Eleven of the events are in the narrow region about the mass of the ϕ. Resolution in the K^+K^- mass for each event is 0.6 MeV, and this permits a measurement of the φ mass and width. Figure 2 is the Gaussian ideogram of the mass distribution for the events. Included in the figure is the resolution function obtained as in reference 2, and a Breit-Wigner resonance distribution of width $\Gamma = 3.1$ MeV. Uniform background has been added to this distribution, and the resolution has been folded in. The observed width is substantially larger than the resolution. We find

$$\Gamma_\phi = 3.1 \pm 1.0 \text{ MeV},$$

$$M_\phi = 1018.6 \pm 0.5 \text{ MeV}.$$

We note for comparison that the width of the ω has been found[2] to be

$$\Gamma_\omega = 9.5 \pm 2.1 \text{ MeV}.$$

It is hoped that such measurements of the widths will help to clarify the roles of the ω and φ and the conjectured ω-φ mixing[3] in the unitary symmetry scheme. At present, however, the authors are not aware of any substantial arguments capable of explaining or relating the two widths.

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REGGE-POLE HYPOTHESIS AND π-p DIFFRACTION EXPERIMENTS*

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Recent experiments at 5-20 BeV[1] have shown a substantial shrinkage with increasing energy of the forward peak width for p-p elastic scattering, whereas only a slight shrinkage was observed for π-p scattering. At first sight this result seems to contradict the prediction of the Regge-pole hypothesis, and the opinion has been expressed that a reasonably simple superposition of Regge poles is unlikely to fit all the experimental data. The purpose of this Letter is to show that when other available experimental and theoretical information is employed, the existing π-p data are, in fact, entirely consistent with a simple Regge-pole representation. In particular, we present a two-parameter fit to the elastic π-p scattering.

The behavior of the total π-p cross sections has made it clear for a long time that to represent the 5- to 20-BeV region, the Pomeranchuk trajectory must be supplemented by at least one further trajectory, the simplest possibility being the P' of Igi.[2] Furthermore, without any firm basis, it has often been assumed that all trajectories are linear with slopes near 1 BeV^{-2} in magnitude, even after the discovery of the f^0 particle gave evidence to the contrary.[3,4] In a previous paper,[5] the authors used dispersion theory together with the mass and width of the f^0 to estimate the slope of the Pomeranchuk trajectory as between 0.3 and 0.4 BeV^{-2} in the region of interest ($-0.8\ \text{BeV}^2 \lesssim t < 0$), while with similar but more conservative arguments, Pignotti[6] placed a firm upper bound of 0.6 BeV^{-2} on the slope. Appreciable curvature also was indicated by our study. We propose here to employ the Pomeranchuk trajectory already deduced by us in reference 5 and shown in Fig. 1. The detailed shape of the P' trajectory is less important and, for lack of other information, we shall take it parallel to the P. The ρ-meson contribution will be neglected since it contributes with opposite signs in π^+-p and π^--p scattering where the cross sections are known experimentally to be almost identical.[1]

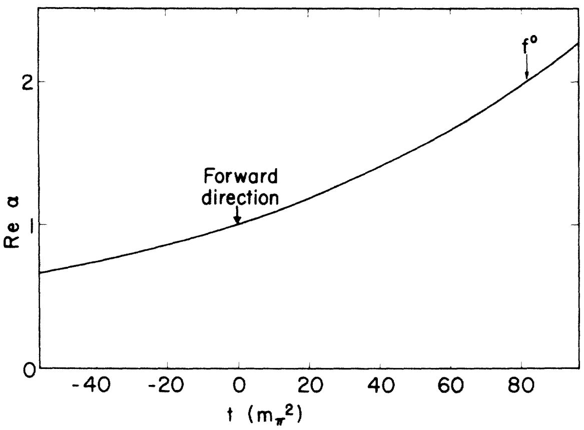

FIG. 1. Re$\alpha(t)$ vs t for the Pomeranchuk trajectory from reference 5.

A related but somewhat oversimplified proposal has already been made by Desai[7] to fit the π-p and p-p data. With respect to π-p, he assumes that the Pomeranchuk trajectory alone is sufficient and that its slope is negligibly small. To assume such a flat trajectory, however, is unrealistic from the point of view of the f^0 particle; furthermore, the least-squares fits to the data of Foley et al.[1] [$d\sigma/dt$ vs $\log(s/\mathrm{BeV}^2)$] are not exactly horizontal lines. We have already remarked on the necessity for including P' as well as P.

The differential cross section for π-p scattering can be written as[8]

$$\frac{d\sigma}{dt}=\frac{1}{16\pi s^2}\left\{(4M^2-t)\,|A'|^2+\frac{t}{(4M^2-t)}[4M^2-ts-(s-M^2-1)^2]\,|B|^2\right\} \quad (1)$$

in pion mass units, where $s=2EM+M^2+1$ if E is the lab energy of the pion. In our two-pole approximation, we have

$$|A'|^2=\left[\beta_{A'P}(t)E^{\alpha_P(t)}\frac{1+\cos\pi\alpha_P(t)}{\sin\pi\alpha_P(t)}+\beta_{A'P'}(t)E^{\alpha_{P'}(t)}\frac{1+\cos\pi\alpha_{P'}(t)}{\sin\pi\alpha_{P'}(t)}\right]^2+\left[\beta_{A'P}(t)E^{\alpha_P(t)}+\beta_{A'P'}(t)E^{\alpha_{P'}(t)}\right]^2, \quad (2)$$

and we propose to neglect the helicity-flip term proportional to $|B|^2$. An analysis we have made of the experimental shape of the forward peak indicates that this term is small for $|t|\lesssim 0.8$ BeV^2, a point that can eventually be checked with polarization measurements. Using the same arguments as Desai,[7] we have taken the residues to be of the form

$$\beta_P(t)=\beta_P(0)e^{t/a},$$

where

$$\beta_P(0)=\sigma_N^{\text{total}}(\infty)=20.67\text{ mb}\approx 1.0m_\pi^{-2}$$

and

$$\beta_{P'}(t)=\beta_{P'}(0)e^{t/b}.$$

Such an exponential dependence is reasonable for not too large a value of momentum transfer. [Neither $\alpha_P(t)$ nor $\alpha_{P'}(t)$ vanish in the region of interest.] Igi[9] gives a relation between $\alpha_{P'}(0)$ and $\beta_{P'}(0)$. We have chosen $\alpha_{P'}(0)=0.5$ and correspondingly $\beta_{P'}(0)=2.4$. With Eqs. (1) and (2) we have tried to fit all the π-p data using the two parameters a and b. The best fit was obtained for the following values:

$$a=24.6m_\pi^2,$$

$$b=14m_\pi^2,$$

and is shown by the solid lines in Figs. 2 and 3 against the experimental data of Foley et al. (second part of reference 1) and Brandt et al.[10]

With regard to still higher energies, we predict that as the P' effect dies out, the rate of shrinkage of the π-p forward peak will increase by about a factor two to the asymptotic rate determined uniquely by the slope of the Pomeranchuk trajectory at $t=0$.[11] At the same time the rate of shrinkage of the p-p forward peak should decrease by about a factor two to approach this same limit.

Finally, we would like to remark that to fit p-p scattering at currently accessible energies in terms of $P+P'+\omega$, no essential difficulty should arise since Desai[7] has already succeeded in finding a fit with zero-slope trajectories. Our task can only be easier than his.

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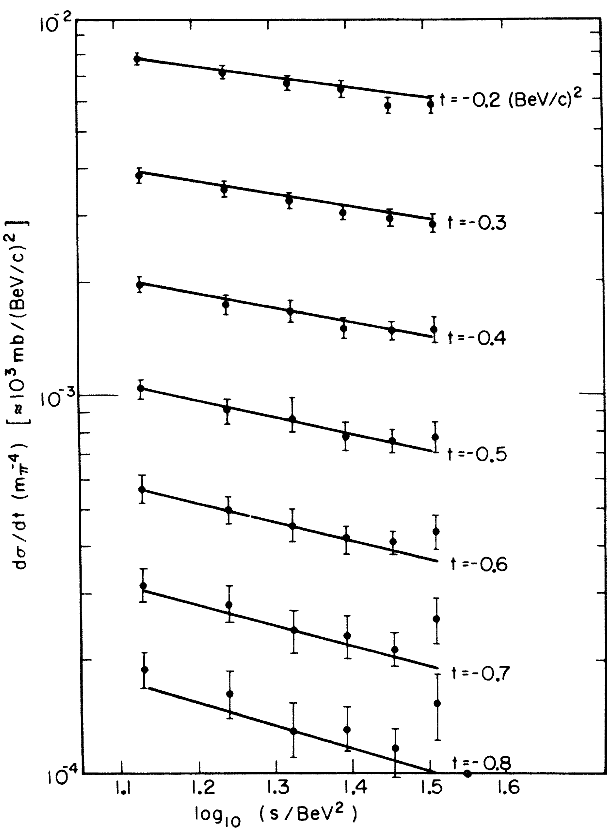

FIG. 2. Differential cross-section data for π^+-p scattering of Foley et al. and the fit obtained with the present calculation.

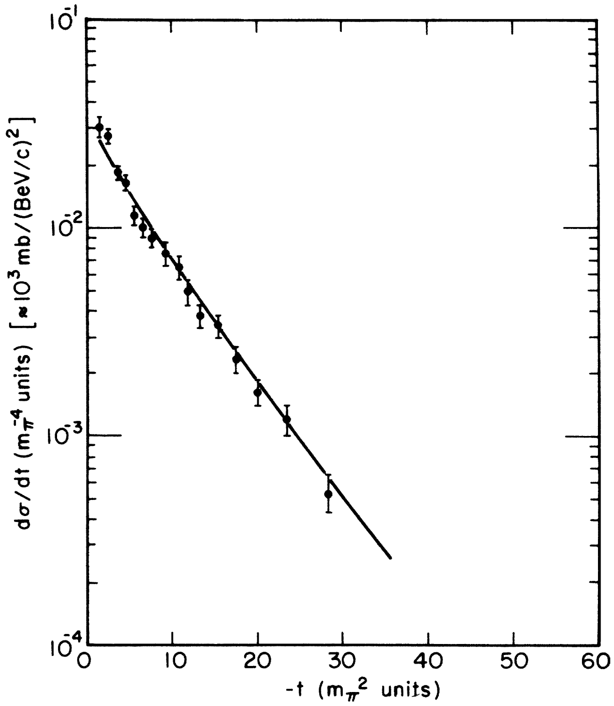

FIG. 3. Differential cross-section data for π^+-p scattering of Brandt et al. at 10-BeV lab energy and the fit obtained with the present calculation.

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