ELECTROPRODUCTION OF PIONS BY POLARIZED ELECTRONS ON POLARIZED PROTONS

A.S. Omelaenko
Physico-technical Institute, Ukrainian Academy of Sciences
Submitted 29 July 1971
ZhETF Pis. Red. 14, No. 6, 395 - 397 (20 September 1971)

In this article we estimate, in the region of the first nucleon resonance, the cross section of the reaction $ep \to e'n\pi^+(p'\pi^0)$ for the conditions of an experiment in which one registers only the scattered electron, with e and p assumed polarized.

The cross section of such a process in the single-photon approximation is given in [1][1)] (in terms of standard variables):

$$d^2\sigma / dE'd\Omega_e = N[\sigma_t + \epsilon\sigma_\ell + \sqrt{\epsilon(1+\epsilon)/2}\,\sigma_D^y \zeta_y + \xi\sqrt{\epsilon(1-\epsilon)/2}\,\sigma_D^x \zeta_x + \xi\sqrt{1-\epsilon^2}\,\sigma_D^z \zeta_z].$$

The dynamic quantities σ_i depend on the effective energy of the virtual photon E_γ and on the square of the 4-momentum transferred from the electron at λ^2: σ_t and σ_ℓ are the contributions from the transverse and longitudinal parts of the amplitude for unpolarized particles, $\sigma_D^{x,y,z}$ are due to the presence of the target polarization $\vec{\zeta}$. By virtue of the T-invariance requirement [3], which is equivalent at low energies to the applicability of the Watson theorem [4], σ_D^y vanishes. Estimates of other quantities for E_γ = 320 meV and λ^2 = 10 F^{-2} on the basis of the dispersion model [5] (multipole ratio 10_γ), with indication of the contributions of the experimentally inseparable channels with formation of π^+ and π^0 mesons, yield (the cross sections in the table are in microbarns):

	σ_t	σ_ℓ	σ_D^x	σ_D^z
π^+	63	8.3	-5.9	17.5
π^0	87	2.5	7.9	51.0
Sum	150	10.8	2.0	68.5

The most interesting fact in the result is that σ_D^z has an appreciable value, comparable with σ_t (the channel with production of a neutron pion predominates); a similar picture is observed also for other λ^2.

Thus, when polarized electrons are used in conjunction with the polarized proton target, the asymmetry in the reaction under consideration is appreciable (it reaches ∿45% in the example under consideration) and can be effectively investigated in experiments in which only the scattered electron is registered [6]. This is quite important for linear accelerators, where observation of polarization effects in cases where only the target is polarized [7] or only the incident electrons are polarized [8] is made complicated by the difficulties inherent in the detection for coincidence.

1)It is erroneously assumed in [1] that the nuclear tensor $T_{\mu\nu}$ does not have the antisymmetrical part [2] responsible for the asymmetry effect in the angular distribution of the cross section of the reaction $eN \to e'N'\pi$ when the polarized electron is scattered by an unpolarized target.

Data on σ_D^z are interesting since they serve as an independent source (alongside with σ_t) of information concerning the transverse contributions to the amplitude (σ_D^z, like σ_t, does not depend on its longitudinal part), and, in particular, can facilitate the separation of the longitudinal cross section σ_ℓ.

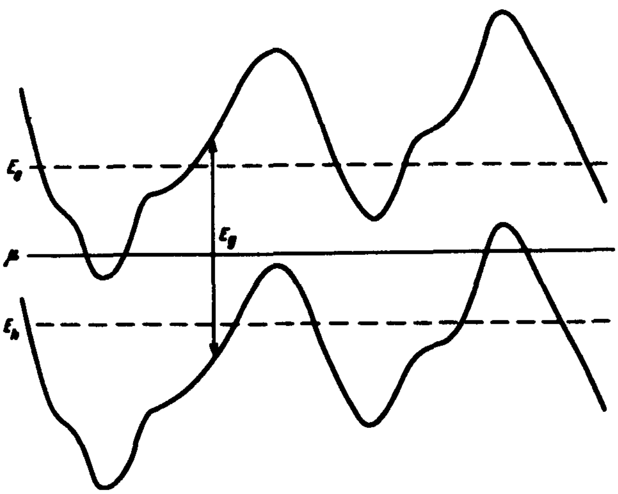
The author is grateful to M.P. Rekalo for suggesting a consideration of this effect.

[1] N. Dombey, Rev. Mod. Phys. 41, 236 (1969).
[2] S.M. Berman, Phys. Rev. 135B, 1249 (1964).
[3] N. Christ and T.D. Lee, Phys. Rev. 143, 1310 (1966).
[4] K. Watson, Phys. Rev. 95, 228 (1954).
[5] G. V. Gehlen, Nucl. Phys. B20, 102 (1970).
[6] Yu.I. Titov, N.F. Severin, N.G. Fanas'ev, et al., Yad. Fiz. 13, 541 (1971) [Sov. J. Nucl. Phys. 13, 304 (1971)].
[7] N. Zagury and A.F.F. Teixeira, Nuovo Cim. 61A, 83 (1969).
[8] G.V. Gehlen, Bonn Univ., PI2-81, Sept. 1970.

FORBIDDEN OPTICAL AND ELECTRICAL BANDS OF AN AMORPHOUS SEMICONDUCTOR

B.I. Shklovskii
A.F. Ioffe Physico-technical Institute, USSR Academy of Sciences
Submitted 9 August 1971
ZhETF Pis. Red. 14, No. 6, 397 - 400 (20 September 1971)

In amorphous semiconductors, the light absorption coefficient decreases exponentially at quantum energies $\hbar\omega$ that are smaller than a certain value E_g, called usually the optical forbidden band. At the same time, experiment shows that the density of states in the interior of the forbidden band is apparently quite large. Fritzsche [1] noted that these facts can be understood by assuming that in an amorphous semiconductor there exist large-scale fluctuations of the electrostatic potential, which lead to a parallel bending of the energy bands (see the figure). Indeed, in such a model there can exist an appreciable number of electronic states even on a Fermi level μ located deep in the forbidden band. On the other hand, absorption of light with quantum energy $\hbar\omega < E_g$ occurs only as a result of tunneling of the carriers under the humps of the large-scale relief, and is therefore very small.



Energy scheme of an amorphous semiconductor. The wavy lines represent the bottom of the conduction band and the ceiling of the valence band. The solid straight line is the Fermi level, and the dashed lines are the percolation energies of the electrons and holes.

To discuss the conductivity in the Fritzsche model, it can be assumed that the carriers behave like classical particles with respect to the large-scale potential. It is known [2] that for a classical particle in an arbitrary potential-energy relief $V(r)$ there exists a so-called percolation energy E_{perc}, i.e., the maximum value of the particle energy E,