Do Regge Pole-Cuts Account for $\Delta\sigma_T(\pi p)$?*

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The difference between $\sigma_T(\pi^+p)$ and $\sigma_T(\pi^-p)$ tends to level off around 40 GeV/c. Recent articles have contended the Regge pole-cuts can account for this trend. We have extended the calculations from a previous paper on π^-p charge-exchange scattering to $\Delta\sigma_T(\pi p)$. We find that the Regge pole-cut model does not improve the single-Regge-pole predictions to the high-energy end of $\Delta\sigma_T(\pi p)$.

In a recent publication[1] a phenomenological study of π^-p charge-exchange (CEX) differential cross section and polarizations was made using two different Regge-pole models: (1) the conspiracy model which consisted of the ρ plus a conspiring ρ' trajectory; (2) the Regge pole-cut model which consisted of the ρ plus an absorptive cut. In both cases the amplitudes were taken to have the Veneziano-type residue of $1/\Gamma(\alpha)$. In that calculation it was found that the conspiracy model was favored by the data over the Regge pole-cut model. Here we extend the same calculation to total cross sections directly by looking at the difference between π^+p and π^-p total cross sections $[\Delta\sigma_T(\pi p)]$.

Recent articles have shown that a plain Regge-pole model is inadequate to account for the high-energy end of the total cross sections.[2] It has been been suggested that a logarithmic term in the form of a Regge pole-cut be added to the plain Regge pole to explain this behavior. One might think that a similiar kind of pole-cut model should be applied to $\Delta\sigma_T(\pi p)$. This is directly related to the nonflip amplitude of π^-p charge-exchange scattering which we have considered in the previous calculation. Thus the results from the previous calculation can be applied directly. In the previous paper we considered a conspiracy model; however, because of the conspiracy relation the nonflip part of the conspiring ρ' amplitude vanishes at $t=0$. So it has no effect on the total cross sections.

Using isospin analysis π^-p charge-exchange amplitudes can be related to the elastic amplitudes of π^+p and π^-p by

$$A(\pi^-p\to\pi^0n)=\frac{1}{\sqrt{2}}\left[A(\pi^+p\to\pi^+p)-A(\pi^-p\to\pi^-p)\right].$$

Using the optical theorem, the total cross sections are thus related by

$$\sigma_T(\pi^+p)-\sigma_T(\pi^-p)=\frac{\sqrt{2}}{2k\sqrt{s}}\,\mathrm{Im}\,M_{++}(\pi^-p\to\pi^0n;\,t=0),$$

where M_{++} is the helicity-nonflip amplitude used in the previous paper.[1] This amplitude is further broken down into two parts as follows:

$$M_{++}=M^{\rho}_{++}+\lambda_{++}M^{\text{cut}}_{++}.$$

The M^{ρ}_{++} is the plain ρ amplitude (the ρ' contribution vanishing in the forward direction). The M^{cut}_{++} is the cut amplitude which is generated by a convolution integral.[3] The plain Regge-pole model (using M^{ρ}_{++} only) contains only one parameter. The Regge-cut model contains three parameters, including the λ_{++} factor. The data used ranged in momentum from 6 to 65 GeV/c.[4]

In the previous calculation the conspiracy model gave a χ^2 of 143 for 109 data points and the Regge pole-cut model gave a χ^2 of 257. The parameter values from the best CEX fits were used to make predictions for $\Delta\sigma_T(\pi p)$. Looking at Fig. 1, we find that both models give essentially the same results. Both solid curves give χ^2 of 15 for 18 data points; however, they consistently fall below the experimental data at 40 to 70 GeV/c. The Pome-

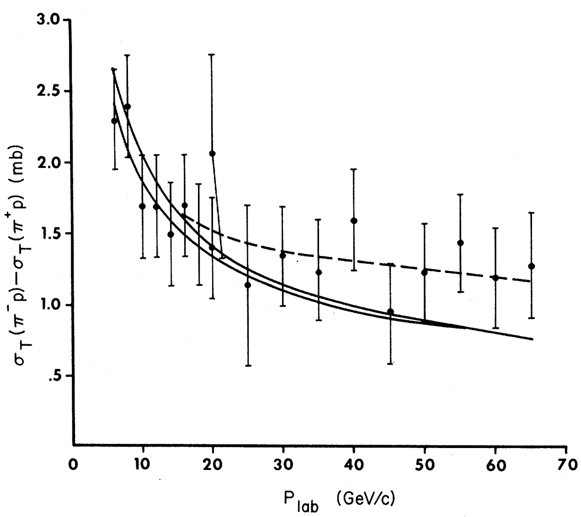

FIG. 1. Solid curves are predictions for $\Delta\sigma_T(\pi p)$ based on previous calculation. Upper solid curve is for ρ alone. Lower solid curve is for ρ plus cut. Dashed curve is for ρ plus cut best fit to $\Delta\sigma_T(\pi p)$.

ranchuk theorem states that the graph should approach zero.

Next the parameters were allowed to vary in fitting $\Delta\sigma_T(\pi p)$. There was no significant change in the plain Regge-pole model. However the Regge pole-cut model was then able to better approximate the high-energy end of $\Delta\sigma_T(\pi p)$ and gave a χ^2 of five. This corresponds to the dashed curve. But this required a rather large cut correction. That is $\lambda_{++}\approx 5$. This result is in agreement with other works.[5] However when the parameter values corresponding to the best $\Delta\sigma_T(\pi p)$ fit were used in the CEX differential cross sections and polarization calculation, astronomical χ^2 values resulted. It was further found that there is no consistent solution for $\lambda_{++}\approx 5$ for $\Delta\sigma_T(\pi p)$ and CEX differential cross sections and polarization.

In summary, both the conspiracy model and the Regge pole-cut model are unable to account for the leveling off of $\Delta\sigma_T(\pi p)$ at higher energies.

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Limit on Nuclear Time-Reversal-Invariance Violation from the Neutron Electric Dipole Moment*

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Time-reversal noninvariance in nuclei has recently been parametrized in terms of a four-point coupling, of undetermined strength, of an isovector photon, a charged pion, and the nucleon current. If parity violation is introduced via the weak interaction, this coupling is restricted by the failure to observe a neutron electric dipole moment to a size which is an order of magnitude smaller than the limit imposed by present nuclear γ-decay experiments.

In a recent letter[1] Clement and Heller discuss the expected size of T-violating effects in nuclear γ decay arising from a possible C and T noninvariance of the electromagnetic interaction.[2] We investigate here the limit imposed on these effects by the failure to observe a neutron electric dipole moment.[3]

Clement and Heller calculate the T-odd two-nucleon matrix elements of the long-range $E1$ and $M1$ multipole operators from a supposed T violation in the four-point coupling of an isovector photon, a charged pion, and the nucleon current. They make a "rough guess" as to that size of coupling constant which would correspond to a large or "maximal" effect and conclude that the most sensitive present limit on the $E2$-$M1$ phase (in ^{36}Cl) still falls short of probing such an effect. The virtue of this approach is that it avoids the consideration of off-shell nucleons that necessarily attends any attempt to parametrize T violation without P violation at the $NN\gamma$ vertex.[4]

The question arises whether the coupling they take as "maximal" would lead to observable effects in other low-energy T-violation tests. More usefully, we would like to know whether the present nuclear experiments, when interpreted in their model, are more or less sensitive to electromagnetic T violation than is the present experimental upper limit[3] of 5×10^{-23} cm on the neutron electric dipole moment (EDM). Our calculation indicates