DIFFRACTION PATTERNS FOR INELASTIC ELEMENTARY PARTICLE PROCESSES*

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The purpose of this Letter is to point out a possible application of optical diffraction ideas to inelastic processes where strong absorptive competing channels are open. Such conditions prevail in nucleon-antinucleon scattering due to a large probability for annihilation in collisions with small impact parameters. This is proven by the good fit of elastic $\bar{p}p$ scattering to a diffraction pattern from a black sphere.[1] A diffraction mechanism for direct nuclear reactions where similar conditions are valid has recently been proposed by one of us.[2] We have applied the same formalism to $p+\bar{p}\rightarrow B+\bar{B}'$ processes. The physical picture underlying our treatment is that the combined effect of strong absorption at small impact parameters and the finite range of the interaction localizes the process to an annular region encircling the target (Fig. 1). If the width of the annular region is small in comparison to its radius, then the corresponding diffraction pattern in the Fraunhofer approximation[2] is given by

$$d\sigma/d\Omega = A(1+|\vec{k}_i/\vec{k}_f|\cos\theta)^2 J_0(|\vec{q}|R)^2, \qquad (1)$$

where $\vec{k}_i$, $\vec{k}_f$ are the initial and final center-of-mass momenta, respectively, $\vec{q}=\vec{k}_f-\vec{k}_i$ is the momentum transfer, $J_0(x)$ is the cylindrical Bessel function, R is the radius of the annulus, A is a normalization factor, and θ is the center-of-mass scattering angle.

Figures 2 and 3 illustrate the kind of fit obtained for $\bar{p}p$ going to $\bar{n}n$ at 0.9 GeV/c and $\bar{\Lambda}\Lambda$ at 3.3 GeV/c. The experimental data are taken from Wenzel[3] and Baltay et al.,[4] respectively. The oscillatory behavior characteristic of the diffraction pattern as opposed to the monotonic decrease predicted by the single K^* exchange[5] agrees quite well with experimental data. The data of $p+\bar{p}\rightarrow\Sigma^0+\bar{\Lambda}$, $\Sigma^++\bar{\Sigma}^+$, $\Sigma^-+\bar{\Sigma}^-$ [6] show the same features, but because of the small number of events the fit obtained is not significant. It is worthwhile noting that the radii used for the two fits, $R_{n\bar{n}}=1.7\times10^{-13}$ cm, $R_{\Lambda\bar{\Lambda}}=1.5\times10^{-13}$ cm, are slightly larger than the "annihilation radius"[7] at the corresponding energies[3] (Fig. 1), $R_{\rm ann}(T=900\text{ MeV})\sim1.25\times10^{-13}$ cm, $R_{\rm ann}(3.3\text{ GeV}/c)$

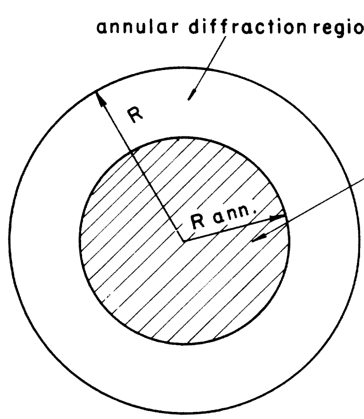

FIG. 1. Schematic description of annihilation and diffraction regions. The beam of incoming particles is perpendicular to the plane of the paper.

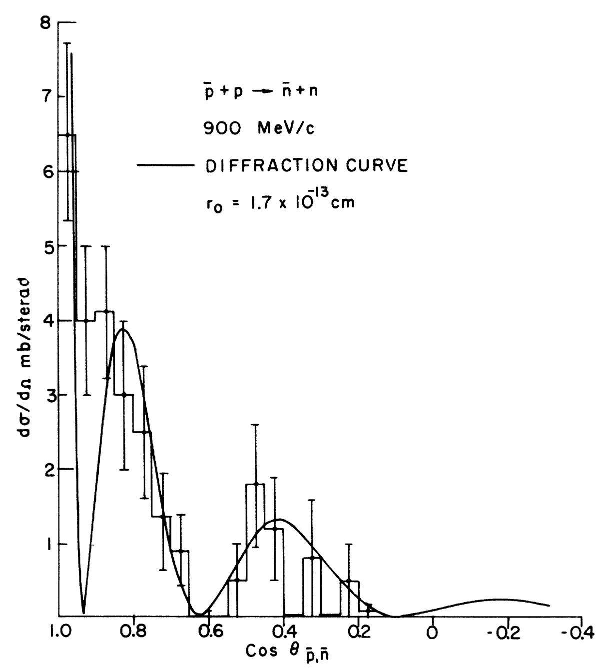

FIG. 2. Experimental results and diffraction fit for $\bar{p}+p\rightarrow\bar{n}+n$ angular distribution at 0.9 GeV/c.

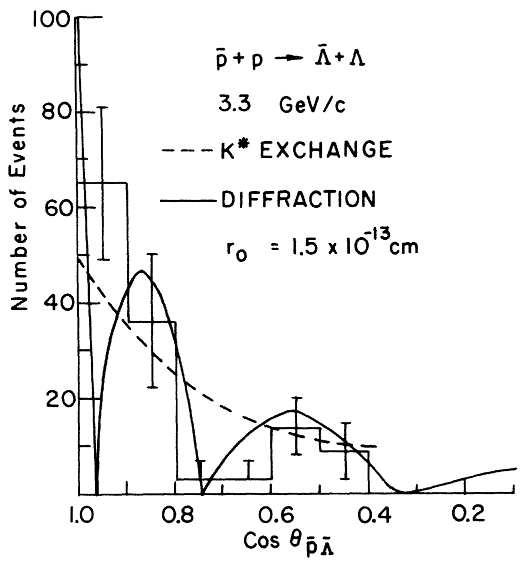

FIG. 3. Experimental results, K^* exchange, and diffraction fit for $\bar{p}+p \to \bar{\Lambda}+\Lambda$ at 3.3 GeV/c.

$\sim 1\times 10^{-13}$ cm. This fact supports the assumption of a narrow annular diffraction region. One is thus led to the conclusion that strong absorption in the entrance channel may dominate the angular distribution regardless of the details of the process. The fact that the first minimum is not as pronounced as the second one is typical also of nuclear reactions[2] and may be explained by finer details of the interaction.

The same ideas have also been applied to other quasielastic processes such as $K^+ + n \to K^0 + p$, $\pi^- + p \to n + p$, $K^+ + p \to K^* + N^*$, etc. Similar fits were obtained. The theory underlying this phenomenological approach is being investigated.

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[1]B. Cork et al., Nuovo Cimento 25, 497 (1962); see also reference 3.

[2]A. Dar, Phys. Letters 7 (1963) (in press); Nucl. Phys. (to be published).

[3]W. A. Wenzel, Proceedings of the Tenth Annual International Rochester Conference on High-Energy Physics, 1960 (Interscience Publishers, Inc., New York, 1960), p. 151.

[4]C. Baltay et al., Proceedings of the International Conference on High-Energy Nuclear Physics, Geneva, 1962 (CERN Scientific Information Service, Geneva, Switzerland, 1962), p. 233.

[5]H. D. D. Watson, Nuovo Cimento 29, 1338 (1963).

[6]R. Armenteros et al., Proceedings of the International Conference on High-Energy Nuclear Physics, Geneva, 1962 (CERN Scientific Information Service, Geneva, Switzerland, 1962), p. 236.

[7]The annihilation radius is defined by $\sigma_{\text{ann}} = \pi R_{\text{ann}}^2$.

TRANSFORMATION PROPERTIES OF NONLEPTONIC WEAK INTERACTIONS*

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The $\Delta T = \frac{1}{2}$ rule for nonleptonic decays of strange particles means that the part of the Hamiltonian $H_W(\Delta S = +1)$, responsible for these decays with $\Delta S = 1$, transforms like the K^0 meson with respect to the hypercharge gauge transformation and isospin rotations $[H_W = H_W(\Delta S = +1) + H_W(\Delta S = -1)$; $H_W(\Delta S = -1) = H_W{}^\dagger(\Delta S = +1)]$. We would like to propose that $H_W(\Delta S = +1)$ transforms like the K^0 meson with respect to all SU_3 transformations,[1] and H_W is approximately invariant under the product of parity conjugation (P) and R conjugation.[2] We shall discuss some consequences of these proposed rules on nonleptonic decays of strange particles.

The first part of the proposal[3] means that $H_W(\Delta S = +1)$ is an irreducible tensor operator transforming like the operator E_3 of Behrends et al.[4] We can offer no a priori justification for this extension of the $\Delta T = \frac{1}{2}$ rule, but merely point out that assignments of irreducible tensor characters to symmetry-breaking interactions (e.g., electromagnetic,[5] mass-splitting[6]) are not unprecedented and have been fruitful. The new rule, of course, encompasses all the consequences of the $\Delta T = \frac{1}{2}$