Comments and Addenda

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Pomeranchuk Dominance of the Imaginary Part of the K^+p Elastic Amplitude*

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Using a phase-shift solution for K^+p scattering, it is found that $\mathrm{Im}A'(\nu,t)$ is well described by a Pomeranchuk exchange in agreement with the Harari-Freund duality conjecture.

I. INTRODUCTION

Resonances in the K^+p system are not expected on the basis of the quark model, and from experiment one can at least say that they are much less prominent than in other channels.[1] The hypothesis of local duality, together with the suggestion that two-body scattering amplitudes are made up of two components,[2] namely, the resonance (ordinary Regge-trajectory part) and the background (Pomeranchuk part), leads us to expect that the imaginary part of the K^+p amplitude may be well represented by the Pomeranchuk contribution even at low energy. For forward scattering the consistency of this statement is evident from the observation that the total K^+p cross section is quite flat from 1.4 GeV/c up.[3] In this article we shall present a test of this hypothesis for nonforward directions.

The analysis is straightforward. Using a phase-shift solution for elastic K^+p scattering, we compute $\mathrm{Im}A'(\nu, t)$ and $\mathrm{Im}B(\nu, t)$ and note how well these amplitudes may be represented by $\beta_{A'}(t)\nu^{1+\alpha' t}$ and $\beta_B(t)\nu^{\alpha' t}$. For this analysis we have used the phase-shift solutions of Barber *et al.*[4] In the above, $\nu = E_{\mathrm{lab}} + t/4M$ and we have parametrized the Pomeranchuk trajectory with a linear t dependence. We carried our analysis to $t = -0.6\ \mathrm{GeV}^2$.

II. RESULTS

The analysis was performed by plotting $\mathrm{Im}A'(\nu, t)/\nu^{1+\alpha' t}$ for various values of α' and noting how well this function approached a constant. For solutions I, II, and IV of Ref. 4, a desired result was obtained with the slope between $\alpha' = 0$ and $\alpha' = 0.5$.

In Fig. 1 we present the result for solution II and it may be seen that, with the above slopes, the Pomeranchuk trajectory is a good representation of the scattering amplitude for $\nu > 1.5$ GeV/c. With the exception of solution III, the other solutions gave equally acceptable results. Solution III had much more rapid variation with energy and thus could not be fitted with our simple assumptions. Likewise, there was no point in testing this hypothesis on the B amplitude as, even in the forward direction where one would expect it to be flat, this amplitude showed great fluctuation, both as a function of energy and from solution to solution. This lack of stability in the determination of $\mathrm{Im}B$ is due to the fact that this part of the amplitude is relatively small; it varies from 5% to 25% of $\mathrm{Im}A'$ and is a comparably small fraction of $\mathrm{Re}B$. Thus, neither the differential cross section nor the polarization is sensitive to this small amplitude. In Fig. 2 we present $\beta_{A'}(t)$ as obtained from solution II. [The linear behavior of $\beta_{A'}(t)$ for $\alpha' = 0.5\ \mathrm{GeV}^{-2}$ must be regarded as fortuitous.]

III. CONCLUSION

We conclude that the imaginary part of the A' amplitude in K^+p scattering is well represented by the diffractive Pomeranchuk amplitude in accordance with the hypothesis of Ref. 2.

There are other works where related analyses were performed. Carreras and Donnachie[5] com-

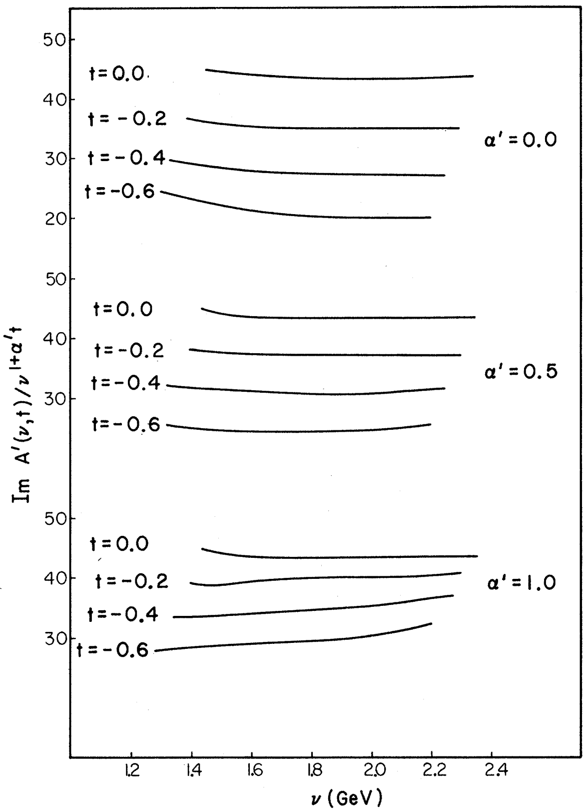

FIG. 1. $\mathrm{Im}A'(\nu,t)/\nu^{1+\alpha' t}$ for various values of α' as a function of ν. ($\nu = E_{\mathrm{lab}} + t/4M$.)

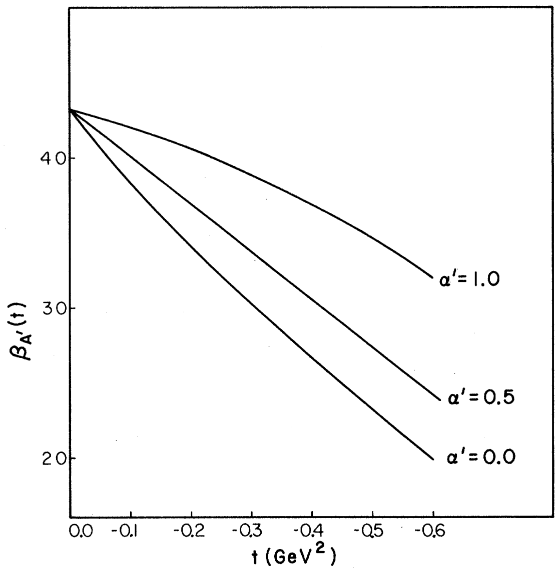

FIG. 2. $\beta(t) = \mathrm{Im}A'(\nu,t)/\nu^{1+\alpha' t}$ for various values of α' as a function of t. $E_{\mathrm{lab}} = 2.0$ GeV/c.

pared a Regge-pole model with phase-shift solutions. Since in their analysis the ordinary trajectories contributed to the imaginary parts of the K^+p amplitude, i.e., the ρ-ω-f_0-A_2 trajectory system was not degenerate, their results are not directly comparable to ours.

Recently Lovelace and Wagner[6] used a high-energy Regge-pole fit to obtain the higher partial waves used in a phase-shift analysis. As the Pomeranchuk contribution was turned off below 2 GeV/c, it cannot be used as a test of the hypothesis discussed in the Introduction.

The presence of Regge cuts brings up the question of which part of the A' amplitude these cuts should be associated with. During the preparation of this work we received a preprint by Meyers and Salin[7] who likewise studied the same amplitude, but using different phase-shift solutions. These authors made a model-dependent separation of the cut contribution to the imaginary part of the amplitude to isolate the "pure" Pomeranchuk contribution. The spirit of this work was different from theirs in that they assumed the above-mentioned duality picture while this work tested it. Nevertheless, as the results obtained were consistent with a dominant Pomeranchuk description of the K^+p scattering amplitude above 1.5 GeV/c, our results were consistent with those obtained in the above work.

The value of $\alpha' = 0.5$ is favored by other analyses described in Refs. 6–8 and is consistent with our results. In Ref. 8 it was likewise noted that a Regge-pole solution does describe certain phase and magnitude relations of the phase-shift solutions of the K^+p system.

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