Allowance for rescattering in the eikonal approximation shows that asymptotic spin flip effects (the parameters $A$ and $R$) at small $q$ should not depend on the energy and on the nature of the incident particles.

Grigoryev and Pomeranchuk\(^1\) have shown that asymptotically the value of spin flip in the scattering of polarized nucleons does not depend on the energy and nature of the incident particles, provided that the amplitude is determined by one Hegge pole. Under the same condition the asymptotic value of recoil nucleon polarization is equal to zero. These simple consequences of the factorization of residues and of the properties of the signature factor can be easily illustrated for the process $0^+ + p - 0^+ + \pi^-$.

We define the t-channel amplitudes in the s-channel without spin flip and with spin flip, respectively, as $M_0$ and $M_1$. When account is taken of one pole

$$
M_0 = 4\pi \int \frac{(1 - e^{i\delta(t)} \cos b_1(t)) I_0(qb) dqb}{q},
$$

and

$$
M_1 = -4\pi \int e^{i\delta(t)} \sin b_1(t) I_1(qb) dqb.
$$

From (1), (1'), and (2), (2') we obtain

$$
P_\perp = -2Re M_0 M_1^* (|M_0|^2 + |M_1|^2)^{-1},
$$

$$
P_\parallel = 2Im M_0 M_1^* (|M_0|^2 + |M_1|^2)^{-1}.
$$

which are the results of Pomeranchuk and Grigoryev.

There arises the question of how these conclusions are modified when account is taken of rescattering effects (branch cuts in the j-plane). The precise answer can hardly be obtained at present. Nevertheless, it is possible to show that formula (3) remains approximately correct when account is taken of rescattering at the expense of one pole in the eikonal approximation\(^2\), that is, with account taken of only one-particle intermediate states of the interacting particles. Stated more precisely, the independence of $P_\perp$ of the nature of the incident particles arises when

$$
\delta(t) = \frac{1}{4\pi} \int \frac{M_0 I_0(qb) dqb}{g_0N(0)},
$$

and $M_1$ with the calculation of (8) in the form

$$
M_1 \approx -4\pi i \int \frac{1}{2m} \frac{g_1N(0)}{g_0N(0)} d(1 - e^{i\delta(t)}) I_1(qb) b db.
$$

\(^1\)The value of spin flip $P_\perp$ is simply related to the parameters $A$ and $R$ of Wolfenstein: $P_\perp = A \cos \theta + R \sin \theta$, where $\theta$ is the proton scattering angle in the laboratory system.\(^2\)
Integrating (10) by parts and using the relation
d\[bJ_l(bq) = J_0(qb)qbdb,\]
we obtain for \(M_1\):

\[
M_1 \approx \frac{4\pi i}{2m} \int \frac{g_{\Sigma N}(0)}{g_{\Sigma N}(0)} \left(1 - e^{ib\delta_\Sigma}\right) J_0(qb) bdq,
\]

i.e.,

\[
M_1 \approx \frac{\gamma(t)}{2m} \frac{g_{\Sigma N}(0)}{g_{\Sigma N}(0)} M_0.
\]

The relation (12) immediately leads to a formula for \(P_1\), analogous to (3), in which \(g_{\Sigma N}(t)\) and \(g_{\Sigma N}(t)\) must be taken at \(t = 0\). As is evident, the polarization in the approximations (9)–(12) is, as before, equal to zero.

The polarization with allowance for one pole is due to diagrams corresponding at least to double and triple rescattering with a change in helicity respectively in \(M_0\) and \(M_1\), i.e., due to expansion terms containing \((\delta_\Sigma)^2\) in \(M_0\) and \((\delta_\Sigma)^3\) in \(M_1\). At \(t = 0\) the relative contribution of these terms to \(M_0\) and \(M_1\) is of the order of \((\delta_\Sigma)^2\), since according to the pole parametrization given by Phillips and Rarita, \((\delta_\Sigma)^2\) lies between the limits of \(10^{-2}\) and \(10^{-3}\). Substantial deviations from (12) and the emergence of considerable polarization at \(E \approx 100\) GeV can, apparently, take place at \(|t| \approx 1\text{GeV/c}\), when \(M_0\) falls to \(10^{-3}\) of its value at \(t = 0\). The polarization arising because of the rescattering due to the Pomeranchuk pole must evidently become the same in \(\pi^0 p\) and \(\pi^0 n\) scattering. At very high energies the phases \(\delta_0\) and \(\delta_\Sigma\) become purely imaginary and the polarization tends to zero for all \(t\). In this manner allowance for the branch cuts in the eikonal approximation leads to the conclusion that asymptotic spin flip effects at small \(t\) should not depend on the energy and on the nature of the incident particles.

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