Epsilon Production in a Geometrical Approach.

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In a previous paper (1) ε production (2) was studied, by making used of dual properties, and it was qualitatively shown that pion exchange dominates near the forward direction and there is a small exchange with the A_1 quantum numbers. This is confirmed by the polarization data, since it clearly shows that two independent amplitudes are essential in this reaction. Duality also provides a guidance for the position of the zeros of the imaginary parts of these amplitudes. In this note we shall take over this problem again and quantitatively show that the dual predictions are in agreement with the experimental data.

To accomplish this task we shall follow a prescription recently suggested by HARARI (3). According to this proposal the behaviour, as a function of t, of the imaginary part of the s-channel helicity amplitude is essentially given, for a fixed value of the energy, by a Bessel function $J_{\Delta\lambda}(R\sqrt{-t})$, where the interaction radius R is of the order of 1 fm and and $\Delta\lambda$ is the amount of *helicity flip* in that channel. This behaviour is in general modulated by a smooth function of t, like an exponential. This explains why a nonzero-width peripheral distribution of angular momenta is effective in the non-pomeron exchanging reactions. When instead the pomeron is exchanged one finds that central interaction is important. DAVIER and HARARI checked these prescriptions in the case of K$\mathcal{N}$ elastic scattering with remarkable success (4). However, in that case

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(1) A. GARCÍA, C. A. GARCÍA CANAL and R. ODORICO: *Lett. Nuovo Cimento*, **2**, 619 (1969).
(2) P. SONDEREGGER and P. BONAMY: *Lund Conference* (1969).
(3) H. HARARI: *Phys. Rev. Lett.*, **26**, 1400 (1971).
(4) M. DAVIER and H. HARARI: *Phys. Lett.*, **35** B, 239 (1971).

they construct the nonpomeron amplitude by taking differences of physical quantities to which the pomeron contributes in the same way. An advantage of reactions like ours is that, due to the absence of vacuum exchanges, the peripheral prescription can be tested directly.

Already on a qualitative ground the zero of the polarization data at $t \sim -0.2$ (GeV)^2 might be related to the geometrical zero of the nonflip amplitude. We remark that the Harari prescription applies only to the imaginary part of the amplitudes. In our case also real parts are certainly important because the pion pole is very close to the physical region. In order to evaluate the spin-flip amplitude (the only one important for the differential cross-section (1)) we impose that, being the imaginary part given by the Harari prescription, its phase can be obtained, using the Phragmén-Lindelöf theorem, from the asymptotic energy behaviour of the amplitude. This, in our case, means that

$$\frac{\operatorname{Re} f_{+-}}{\operatorname{Im} f_{+-}} = -\operatorname{ctg}\frac{\pi}{2}\alpha(t) .$$

Thus we fitted the differential cross-section with an expression of the form

$$\frac{d\sigma}{dt} = A \exp[2Bt]\left\{J_1(R\sqrt{-t})/\sin\frac{\pi}{2}\alpha(t)\right\}^2 .$$

We remark the similarity of our result with that obtained by DAR *et al.* for meson-exchange reactions induced by pions using a slightly different philosophy (5). Since the points are taken at an average energy $\nu = 5$ GeV we do not explicitly include the ν^α-factor which is implicitly contained in the residue. As we already said we expect that the parameter R should be of the order of 1 fm. The trajectory $\alpha(t)$ is the pion trajectory. As further evidence for pion exchange we notice that data taken at different energy in the near forward direction for this reaction suggest a value of $\alpha(0) \approx 0$ (2).

We impose the trajectory to pass through zero at $t = \mu_\pi^2$, so that

$$\alpha(t) = \alpha'(t - \mu_\pi^2) .$$

Thus we are left with four free parameters A, B, R and α' to be determined by the fit.

We fitted 14($d\sigma/dt$) experimental points in the t range $0 < |t| < 0.32$ (GeV)^2 and found the following solution:

$$A = 6.76\ \mu b/(\text{GeV})^2 \qquad B = 1.53\ (\text{GeV})^{-2} \qquad R = 0.77\ \text{fm} \qquad \alpha' = 0.79\ (\text{GeV})^{-2}$$

with a $\chi^2 = 13.6$. In Fig. 1 the $d\sigma/dt$ calculated from the best-fit parameters is compared with experiment.

A feature of this result which is worth stressing is that, though all the parameters were free in the fit the good χ^2 achieved corresponds to a value of them in agreement with other pieces of evidence namely B turns out to be very close to the value of ref. (4); R is of the correct order of magnitude and finally α' is reasonable in a Reggeized scheme.

For what concerns the polarization data which were not included in fit we recall that

$$P = \frac{2 \operatorname{Im}(f_{++}^* f_{+-})}{|f_{++}|^2 + |f_{+-}|^2} ,$$

(5) A. DAR, T. L. WATTS and V. F. WEISSKOPF: *Nucl. Phys.*, **13** B, 477 (1969).

and since pion dominance implies that $|f_{++}| \ll |f_{+-}|$, and moreover f_{+-} is essentially real in the small-t region

$$P \approx -2 \frac{\mathrm{Im}\, f_{++}}{\mathrm{Re}\, f_{+-}}\,.$$

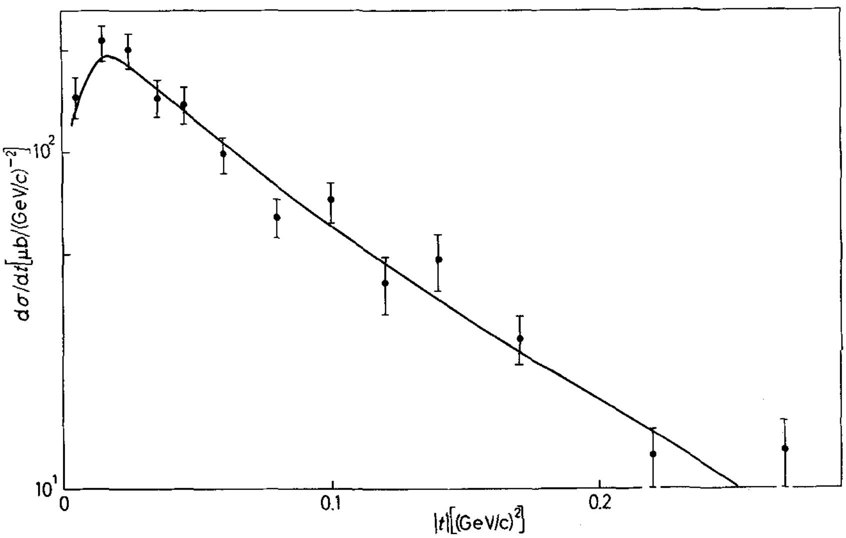

Fig. 1. – Comparison of the experimental value of $d\sigma/dt$ [4] with our best fit.

Thus it is obvious that a solution exists with the required zero in the polarization close to $t = -0.2$ (GeV)^2, since $\mathrm{Im}\, f_{++}$ should be proportional to a J_0 Bessel function, vanishing just in this region. The two polarization points in the interval $0.02 < |t| < 0.1$ (GeV/c)^2 can then be fitted trivially by simply adjusting a proportionality constant.

We observe that also other models, such as for example elementary pion exchange with form factors, are able to reproduce the data [2].

However, the analysis presented here gives confidence in the possibility of applying the Harari model to the quantitative determination of s-channel amplitudes. We want to point out once more that the good result obtained cannot be considered as definite evidence in favour of the model. Probably, the most important point to stress is not the fit itself but the fact that the values of the output parameters in a reaction exchanging pions are in agreement with other independent estimates where the exchanged particles are vector or tensor mesons.

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