$\eta = -1$. Investigating the forward scattering of B and recognizing that B is produced in the pure state, we can confirm or reject $j = 3$, $\eta = 1$.

If not all $A_L \neq 0$, then we can investigate the angular distribution of one of the particles produced during the decay of B. All the statements remain valid in this case, too, provided we take $\vec{n}$ to mean a unit vector in the direction of this momentum.

The method presented for determining j and η is usable also in the case of decay of B into a vector and pseudoscalar meson (in this case $\vec{n}$ is a unit vector in the direction of the momentum of the second vector).

We take this opportunity to note that the formulas obtained in [5] can be used to determine not only the parity but also the spin of an isobar.

We note that the use of a spinless target to determine the spin and parity of a boson in the case of two-particle decay was proposed earlier by Bilen'kii and Ryndin [7].

The author is sincerely grateful to I. I. Levintov and Yu. A. Simonov for valuable discussions.

[1] M. Ademollo, R. Gatto, and G. Preparata, Phys. Rev. 139B, 1608 (1965).
[2] S. M. Bilen'kii, L. I. Lapidus, and R. M. Ryndin, UFN 84, 243 (1964), Soviet Phys. Uspekhi 7, 721 (1965).
[3] G. Shapiro, Phys. Rev. 134B, 1393 (1964).
[4] S. M. Bilenky and R. M. Ryndin, Phys. Lett. 18, 346 (1965).
[5] M. S. Dubovikov, JETP Letters 3, 8 (1966), transl. p. 4.
[6] M. S. Dubovikov, Yadernaya fizika, in press
[7] S. M. Bilenky and R. M. Ryndin, Phys. Lett. 13, 159 (1964).

CHECK OF C-INVARIANCE IN PHOTOPRODUCTION OF STRONGLY-INTERACTING PARTICLES

M. P. Rekalo
Physico-technical Institute, Ukrainian Academy of Sciences
Submitted 27 December 1965
ZhETF Pis'ma 3, No. 4, 160-163, 15 February 1966

We discuss in this note the possibility of checking on the hypothesis concerning C-noninvariance of electromagnetic and strong interactions [1] in experiments with high-energy γ quanta and electrons. Many difficulties arising in the verification of C-invariance in different hadron decays can be circumvented in these experiments.

1. The decay $\pi^0 \rightarrow 3\gamma$ is due to C-noninvariant interactions. However, the large centrifugal barriers and the small interaction radii, together with the low energy release, greatly suppress this decay compared with $\pi^0 \rightarrow 2\gamma$, in spite of the smallness connected with the emission of the additional γ quantum. This difficulty can be circumvented in principle by investigating the process inverse to $\pi^0 \rightarrow 3\gamma$, viz., photoproduction in the Coulomb field of the nucleus of a π^0 meson and a γ quantum (analog of the Primakoff effect [2]). The process $\gamma + Z \rightarrow Z + \pi^0 + \gamma$ will have the appearance of the transformation of a high-energy photon in-

to three γ quanta in the field of the nucleus. The competing process of pure electrodynamic production of 3γ is of higher order in $\alpha = 1/137$. At γ energies $h\nu = hc/R$ (R = interaction radius in the $\pi^0 \to 3\gamma$ decay) the centrifugal repulsion becomes insignificant. Analogous considerations hold also for the photoproduction of an η meson and a γ quantum in the Coulomb field of the nucleus.

2. Study of the electroproduction of $\pi^0(\eta)$ mesons at high energies also enables us to investigate the violation of C-invariance in electromagnetic interactions.

As is well known [3], at high energies ($h\nu \simeq 1$ GeV) the photoproduction of π^+ mesons at small angles is determined essentially by a peripheral mechanism corresponding to π^+-meson exchange. In π^0 photoproduction there is no such mechanism.

However, in the electroproduction of π^0 mesons a peripheral mechanism of η-meson exchange is possible. The differential cross section for this mechanism is of the form (in the c.m.s. of the entire reaction)

$$d\sigma = \alpha \frac{f_\eta^2}{4\pi} f_1(h^2\nu^2) \frac{(-\Delta^2)((h\nu)^2 m_\pi^2 - 4qr_1qr_2)|\vec{p}|d\Omega_p d^3\vec{r}_2}{(h\nu)^4 (\Delta^2 - m_\eta^2)^2 8\pi^3 W \epsilon_2[(\omega + E_2)(\vec{q}\cdot\vec{p}_2/\vec{p}^2)]}, \quad (1)$$

where f_η is the constant of the (ηNN) interaction, $f_1(h^2\nu^2)$ the form factor of the ($\gamma\eta\pi$) vertex, r_1 and r_2 the 4-momenta of the initial and final electrons, $h\nu = r_2 - r_1$, q the 4-momentum of the π^0 meson, ϵ_2, E_2, ω the energies of the final electron, the nucleon, and the π^0 meson, $W = E_2 + \epsilon_2 + \omega$, and Δ^2 the square of the 4-momentum transferred to the nucleon.

Therefore, if we disregard the contribution of the vector mesons, the behavior of the cross sections for electroproduction of π^0 and π^+ mesons on protons at small angles relative to the momentum of the virtual γ quantum will differ from the behavior of the cross sections for the photoproduction of π^0 and π^+ when C-invariance is violated.

To get rid of the contribution of the vector mesons, we can operate in the energy region where exchange of vector mesons is insignificant as a result of their appreciable mass, whereas exchange of pseudoscalar mesons plays an important role (this corresponds to a virtual-photon energy in the interval 400 - 800 MeV). Another possibility arises when linearly polarized γ quanta are used. Then in the case of pseudoscalar-meson exchange the π^0 mesons are produced predominantly in the polarization plane, and for vector-meson exchange there is preferred production of π^0 perpendicular to the polarization plane. Such an investigation is made easy by the fact that the virtual γ quanta have a considerable linear polarization.

Everything stated above is valid also for the process $e^- + p \to e^- + p + \eta$, with the only advantage that the C-noninvariant peripheral exchange of the π^0 meson at γ-quantum energies up to 1 GeV should exceed the contribution of the vector mesons in the small-angle region. The validity of this statement can be checked in the process $e^- + d \to e^- + d + \eta$, where there should be no η mesons at small angles.

3. The decays $\omega \to \rho^0 + \gamma$ and $\varphi \to \rho(\omega) + \gamma$ are of interest for explaining the isotopic structure of the C-invariance-violating electromagnetic current. The difficulty connected with the suppression of these decays by the low energy release can be circumvented by investigating the processes

$$\gamma + p \to p + \rho^0, \quad \gamma + p \to p + \omega, \quad \gamma + p \to p + \varphi$$

in the angle and energy region where peripheral mechanisms corresponding to vector-meson exchange take place. Exchange of pseudoscalar mesons, which does not violate C-invariance, is a competing process. With the aid of linearly-polarized γ quanta it is possible to separate the mechanism of interest to us.

4. In conclusion let us consider the process $\gamma + p \to p + f^0$ at small angles of f^0 production. If C-parity is not conserved, then peripheral mechanisms take place with $\pi^0(\eta)$ meson exchange. In this case the form of the cross section is (we retain the contribution of the π^0 meson only)

$$\frac{d\sigma}{d\Omega} = \frac{g^2}{4\pi}\frac{5}{2}\frac{m\Gamma(f \to \pi^0\gamma)(-\Delta^2)}{W^2(1 - m_\pi^2/m^2)(\Delta^2 - m_\pi^2)^2}\left(\frac{\Delta^2/m^2 - 1}{m_\pi^2/m^2 - 1}\right)^4, \tag{2}$$

where g is the (πN) interaction constant, $\Gamma(f \to \pi^0\gamma)$ the width of the decay $f \to \pi^0 + \gamma$, m the mass of the f meson, W the total energy, and Δ^2 the square of the momentum transfer.

We note that a direct investigation of the decay $f \to \pi^0 + \gamma$ is made difficult by the large width of the f meson, which decays as a result of the strong interactions.

[1] J. Prentki, Lecture given at Oxford Internat. Conf. on Elementary Particles, CERN Preprint 65/1358/5-TH, 604.

[2] A. Primakoff, Phys. Rev. 81, 899 (1951).

[3] M. Beneventano, R. Finzi, L. Mezzetti, L. Paoluzi, and S. Tazzari, Nuovo Cimento 28, 1464 (1963).

CROSS SECTION FOR THE PRODUCTION OF CHARGED PIONS IN (n-p) COLLISIONS AT A NEUTRON EFFECTIVE ENERGY 585 keV

S. G. Basiladze, P. F. Ermolov, and K. O. Oganesyan
Joint Institute of Nuclear Research

Submitted 2 January 1966
ZhETF Pis'ma 3, No. 4, 163-166, 15 February 1966

The cross section for the production of charged pions in the reactions

$$\begin{aligned} n + p &\to \pi^+ + n + n, \\ n + p &\to \pi^- + p + p \end{aligned} \tag{1}$$

plays an important role in the phenomenological analysis of pion production in nucleon-nucleon collisions.

The cross sections of (1) were measured in [1,2] for 600 MeV neutrons. To obtain more accurate values, we have made new measurements with the aid of a scintillation telescope and a liquid-hydrogen target in the form of a Dewar of special construction.

Figure 1 shows the diagram of the experiment. A neutron beam from the JINR synchrocyclotron was incident on the liquid-hydrogen target. The pions of both polarities produced