesis (BBN). The result confirms the theoretical evaluation on which the BBN in the precision era relies. [Phys. Rev. D **68**, 072001 (2003)]

Leptogenesis and neutrino oscillations within a predictive G(224)/SO(10) framework. Jogesh C. Pati, *Department of Physics, University of Maryland, College Park, Maryland 20742, USA, and Stanford Linear Accelerator Center, Stanford University, Menlo Park, California 94025, USA.* (Received 30 May 2003; published 8 October 2003)

A framework based on an effective symmetry that is either $G(224)=SU(2)_L\times SU(2)_R\times SU(4)^c$ or SO(10) has been proposed (a few years ago) that successfully describes the masses and mixings of all fermions including neutrinos, with seven predictions, in good accord with the data. Baryogenesis via leptogenesis is considered within this framework by allowing for natural phases ($\sim$1/20–1/2) in the entries of the Dirac and Majorana mass matrices. It is shown that the framework leads quite naturally, for both thermal as well as nonthermal leptogenesis, to the desired magnitude for the baryon asymmetry. This result is obtained in full accord with the observed features of the atmospheric and solar neutrino oscillations, as well as with those of the quark and charged lepton masses and mixings, and the gravitino constraint. Hereby one obtains a *unified description* of fermion masses, neutrino oscillations and baryogenesis (via leptogenesis) within a single predictive framework. [Phys. Rev. D **68**, 072002 (2003)]

Role of matter density uncertainties in the analysis of future neutrino factory experiments. Tommy Ohlsson, *Division of Mathematical Physics, Department of Physics, Royal Institute of Technology (KTH)-Stockholm Center for Physics, Astronomy, and Biotechnology (SCFAB), Roslagstullsbacken 11, 106 91 Stockholm, Sweden;* Walter Winter, *Institut für Theoretische Physik, Physik–Department, Technische Universität München (TUM), James-Franck-Strasse, 85748 Garching bei München, Germany.* (Received 18 July 2003; published 29 October 2003)

Matter density uncertainties can affect the measurements of the neutrino oscillation parameters at future neutrino factory experiments, such as the measurements of the mixing parameters θ_{13} and δ_{CP}. We compare different matter density uncertainty models and discuss the possibility to include the matter density uncertainties in a complete statistical analysis. Furthermore, we systematically study in which measurements and where in the parameter space matter density uncertainties are most relevant. We illustrate this discussion with examples that show the effects as functions of different magnitudes of the matter density uncertainties. We find that matter density uncertainties are especially relevant for large $\sin^2 2\theta_{13}\gtrsim 10^{-3}$. Within the KamLAND-allowed range, they are most relevant for the precision measurements of $\sin^2 2\theta_{13}$ and δ_{CP}, but less relevant for ''binary'' measurements, such as for the sign of Δm^2_{31}, the sensitivity to $\sin^2 2\theta_{13}$, or the sensitivity to maximal CP violation. In addition, we demonstrate that knowing the matter density along a specific baseline better than to about 1% precision means that all measurements will become almost independent of the matter density uncertainties. [Phys. Rev. D **68**, 073007 (2003)]

Nonperturbative structure of the polarized nucleon sea. Fu-Guang Cao and A. I. Signal, *Institute of Fundamental Sciences PN461, Massey University, Private Bag 11 222, Palmerston North, New Zealand.* (Received 3 June 2003; published 8 October 2003)

We investigate the flavor and quark-antiquark structure of the polarized nucleon by calculating the parton distribution functions of the nucleon sea using the meson cloud model. We find that the SU(2) flavor symmetry in the light antiquark sea and quark-antiquark symmetry in the strange quark sea are broken, i.e., $\Delta\bar{u}<\Delta\bar{d}$ and $\Delta s<\Delta\bar{s}$. The polarization of the strange sea is found to be positive, which is in contradiction with previous analyses. We predict a much larger quark-antiquark asymmetry in the polarized strange quark sea than that in the unpolarized strange quark sea. Our results for both the polarized light quark sea and the polarized strange quark sea are consistent with the recent HERMES data. [Phys. Rev. D **68**, 074002 (2003)]

Resummation of nuclear enhanced higher twist in the Drell-Yan process. Rainer J. Fries, *Department of Physics, Duke University, P.O. Box 90305, Durham, North Carolina 27708, USA, and Institute for Theoretical Physics, University of Regensburg, 93040 Re-*

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We investigate higher twist contributions to the transverse momentum broadening of Drell-Yan pairs in proton nucleus collisions. We reexamine the contribution of matrix elements of twist 4 and generalize this to matrix elements of arbitrary twist. An estimate of the maximal nuclear broadening effect is derived. A model for nuclear enhanced matrix elements of arbitrary twist allows us to give the result of a resummation of all twists in closed form. Subleading corrections to the maximal broadening are discussed qualitatively. [Phys. Rev. D **68**, 074013 (2003)]

Observing nucleon decay in lead perchlorate. R. N. Boyd,[1,2] T. Rauscher,[3] S. D. Reitzner,[1] and P. Vogel[4] [1]*Department of Physics, Ohio State University, Columbus, Ohio 43210, USA,* [2]*Department of Astronomy, Ohio State University, Columbus, Ohio 43210, USA,* [3]*Department of Physics, University of Basel, CH-4056 Basel, Switzerland,* [4]*Department of Physics, California Institute of Technology, Pasadena, California 91125, USA.* (Received 21 July 2003; published 31 October 2003)

Lead perchlorate, part of the OMNIS supernova neutrino detector, contains two nuclei ^{208}Pb and ^{35}Cl that might be used to study nucleon decay. Both would produce signatures that will make them especially useful for studying less-well-studied neutron decay modes, e.g., those in which only neutrinos are emitted. [Phys. Rev. D **68**, 074014 (2003)]

Quark mass dependence of the nucleon axial-vector coupling constant. Thomas R. Hemmert, *Physik Department, Theoretische Physik, Technische Universität München, D-85747 Garching, Germany;* Massimiliano Procura and Wolfram Weise, *Physik Department, Theoretische Physik, Technische Universität München, D-85747 Garching, Germany, and ECT*, Villa Tambosi, I-38050 Villazzano, Trento, Italy.* (Received 26 March 2003; published 29 October 2003)

We study the quark mass expansion of the axial-vector coupling constant g_A of the nucleon. The aim is to explore the feasibility of chiral effective field theory methods for extrapolation of lattice QCD results—so far determined at relatively large quark masses corresponding to pion masses $m_\pi \gtrsim 0.6$ GeV—down to physical values of m_π. We compare two versions of non-relativistic chiral effective field theory: One scheme restricted to pion and nucleon degrees of freedom only, and an alternative approach which incorporates explicit $\Delta(1230)$ resonance degrees of freedom. It turns out that, in order to approach the physical value of g_A in a leading-one-loop calculation, the inclusion of the explicit $\Delta(1230)$ degrees of freedom is crucial. With information on important higher order couplings constrained from analyses of the $\pi N \to \pi\pi N$ reaction, a chiral extrapolation function $g_A(m_\pi)$ is obtained, which works well from the chiral limit across the physical point into the region of present lattice data. The resulting enhancement of $g_A(m_\pi)$ near the physical pion mass is found to arise from an interplay between long- and short-distance physics. [Phys. Rev. D **68**, 075009 (2003)]