ОБЪЕДИНЕННЫЙ ИНСТИТУТ ЯДЕРНЫХ ИССЛЕДОВАНИЙ

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REGGE–POLES AND FORM FACTORS

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The connection between Regge-poles and resonances has been repeatedly pointed out by several authors [1].

[1] See e.g. T.Regge. Nuovo Cim. 18, 947 (1960). Blankenbecler, Goldberger; Preprint.

In the present note we want to point out that - by an almost trivial modification of the famous "resonance approximation" for form factors [2], one can use experimental data on form factors to determine Regge-trajectories.

[2] W.Frazer, J.Fulco. Phys. Rev. 117, 1609 (1960).

In fact, let us assume that the form factor in question is mainly determined by one resonance (i.e. Regge-pole, in our present formulation). Take e.g. isovector, electric form factors of pions (F_π) and nucleons (F_N). Then the unitarity condition gives (in the two-pion approximation):

$$Jm\, F_\pi = \rho \cdot F_\pi \cdot A^*_\ell$$

$$Jm\, F_N = \rho \cdot F_\pi \cdot B^*_\ell$$

where $\rho = \left(\frac{t-4}{t}\right)^{1/2}$; A_ℓ , B_ℓ are the ℓ -th partial wave aplitudes of the processes: $\pi\pi \to \pi\pi$ and $\pi\pi \to N\tilde{N}$ respectively in the state $T = 1$. Assuming that both of the latter are determined by a Regge-pole, the trajectory of which is given by $L_1(t)$ one easily finds:

$$A_\ell = \frac{1}{\rho}\,\frac{\ell - L_1^*}{\ell - L_1}$$

$$B_\ell = \frac{\beta(t)}{\ell - L_1}$$

$\beta(t)$ being the residue of the pole at $\ell = L_1$ Hence one finds the normalized form factor in the pole approximation:

$$F_\pi(t) = \frac{1 - L_1(0)}{1 - L_1(t)}$$

$$F_N(t) = \frac{\beta(t)}{\lambda(t)} \cdot \rho\, F_\pi(t)$$

$\lambda(t)$ being the imaginary part of $L_1(t)$ (analytically continued below threshold). From the normalization condition of F_N obviously: $\lim_{t \to 0} \frac{\beta(t)}{\lambda(t)} \cdot \rho = 1/2$. Let us make the bold assumption that $(\rho \cdot \beta(t)/\lambda(t)) =$ constant for not too large values of t and as an illustration determine $L_1(t)$ from the experimental data [3] on F_N.

[3] Hand, Miller, Wilson. Phys. Rev. Lett. 8, 110 (1962).

Results are shown in the Fig. 1 The experimental values of $L_1(t)$ (obtained from interpolated data of ref. [3] are marked by crosses. They suggest rather strongly an almost linear dependence of L_1 on t (In evaluating the curve we assumed $L_1(0) = 1/2$, consistently with high energy charge-exchange total cross sections [4]).

[4] Udgaonkar. Phys. Rev. Lett. 8 142 (1962).

The solid line is $L(t) = 1/2 + a \cdot t$ the coefficient a being determined by the method of least squares.

Obviously, the function $L_1(t)$ cannot have a first order cusp (it is monotonous[5] in $0 < t < 4$ and $L_1(0) = ½$), therefore one can

[5] Cf. G.Domokos. Nuovo Cim. (to be published).

tentatively extrapolate it by the same straight line for $t > 4$. Doing so, one sees that the curve passes through one at $t = 26.3$, suspiciously near to the ρ – particle: One may wonder why the other candidate (ζ) seems to play such an important role in the form factor. A possible explanation is the difference in their coupling strength to pions (the level width of ρ is $\approx$ 50 MeV as compared with the $\approx$ 35 MeV of ζ).

In conclusion we want to remark that a perhaps better procedure of evaluating $L_1(t)$ would be to take the pion form factor, as evaluated e.g. from pion electroproduction data. We hope to come back to this and similar problems in a subsequent paper.

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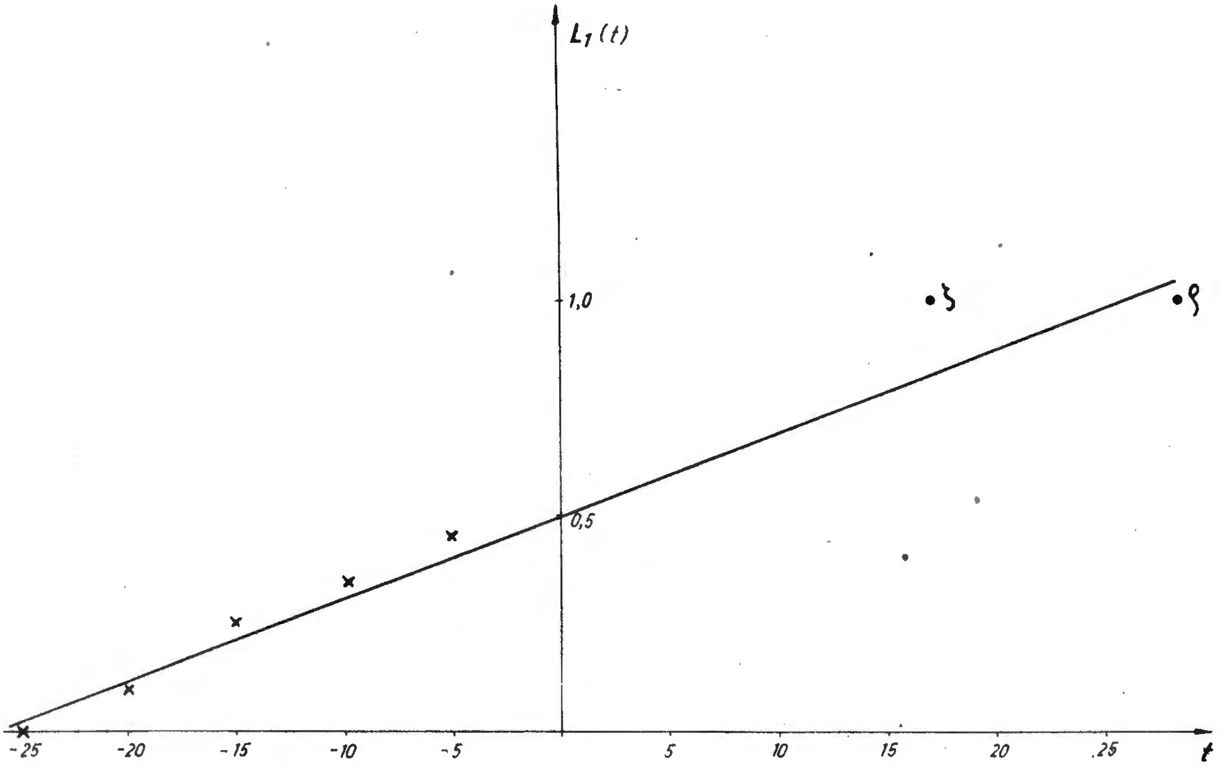

Fig. 1