индекс 3624

ԵՐԵՎԱՆԻ ՖԻԶԻԿԱՅԻ ԻՆՍՏԻՏՈՒՏ
ЕРЕВАНСКИЙ ФИЗИЧЕСКИЙ ИНСТИТУТ

ЕФИ-529(16)-82

A.A.GRIGORYAN, G.N.KHACHATRIAN

# PRODUCTION OF $E_{55}$-BARYONS IN NN-COLLISIONS

ԵՐԵՎԱՆ 1982 ЕРЕВАН

## 1. Introduction

In the recent years exotic states attract both experimental and theoretical special interest.

Several theoretical schemes such as old bootstrap model, strings, bags, dual and quasinuclear approaches [1-5] predict the existence of exotic resonances.

Recently a method of superconvergent sum rules (SSR) for the reggeon-particle scattering amplitudes has been developed by A.B.Kaidalov and one of us [6-8]. A whole series of exotic baryon resonances with isospins has been predicted in the framework of SSR [9,10].

Properties of the first resonance from this series with $I = 5/2$ (called $E_{55}$) have been analyzed in Ref. [9]. It has been shown that SSR allow one to determine unambiguously the spin ( $S_E = 5/2$ ), P-parity ( $\eta_E = +$ ) of $E_{55}$ - baryon and relations between the helicity residues $G^{a \alpha_i A}_{\lambda_a \lambda_E}$ ( $a = \Delta_{33}$ , $E_{55}$, $i = \rho, \pi, A_2$) of reggeons $\alpha_i$ .

As a consequence the following relation between the widths of and $\Delta_{33} \to N\pi$ decays holds

$$\Gamma_{E \to \Delta\pi} = \frac{4}{3} \left( \frac{K^*}{K} \right)^3 \Gamma_{\Delta \to N\pi} \tag{1.1}$$

where $K$ and $K^*$ are the $\pi$ -meson momenta in $E_{55}$ and $\Delta_{33}$ decays.

An experimental evidence for the $I = 5/2$ resonance existence has been given recently in JINR experiments on the neutron beam at $P_{lab} = 5.1, 4.8, 3.5$ GeV/c. A narrow peak with a mass 1.42 GeV in $\pi^+ \Delta^{++}$ and $\Delta^- \pi^-$ systems has been observed in the reaction $np \to p\pi^-\pi^- p\pi^+\pi^+$ [11,12]. This maximum is probably the predicted $E_{55}$ -resonance since: a) its mass in theoretically expected interval ($1.4 \le M_E \lesssim 1.7$ GeV); b) its width is close to the one predicted from Eq.(1.1) ( $\Gamma_E \simeq 30$ MeV at $M_E = 1.42$ GeV and $\Gamma_\Delta = 115$ MeV) and c) the observed angular distribution of decay products does not contradict the spin $5/2$ and positive P-parity.

The relations between the helicity vertices obtained from SSR allow one to estimate theoretically the cross sections of the processes

$$\begin{aligned} NN &\to E_{55}\,\bar{\Delta}_{33} \\ N\bar{N} &\to \bar{E}_{55}\,\bar{\Delta}_{33} \\ N\bar{N} &\to \bar{E}_{55}\,\Delta_{33} \end{aligned} \tag{1.2}$$

$$\begin{aligned} NN &\to E_{55}\,E_{55} \\ N\bar{N} &\to E_{55}\,\bar{E}_{55} \end{aligned} \tag{1.3}$$

and to give the prediction for $E_{55}$ density matrix elements. In Sec.2 we formulate the model. In Sec.3 the calculations results are presented.

## 2. Model

Our calculations are based on the reggeized two pions exchange diagram (Fig.1).

In the processes (1.2) the main $S$ -channel contribution give the intermediate states $\Delta_{33}\Delta_{33}$ and $\Delta_{33}N$ ( $a = \Delta_{33}N$ ) and in the processes (1.3) the contribution of $\Delta_{33}\,\Delta_{33}$ state dominates. Moreover, at not too



high energy one can neglect the contribution of other t -channel exchanges such as $\alpha_i \pi$ , $\alpha_i \alpha_k$ ( $i, k = \rho, A_2$ ) for the following reasons.

As it follows from the experimental data [13,14] at $P_{lab} \lesssim 100$ GeV/c the main contribution to the reactions $NN \to N\Delta_{33}$ and $NN \to \Delta_{33}\Delta_{33}$ gives the $\pi$ -pole, the contribution of $\rho$ and $A_2$ poles being negligibly small. On the other hand, the sum rules predict that the ratio of $\pi$ and $\rho(A_2)$ poles contributions is the same for all the reactions $NN \to N\Delta_{33}$ , $NN \to \Delta_{33}\Delta_{33}$ , $N\Delta_{33} \to \Delta_{33}E_{55}$ and $\Delta_{33}\Delta_{33} \to E_{55}E_{55}$. Hence it is natural to assume that $\pi$ -meson exchange dominates also in the amplitudes $N\Delta_{33} \to \Delta_{33}E_{55}$, $\Delta_{33}\Delta_{33} \to E_{55}E_{55}$ which enter in the diagram in Fig.1.

The formalism of s-channel helicity amplitudes in the infinite momentum frame is used for the calculations. In this formalism the contribution of diagram 1 in the helicity amplitudes $M_{\lambda_1\lambda_2 \to \lambda_E\lambda_b}$ of the reactions (1.2), (1.3) has the form [15]:

$$M^{NN\to Eb}_{\lambda_1\lambda_2\to\lambda_E\lambda_b} = \frac{1}{2}\frac{i}{2s}\sum_{\lambda_\Delta\lambda_a}\int M^{NN\to\Delta a}_{\lambda_1\lambda_2\to\lambda_\Delta\lambda_a}(q_1,s)\, M^{\Delta a\to Eb}_{\lambda_\Delta\lambda_a\to\lambda_E\lambda_a}(q_2 s)\,\frac{d^2\vec{q}_\perp}{(2\pi)^2} \tag{2.1}$$

where $s = (P_1 + P_2)^2$ , $\vec{q}_\perp$ is the transverse component of momentum transfer. The factor $\frac{1}{2}$ in (2.1) is due to the identity of reggeons. The one-pion-exchange contribution to the amplitudes $M^{NN\to\Delta a}_{\lambda_1\lambda_2\to\lambda_\Delta\lambda_a}(q_1, s)$ and $M^{\Delta a\to Eb}_{\lambda_\Delta\lambda_a\to\lambda_E\lambda_b}(q_2 s)$ is parametrized in the standard form:

$$M^{ab\to cd}_{\lambda_a\lambda_b\to\lambda_c\lambda_d}(q_i s) = e^{i\varphi[(\lambda_a-\lambda_c)-(\lambda_b-\lambda_d)]}\, q_i^{\perp\,|\lambda_a-\lambda_c|+|\lambda_b-\lambda_d|} \times \tag{2.2}$$

$$\times\, G^{a\pi c}_{\lambda_a\to\lambda_c}(q_i^{\perp 2})\, G^{b\pi d}_{\lambda_b\to\lambda_d}(q_i^{\perp 2})\, \mathcal{D}_{i\pi}\, g^{ab\to cd}_{\pi}(q_i^2, s)$$

$\varphi$ is the angle between $\vec{q}^{\perp}$ and X-axis; $\mathcal{D}_{i\pi}$ is the $\pi$-meson propagator

$$\mathcal{D}_{i\pi} = \frac{1}{q_{\gamma_i}^2 - m_\pi^2}$$

$g_\pi^{ab\to cd}(q_i^2, s)$ is the form-factor which describes the $\pi$-meson off-mass shell effects.

The residues $G^{N\pi\Delta}_{\lambda_i\to\lambda_j}$, $G^{\Delta\pi\Delta}_{\lambda_i\to\lambda_j}$, $G^{\Delta\pi E}_{\lambda_i\to\lambda_j}$ and $G^{E\pi E}_{\lambda_i\to\lambda_j}$ are determined by projecting the invariant expressions for the vertices

i) $N\pi N$
$$F^{N\pi N} = G^{N\pi N}\bar{u}(P_{N_j})\gamma_5 u(P_{N_i}) \tag{2.3}$$

ii) $N\pi\Delta_{33}$
$$F^{N\pi\Delta} = G^{N\pi\Delta}\bar{u}_\mu(P_\Delta)P_N^\mu u(P_N) \tag{2.4}$$

iii) $\Delta_{33}\pi\Delta_{33}$
$$F^{\Delta\pi\Delta} = \bar{u}_\mu(P_{\Delta_j})[G^{\Delta\pi\Delta} g_{\mu\nu} + G_2^{\Delta\pi\Delta} P^\mu_{\Delta_j} P^\nu_{\Delta_i}]u_\nu(P_{\Delta_i}) \tag{2.5}$$

iiii) $\Delta_{33}\pi E_{55}$
$$F^{\Delta\pi E} = \bar{u}_{\mu\nu}(P_E)[G_1^{\Delta\pi E} P_\Delta^\mu g_{\nu\rho} + G_2^{\Delta\pi E} P_\Delta^\mu P_\Delta^\nu P_E^\rho]u_\rho(P_\Delta) \tag{2.6}$$

on the helicity states in the infinite momentum frame (see Table 1).

The values of couplings $G^{N\pi\Delta}$, $G_1^{\Delta\pi\Delta}$ and $G_1^{\Delta\pi E}$ are taken as predicted from the SSR. E.g., in the case of processes $pn \to E_{55}^{+++} E_{55}^{--}$ and $pp \to E_{55}^{++} \Delta_{33}^{-}$ the couplings $G^{p\pi^+\Delta^{++}}$, $G_1^{\Delta_0\pi^-\Delta^-}$ and $G_1^{\Delta^{++}\pi^+E_{55}^{+++}}$ enter into the vertices. The SSR predictions for these



couplings are [8,9]:

$$\left(G^{p\pi^+\Delta^{++}}\right)^2 = \frac{9}{8s_0}\left(G^{p\pi^0 p}\right)^2 \tag{2.7}$$

$$G^{\Delta_0\pi^-\Delta^-} = -\frac{1}{\sqrt{s_0}}\,\frac{3\sqrt{6}}{5}\,G^{p\pi^0 p}$$

$$\left(G^{\Delta^{++}\pi^+E^{+++}}\right)^2 = \frac{3}{2s_0}\left(G^{p\pi^0 p}\right)^2$$

with $\left(G^{p\pi^0 p}\right)^2/4\pi = 14.6$ and $s_0 = 1\ \mathrm{GeV}^2$

As to $G_2^{\Delta\pi a}(a = \Delta_{33}, E_{55})$, their values are not fixed from the SSR considered in [8,9] and they are taken zero.

We put
$$g_\pi^{NN\to N\Delta}(q^2, s) = g_\pi^{NN\to\Delta\Delta}(q^2, s) \equiv g_\pi(q^2, s) =$$
$$= (1 + aq^{\perp 2} + bq^{\perp 4})\cdot\exp\left[\left(\alpha'_\pi \ln\frac{s}{s_0} + R^2\right)q^2\right] \qquad (\alpha'_\pi = 1\ \mathrm{GeV}^{-2}).$$

The parameters $a$, $b$ and $R^2$ are found out by fitting the experimental data on the processes $NN \to N\Delta_{33}$, $NN \to \Delta_{33}\Delta_{33}$ and $N\bar{N} \to \Delta_{33}\bar{\Delta}_{33}$ [16–18]. The expressions for the cross sections of these processes are:

$$\frac{d\sigma^{NN\to N\Delta}}{d\vec{q}^{\perp 2}} = 1/[4\cdot 16\pi\cdot s(s-4m_N^2)]\cdot\sum_{\lambda_1\lambda_2\lambda_3\lambda'} |M^{NN\to N\Delta}_{\lambda_1\lambda_2\to\lambda\lambda'}(q^\perp, s)|^2 = \tag{2.8}$$

$$= \frac{(G^{N\pi N}\cdot G^{N\pi\Delta})^2}{16\pi\, 6m_\Delta^2 s(s-4m_N^2)}\cdot\left\{\frac{\vec{q}^{\perp 2}[\vec{q}^{\perp 2} + (m_\Delta - m_N)^2][\vec{q}^{\perp 2} + (m_\Delta + m_N)^2]^2}{\ldots}\right\}(g_\pi(q^2, s))^2$$

and

$$\frac{d\sigma^{NN\to\Delta\Delta}}{dq_{\perp}^{2}} = \frac{(G^{N\pi\Delta})^4}{16\pi\, 36 m_\Delta^4 s(s-4m_N^2)} \times \tag{2.9}$$

$$\times \left\{ \frac{[\vec{q}_{\perp}^{\,2}+(m_\Delta-m_N)^2][\vec{q}_{\perp}^{\,2}+(m_\Delta+m_N)^2]^2}{(q^2-m_\pi^2)}\, g_\pi(q^2,s) \right\}^2$$

Note that since the calculations are carried out at the nonasymtotic energies, the $t_{min}$ effects, i.e. $q^2 = t_{min} - \vec{q}_{\perp}^{\,2}$ are taken into account in $\mathcal{D}_\pi$ and $g_\pi(q^2,s)$. The comparison with experiments gives

$R^2$ = 3.7 GeV$^{-2}$ , $a$ = -3 GeV$^{-2}$ , $b$ = 10 GeV$^{-4}$

The form-factors $g_\pi^{\Delta\Delta\to EE}(q^2,s)$ , $g_\pi^{\Delta\Delta\to\Delta E}(q^2,s)$ and $g_\pi^{\Delta N\to\Delta E}(q^2,s)$ are taken equal to $g_\pi(q^2,s)$ .

3. Production Cross Section and Density Matrix

In Figs. 2 and 3 the theoretical predictions for the different cross sections

$$\frac{d\sigma}{d\vec{q}_{\perp}^{\,2}} = \frac{1}{64\pi s(s-4m_N^2)} \sum_{\lambda_1\lambda_2\lambda_E\lambda_B} \left| M^{NN\to EB}_{\lambda_1\lambda_2\to\lambda_E\lambda_B} \right|^2 \tag{3.1}$$

of the reactions $pp \to E_{55}^{+++}\Delta^-$ and $p_n \to E_{55}^{+++} E_{55}^{--}$ (at $M_E$ = 1.42 GeV) are plotted. In Figs.4, 5 the corresponding total



cross sections are presented.

In the considered production mechanism the cross section of $pn \to E_{55}^{+++} E_{55}^{--}$ and $p\bar{p} \to E_{55}^{+++} \overline{E_{55}^{+++}}$ are equal:

$$\sigma(p\bar{p} \to E_{55}^{+++} \overline{E_{55}^{+++}}) = \sigma(pn \to E_{55}^{+++} E_{55}^{--})$$

and they are the greatest among the cross sections of processes $NN \to E_{55} E_{55}$ and $N\bar{N} \to E_{55} \bar{E}_{55}$ . The simple isotopic calculations show, e.g. that

$$\sigma(pn \to E_{55}^{++} E_{55}^{-}) = \frac{16}{25}\sigma(pn \to E_{55}^{+++} E_{55}^{--})$$

in the kinematical region where the momentum of $E_{55}^{++}$ is close to the proton's one and

$$\sigma(pn \to E_{55}^{-} E_{55}^{++}) = \frac{1}{25}\sigma(pn \to E_{55}^{+++} E_{55}^{--})$$

when the momentum $E_{55}^{-}$ is close to the proton momentum.

As to the processes (1.2), the cross section of $pp \to E_{55}^{+++}\Delta_{33}^{-}$ is maximal, and, for example, the following relation holds

$$\sigma(p\bar{p} \to E_{55}^{++} \overline{\Delta_{33}^{++}}) = \frac{1}{10}\sigma(pp \to E_{55}^{+++}\Delta^-)$$

when the $E_{55}^{++}$ momentum is close to the proton's one.

It is worth emphasizing that in the theoretical calculations the corrections which are due to the experimental cut-off imposed on the masses of $\Delta_{33}\pi$ (when selecting $E_{55}$ ) and $N\pi$ (when selecting $\Delta_{33}$ ) systems are not included. For example, assuming the Breit-Wigner shape distribution for $\Delta_{33}\pi$ system the formula (3.1) must be multiplied by coefficient $(a(\Gamma_E))^2$ with

$$a(\Gamma_E) = \frac{1}{\pi}\left\{\mathrm{arctg}\,\frac{M_u^2 - M_E^2}{M_E \Gamma_E} + \mathrm{arctg}\,\frac{M_E^2 - M_L^2}{M_E \Gamma_E}\right\} \tag{3.2}$$

where $M_E$ and $\Gamma_E$ are the mass and width of $E_{55}$, $M_u$ and $M_L$ are the upper and lower limits of the experimental cut-off.

Taking, for example, the values $M_E$ =1.42 GeV, $\Gamma_E$ =22 MeV, $M_u$ = 1.44 GeV, $M_L$ = 1.4 GeV one has

$$a(\Gamma_E) = 0.68 .$$

The measurements of density matrix elements are of special interest to identify the spin and P-parity of observed resonance. In Figs.5, 6 the predictions for the s-channel density matrix elements of $E_{55}$ in the reactions $pp \to E_{55}^{+++}\Delta^-$ (at $P_{lab}$ =20 GeV/c, $M_E$ =1.42 GeV) and $pn \to E_{55}^{+++} E_{55}^{--}$ (at $P_{lab}$=5.1 GeV/c, $M_E$ =1.42 GeV) are presented.

It is worth emphasizing that one must consider our calculations only as an attempt to estimate theoretically the cross section of $E_{55}$ production. Indeed, on the one hand, the contribution of other mechanisms, such as in Fig.7, can be essential, especially at high energies. On the other hand, due to the asymptotic character of considered model its predictions at low energies pretend only on the order of magnitude.

Nevertheless our calculations demonstrate that the effective experimental search for the exotic baryon resonances production in NN and NN-collisions is available in a sufficiently large range of energies.

We are grateful to K.G.Boreskov and A.B.Kaidalov for valuable remarks.



Table

| $\lambda_1\ \lambda_2$ | $G^{N\pi N}_{\lambda_1 \lambda_2}$ |
|---|---|
| $\frac{1}{2}\ \frac{1}{2}$ | $0$ |
| $\frac{1}{2}\ -\frac{1}{2}$ | $1\, G^{N\pi N}$ |
| $G^{N\pi N}_{-\lambda_1 -\lambda_2} = (-1)^{\lambda_1 - \lambda_2 + 1} G^{N\pi N}_{\lambda_1 \lambda_2}$ | |

| $\lambda_N\ \lambda_\Delta$ | $G^{N\pi\Delta}_{\lambda_N \lambda_\Delta}$ |
|---|---|
| $\frac{1}{2}\ \frac{3}{2}$ | $-\frac{1}{\sqrt{2}}(m_N + m_\Delta)\ G^{N\pi\Delta}$ |
| $\frac{1}{2}\ -\frac{3}{2}$ | $-\frac{1}{\sqrt{2}}\ G^{N\pi\Delta}$ |
| $\frac{1}{2}\ \frac{1}{2}$ | $\frac{1}{\sqrt{6}\,m_\Delta}\left\{(m_N - m_\Delta)(m_N + m_\Delta)^2 + (2m_\Delta + m_N)\, q_\perp^2\right\} G^{N\pi\Delta}$ |
| $\frac{1}{2}\ -\frac{1}{2}$ | $\frac{1}{\sqrt{6}\,m_\Delta}\left\{(m_N + m_\Delta)(2m_\Delta - m_N) - q_\perp^2\right\}\ G^{N\pi\Delta}$ |
| $G^{N\pi\Delta}_{-\lambda_N -\lambda_\Delta} = (-1)^{\lambda_N - \lambda_\Delta} G^{N\pi\Delta}_{\lambda_N \lambda_\Delta}$ | |

| $\lambda_1\ \lambda_2$ | $G^{\Delta\pi\Delta}_{\lambda_1 \lambda_2}$ |
|---|---|
| $\frac{3}{2}\ \frac{3}{2}$ | $0$ |
| $\frac{3}{2}\ \frac{1}{2}$ | $-\frac{1}{\sqrt{3}}\ G_1^{\Delta\pi\Delta}$ |
| $\frac{3}{2}\ -\frac{1}{2}$ | $0$ |
| $\frac{3}{2}\ -\frac{3}{2}$ | $0$ |
| $\frac{1}{2}\ \frac{1}{2}$ | $0$ |
| $\frac{1}{2}\ -\frac{1}{2}$ | $-\left\{\frac{2}{3} + \frac{1}{2m_\Delta^2}\, q_\perp^2\right\}\ G_1^{\Delta\pi\Delta}$ |
| $G^{\Delta\pi\Delta}_{-\lambda_1 -\lambda_2} = (-1)^{\lambda_1 - \lambda_2 + 1} G^{\Delta\pi\Delta}_{\lambda_1 \lambda_2}$ | |

Table
(continuation)

| $\lambda_\Delta\ \lambda_E$ | $G^{\Delta\pi E}_{\lambda_\Delta \lambda_E}$ |
|---|---|
| $\frac{3}{2}\ \frac{5}{2}$ | $\frac{1}{\sqrt{2}}(m_\Delta + m_E)\, G_1^{\Delta\pi E}$ |
| $\frac{3}{2}\ \frac{3}{2}$ | $\frac{1}{m_E\sqrt{10}}\left\{(m_E - m_\Delta)(m_E + m_\Delta)^2 - (2m_\Delta + 3m_E)\, q^{\perp 2}\right\} G_1^{\Delta\pi E}$ |
| $\frac{3}{2}\ \frac{1}{2}$ | $\frac{1}{2\sqrt{5}\, m_E^2}\left\{(m_E + m_\Delta)\left[(m_\Delta - m_E)(m_\Delta + 2m_E) - m_E^2\right] + (m_\Delta + 3m_E)\, q^{\perp 2}\right\} G_1^{\Delta\pi E}$ |
| $\frac{1}{2}\ \frac{5}{2}$ | $\frac{1}{\sqrt{6}\, m_\Delta}(2m_\Delta + m_E)\, G_1^{\Delta\pi E}$ |
| $\frac{1}{2}\ \frac{3}{2}$ | $\frac{1}{\sqrt{30}\, m_\Delta m_E}\left\{(m_E + m_\Delta)\left[2m_E(m_\Delta + m_E) - m_\Delta^2\right] - (4m_\Delta + 3m_E)\, q^{\perp 2}\right\} G_1^{\Delta\pi E}$ |
| $\frac{1}{2}\ \frac{1}{2}$ | $\frac{1}{2\sqrt{15}\, m_\Delta m_E^2}\left\{(m_\Delta + m_E)^2(m_E^3 - m_\Delta^3) + q^{\perp 2}\left[m_\Delta^3 - 2(m_\Delta + m_E)(m_\Delta + 3m_E)\, m_E\right] + (2m_\Delta + 3m_E)\, q^{\perp 4}\right\} G_1^{\Delta\pi E}$ |
| $-\frac{1}{2}\ \frac{5}{2}$ | $\frac{1}{\sqrt{6}\, m_\Delta}\, G_1^{\Delta\pi E}$ |
| $-\frac{1}{2}\ \frac{3}{1}$ | $\frac{1}{\sqrt{30}\, m_\Delta m_E}\left\{\left[(m_\Delta + m_E)^2 + 2m_E^2\right] - 2q^{\perp 2}\right\} G_1^{\Delta\pi E}$ |
| $-\frac{1}{2}\ \frac{1}{2}$ | $\frac{1}{2\sqrt{15}\, m_\Delta m_E^2}\left\{(m_\Delta + m_E)\left[(m_\Delta + m_E)(m_\Delta^2 + m_E^2) + 2m_E^3 - 3m_\Delta^3\right] - \left[(m_\Delta + 2m_E)^2 + 2m_E^2\right] q^{\perp 2} + q^{\perp 4}\right\} G_1^{\Delta\pi E}$ |
| $-\frac{3}{2}\ \frac{5}{2}$ | $0$ |
| $-\frac{3}{2}\ \frac{3}{2}$ | $\frac{1}{\sqrt{10}\, m_E}\, G_1^{\Delta\pi E}$ |
| $-\frac{3}{2}\ \frac{1}{2}$ | $\frac{1}{2\sqrt{5}\, m_E^2}\left\{(m_\Delta + m_E)(2m_E - m_\Delta) + m_E^2 - q^{\perp 2}\right\} G_1^{\Delta\pi E}$ |
| | $G^{\Delta\pi E}_{-\lambda_\Delta -\lambda_E} = (-1)^{\lambda_\Delta - \lambda_E}\, G^{\Delta\pi E}_{\lambda_\Delta \lambda_E}$ |



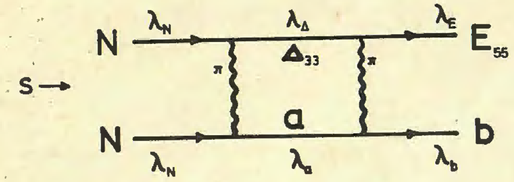


Fig.1. Diagrams of a two-pion exchange.

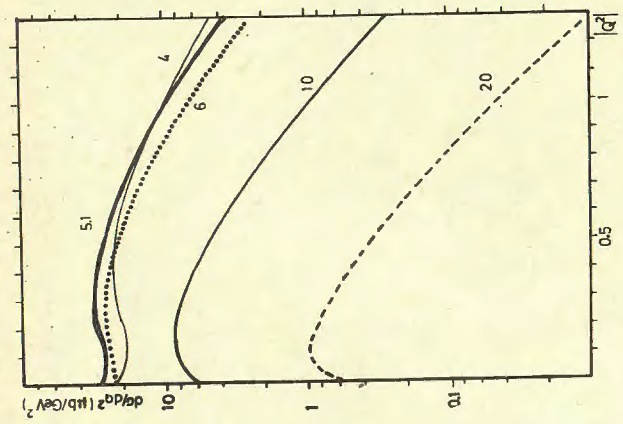


Fig.2. Differential cross sections of the $pp \to E_{55}^{+++}\Delta_{33}^{-}$ reaction at $P_{lab}$ = 4, 5.1, 6, 10 and 20 GeV/c.

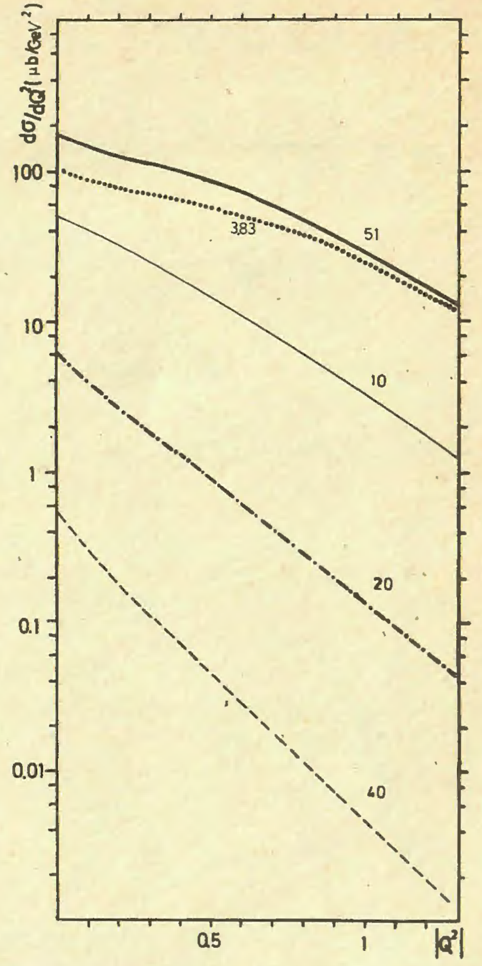


Fig.3. Differential cross sections of the $pn \rightarrow E_{55}^{+++} E_{55}^{--}$ reaction at $P_{lab}$ = 3.83, 5.1, 10, 20 and 40 GeV/c.



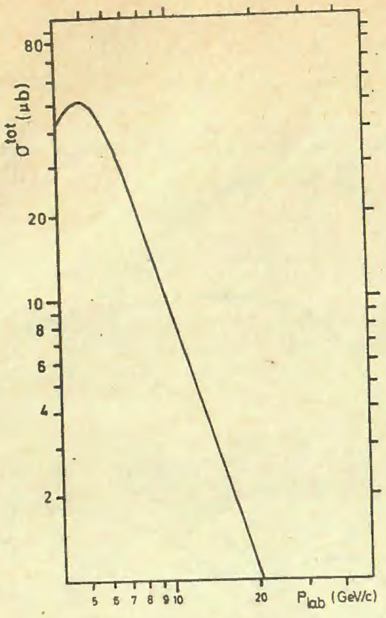


Fig.4. Total cross section of the $pp \rightarrow E_{55}^{+++} \Delta_{33}$ process.

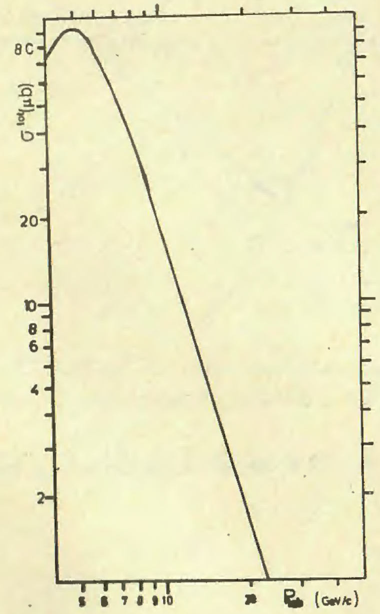


Fig.5. Total cross section of the $pn \rightarrow E_{55}^{+++} E_{55}^{--}$ process.

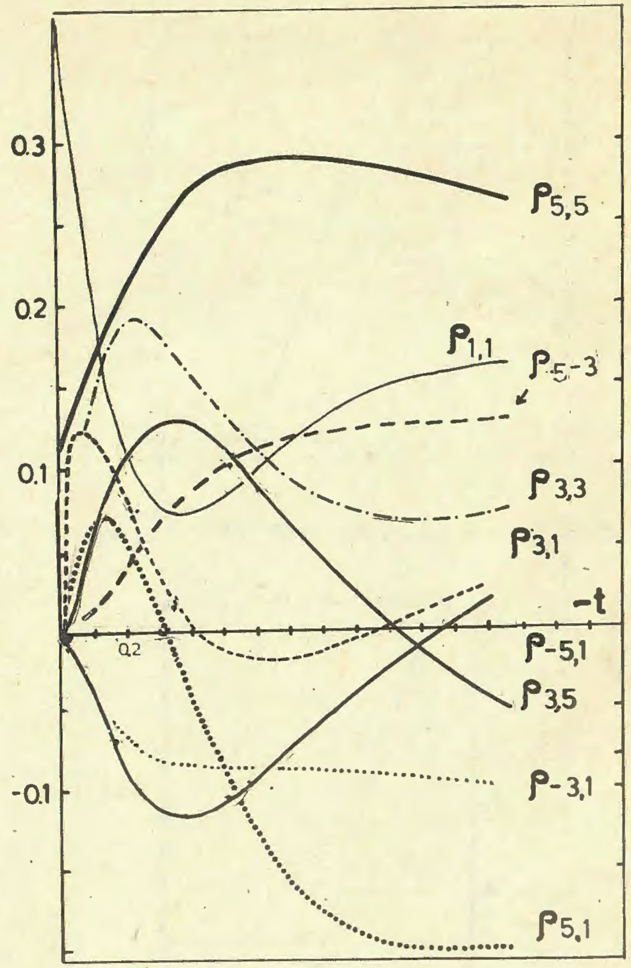


Fig.6. Density matrix elements of the $pn \to E^{+++}_{55} E^{--}_{55}$ process.



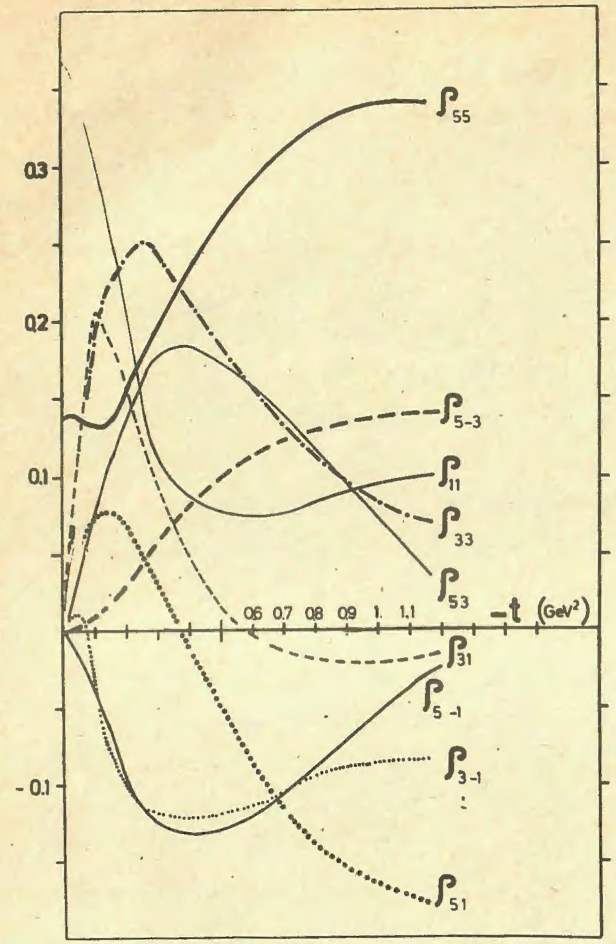


Fig.7. Density matrix elements of the $pp \to E^{+++}_{56} \Delta^{-}_{33}$ process.

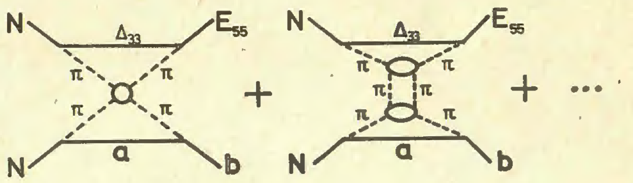


Fig.8. Diagrams contributing into the $NN \to \Delta E_{55}$ and $NN \to E_{55}E_{55}$ processes.



## REFERENCES


1. Abers E.S., Balazs L.A.P., Hara Y. Higher Baryon Resonances in the Static Model. Phys.Rev. 1964, vol.B136, N.5, p.1382-1388.
2. Ioffe R.L. $Q^2Q^2$ Resonances in the Baryon-Antibaryon System. Phys.Rev. 1978, vol.D17, N.5, p.1444-1459.
3. De Grombrugge M., Hogaasen H., Sorba P. Narrow Multiquark Baryons. N.P., 1979, vol.B156, N.2, p.347-363.
4. Mandelstam S. Relativistic Quark Model Based on the Veneziano Representation. Phys.Rev. 1970, vol.D1, N.6, p.1734-1744.
5. Shapiro I.S. The Physics of Nucleon-Antinucleon System. Phys.Rep. 1978, vol.35C, N.2, p.131-185.
6. Grigoryan A.A., Kaidalov A.B. Dispersion Sum Rules for Reggeon-Particle Scattering. N.P. 1978, vol.B135, N.1, p.93-110.
7. Григорян А.А., Кайдалов А.Б. Дисперсионные правила сумм для амплитуд рассеяния бозонных реджеонов с изоспином I =I на частицах. – ЯФ 1979, т.30, вып.6(I2) с.I626-I635.
8. Григорян А.А., Кайдалов. – Сверхсходящиеся правила сумм и структура вершин взаимодействия I =I реджеонов с барионами. – ЯФ, I979, т.30, вып.6 (I2), с.I636-I645.
9. Григорян А.А., Кайдалов А.Б. Диоперсионные правила сумм и экзотические барионные резонансы. – ЯФ, I980. т.32, вып.2(8), с.540-553
10. Grigoryan A.A. Exotic Baryon Resonances with Isospins 5/2. Preprint EPI-462(4)-81.
11. Абдивалиев А., Бешлиу К., Гаспарян А.П. Наблюдение особенности в распределениях эффективных масс $p\pi^+\pi^+(n\pi^-\pi^-)$ комбинации в реакции $np \to p\pi^+\pi^+\pi^-\pi^-n$ при $P_n = 5.1 \pm 0.17$ ГэВ/с

– ЯФ 1979, т.29, вып.6, с.1545–1550.

12. Троян Ю.А. Экзотические барионные резонансы с изоспином I = 5/2 в $np$ – взаимодействиях при энергии 4–5 ГэВ. Труды Международного семинара по проблемам физики высоких энергий, 1981.

13. DeKerret H., Brant A., Aubert J.J. A Study of the Charge-Exchange Reaction $pp \to n\Delta^{++}(1232)$ at ISR Energies. P.L. 1977, vol.69B, N.3, p.372.

14. Goggi G., Cavalli-Sforza M., Conta C. Study of Charge-Exchange Double Dissociation of Protons at the CERN Intersecting Storage Rings. N.P. 1977, vol.72B, N.2, p.356-359.

15. Кайдалов А.Б., Карнаков Б.М. Факторизация амплитуд и движущиеся ветвления.– ЯФ, 1970, т.12, вып.3, с.624–629.

16. Alles-Borelli V. The Production Properties of $\bar{p}p \to \bar{\Delta}^{++}\Delta^{++}$ at 5.7 GeV/c. N.C. 1967, vol.48, N.2, p.360-368.

17. Bockman K., Borecka I., Colletti S. et al. Investigation of the Reaction $p\bar{p} \to N^*_{33}\bar{N}^*_{33}$ at 5.7 GeV/c and 3.6 GeV/c. Phys.Lett. 1965, vol.15, N.4, p.356-358.

18. Donald R.A., Ewards D.N., Holden M.A. et al. The Production Properties of $\bar{p}p \to \bar{\Delta}^{++}\Delta^{++}$ from 3.6 to 12 GeV/c. N.P. 1978, vol.B145, N.1, p.1-24.

The manuscript was received 28 December 1981

А.А.ГРИГОРЯН, Г.Н.ХАЧАТРЯН

РОЖДЕНИЕ $E_{55}$–БАРИОНОВ В $NN$ –СТОЛКНОВЕНИЯХ

(на английском языке, перевод З.Н.Асланян)

Ереванский физический институт

Редактор Л.П.Мукаян

Тех.редактор А.С.Абрамян

| | | |
|---|---|---|
| Заказ 208 | ВФ– 05238 | Тираж 299 |
| Препринт ЕФИ | | Формат издания 60x84/16 |
| Подписано к печати 24/У–82 | 1,4 уч.изд.л.Ц. 20 к. | |

Издано Отделом научно-технической информации Ереванского физического института, Ереван 36, Маркарян 2