Title
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Publication Date
1967-10-06

UCRL-17873

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DISCLAIMER

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Preprint

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AEC Contract No. W-7405-eng-48

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EVALUATION AND FUTURE OF THE REGGE POLE MODEL FOR πN SCATTERING AT HIGH ENERGIES*

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Recently a fairly complete analysis[1] has been made of πN scattering at small momentum transfers and high energies according to the Regge-pole model in which the dominant poles in the crossed channel are P, P', and ρ. The model fits a wide variety of data, including the differential cross sections, recent results from Brookhaven on total cross sections, and ratios of the real to the imaginary parts of the forward scattering amplitude, and also recent πp polarization results. Several sum rule constraints were applied in the search to obtain the best parameters to fit the data. The ρ characteristics--its mass and its nuclear charge and magnetic form factors--are well described by Solution (3), the favored solution of Ref. 1. Additional requirements were imposed by the factorization property of Regge poles connecting $\pi^{\pm}p$ to $p^{\pm}p$.

We do not discuss in detail $\pi^- p \to \pi^0 n$ polarization data. Some new ingredient, such as another Regge pole[2] ρ', must be added. However, such calculations indicate that the corrections to the elastic or charge-exchange scattering are small.

New data[3] on the phase of the forward scattering amplitudes for $\pi^{\pm}p$ became available after the completion of the analysis of Ref. 1.

In Fig. 1 we show these data together with the calculated values obtained from Solution (3). Although the fit is not so remarkable as with the previous Coral Gables data, still we feel that it is good, especially in view of the estimated errors involved. A very similar result for the phase was obtained by Foley et al.[3] with the use of a dispersion relation. Höhler and Strauss (in a recent preprint[4]) arrive at a like conclusion. Figure 2 is taken from their work.[4] The real part of the forward charge-exchange amplitude, Re $F^{(-)}$, is plotted against the incoming pion momentum, k. The overall agreement appears to be highly satisfactory. On the other hand, Gajdicar and Moffat,[5] from the same data, have advocated that Re $F^{(-)}$ passes through zero at about 20 BeV/c. The high-energy end of the dispersion relation was adjusted to bring this about. But the charge-exchange data would resist such an interpretation. Strong support for the view of Refs. 1 and 4 comes from the work of Dolen, Horn, and Schmid,[6] who apply sum rules to the charge-exchange data. These sum rules allow a smooth joining of the low-energy direct-channel πN data to the high-energy crossed channel (the Regge poles). We further remark that Foley et al.[3] (a) employ the Bethe Coulomb correction now, and (b) take the pion form factor as the same as for the proton. Further justification amongst others is given for (a) by Locher[7] and for (b) by a recent Cornell preprint.[8]

The electromagnetic properties of the ρ fit well with the general behavior of the πN elastic polarization. The $(P + P') - \rho$ interference term with opposite signs for $\pi^+ p$ and $\pi^- p$ polarization

seems to dominate. The P-P' term which has the same sign for both is found to be relatively small. Experiment seems to require the latter[9] to be positive at 6 BeV/c and negative at 12 BeV/c. Of course, the simple[4] P-P' term cannot describe such an effect, but could come from interference with the exchange of a third $I = 0$ pole.

Unitarity of one of the solutions of Ref. 1 was tested by making a partial-wave analysis. A simple formula is dervied for the shrinking of diffraction peaks. Also given are predictions for the still unmeasured A_{recoil} and R_{recoil}.

Research should proceed to determine a possible unique set of πN parameters and to test or incorporate some symmetry schemes.

FOOTNOTE AND REFERENCES

* This work was supported in part by the U. S. Atomic Energy Commission.

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FIGURE CAPTIONS

Fig. 1. The ratio of the real to the imaginary part of the forward scattering amplitude for $\pi^{\pm}p$ scattering from Ref. 3 compared with Solution (3) of Ref. 1. The upper curve (x) is for $\pi^{-}p$ and the lower curve (+) is for $\pi^{+}p$.

Fig. 2. This figure is taken from Ref. 4. Here $F^{(-)}$ is the forward charge-exchange amplitude. The curve is from a dispersion relation. The forward charge-exchange data of Stirling et al. o, Mannelli et al. σ, Foley et al.[3] x.

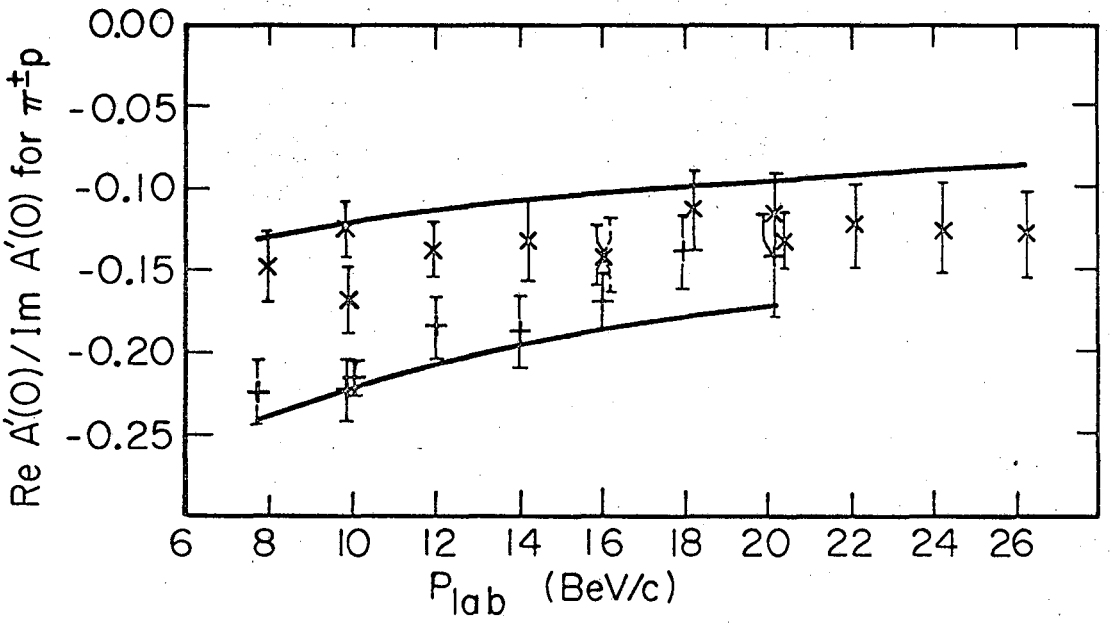

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Fig. 1

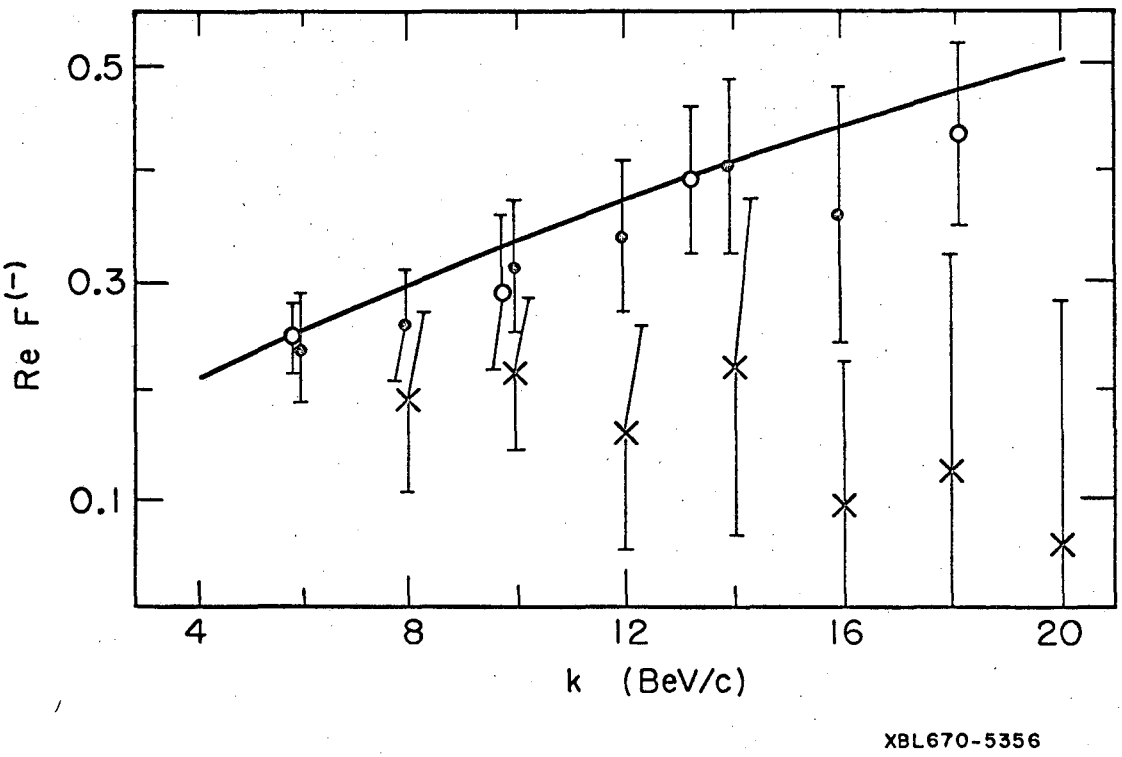

Fig. 2