EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

ON THE $\Lambda\bar{\Lambda}$ SYSTEM FROM THE REACTION $\pi^- p \rightarrow \Lambda\bar{\Lambda}n$

W.E. Fischer
CERN, Geneva
and
ETH, Zurich

ABSTRACT

We present a phenomenological discussion of the properties of the $\Lambda\bar{\Lambda}$ system from the reaction $\pi^- p \rightarrow \Lambda\bar{\Lambda}n$. Asymmetries in angular distributions and $\Lambda(\bar{\Lambda})$ polarizations are explained. We only use well-established symmetries and the general laws of quantum mechanics.

Geneva - 22 July 1968
Preprint

1. INTRODUCTION

This paper deals with an analysis of the $\Lambda\bar{\Lambda}$ system from the reaction $\pi^- p \rightarrow \Lambda\bar{\Lambda}n$ at 12 GeV/c. This experiment has recently been terminated[1], and is a byproduct of the experiment on the $K_1^0 K_1^0$ mass spectrum[2] carried out by the CERN-ETH group.

The paper is an extension of the experimental paper published by the group[1]. It will mainly deal with an extensive discussion of the experimental results from a phenomenological point of view. Since the polarization of the Λ and $\bar{\Lambda}$ can be easily measured by the observation of their weak decay, a maximum of information on the $\Lambda\bar{\Lambda}$ system is obtained. This is therefore a situation where we may get a good insight and a quite complete qualitative picture of the system, without using any model of strong interaction, applying only the well-established invariance principles and the general laws of quantum mechanics. We shall see that this is, at least in this case, already a very powerful tool for a qualitative analysis. This is also to a certain extent the justification of this paper.

2. EXPERIMENTAL SITUATION

In this first part we would like to discuss the experimental situation for the reaction $\pi^- p \rightarrow n\Lambda\bar{\Lambda}$. We do not want to describe the experimental set-up and the details of the experimental analysis anymore, since this has been done elsewhere[1-3]. We only intend to give a short summary of the results obtained in this experiment. Later, it will be our aim to give an interpretation of these results in terms of well-established laws of quantum mechanics.

First information on this reaction is given by a $t_{p\Lambda} - t_{p\bar{\Lambda}}$ plot. $t_{p\Lambda}(t_{p\bar{\Lambda}})$ is the squared momentum transfer from the proton to the $\Lambda(\bar{\Lambda})$. This plot is given in Fig. 1 for the events corrected for the detection efficiency in the spark chamber. The events occur in two, clearly separated, regions; namely, for small t_{pn} (measured by the distance from the base of the "triangle") and small $t_{p\Lambda}$. No events exist for small $t_{p\bar{\Lambda}}$. These regions define obviously different production mechanisms for the $\Lambda\bar{\Lambda}$ system. In the first region (t_{pn} small) we have the events with local baryon number and strangeness conservation (Fig. 2a). For the events in the second region ($t_{p\Lambda}$ small) only the baryon number is locally conserved (Fig. 2b).

The third region would correspond to the exchange of a very complicated baryonic system. Comparing the number of points in these three regions we observe a nice example of the hierarchy of cross-sections related to the exchanged quantum numbers.

In the following we shall restrict ourselves to the discussion of the events in the first region; that is, $\Lambda\bar{\Lambda}$ events produced with a mechanism which is symbolized in Fig 2a. Let us next look at the $\Lambda\bar{\Lambda}$ mass distribution of these events. This mass spectrum (Fig. 3) shows that these $\Lambda\bar{\Lambda}$ events follow essentially a phase-space distribution without any evidence for resonance production. We therefore conclude that this $\Lambda\bar{\Lambda}$ system is not (except for very small masses) in a well-defined quantum state $|JM\Pi\rangle$ (Π means parity), but is a complicated mixture of such states with different angular momenta and parities. Our main goal is to decide which states are present and to describe their interference effects.

Hence, we look at the angular correlations in the c.m. frame of the $\Lambda\bar{\Lambda}$ system. The conventions for the angles are given in Fig. 4. In Fig. 5 we show the experimental distributions in cos ϑ and φ. The first distribution is reproduced by a polynomial

$$I(\cos\vartheta) = a_0 + a_1 \cos\vartheta + a_2 \cos^2\vartheta \,, \qquad (1)$$

where a_0 = (normalized) 1, $a_1 = 0.97 \pm 0.32$, and $a_2 = 2.59 \pm 0.95$. An F-test on higher powers shows that these terms are not significant. Hence, we may already conclude that the $\Lambda\bar{\Lambda}$ system contains mainly states with orbital angular momenta L = 0 and 1, higher values of L being unlikely.

The φ distribution (essentially the Treiman-Yang distribution) is represented by

$$I(\varphi) = b_0 + b_1 \cos\varphi + b_2 \cos 2\varphi \,, \qquad (2)$$

where b_0 = (normalized) 1, $b_1 = 0.48 \pm 0.20$, and $b_2 = 0.33 \pm 0.18$. Higher order terms are again not significant. We shall show later that this φ-distribution is consistent with the conclusions drawn from the cos ϑ distribution. In particular, if $a_1 \neq 0$ then $b_1 \neq 0$ (except in the case of an accident, of course).

The last experimental information is the polarization of the Λ and $\bar{\Lambda}$. Since we observe their decay in the spark chamber, the decay distribution determines the polarization of the Λ and $\bar{\Lambda}$. Namely

$$\frac{dN}{d(\cos\Theta)} = 1 + \alpha P \cos\Theta \qquad \begin{array}{l} \alpha = 2/3 \text{ for } \Lambda \\ \alpha = -2/3 \text{ for } \bar{\Lambda} \,. \end{array} \tag{3}$$

Θ is the angle between the momentum of the proton (antiproton) and the axis with respect to which we measure the polarization. The coordinate system used is shown in Fig. 6. We obtain the following values for the polarizations.

Λ : $P_z = -0.10 \pm 0.32$, $P_y = -0.15 \pm 0.32$, $P_x = -0.14 \pm 0.32$

$\bar{\Lambda}$: $P_z = -0.84 \pm 0.32$, $P_y = -0.40 \pm 0.32$, $P_x = -0.21 \pm 0.32$

We observe that the y- and x-components of the polarization are consistent with zero. If we admit that the difference in P_z for the Λ and $\bar{\Lambda}$ (a two standard deviation effect) is not due to a statistical fluctuation, we have to explain this asymmetry in polarization.

3. THE QUANTUM NUMBERS OF THE $\Lambda\bar{\Lambda}$-SYSTEM

We want to describe this system in terms of eigenstates of C (charge conjugation) and Π (parity). We prefer this representation to the helicity representation usually used, in order to keep track of the C-eigenvalues through the whole calculation. In the following this will be quite important. Let us label the state in the c.m. system as follows:

$$|p, J, M; \ell s\rangle ,$$

where p is the momentum of the particles in the c.m. system ($p_\Lambda = -p_{\bar{\Lambda}}$); J,M is the total angular momentum and its projection; ℓ is the orbital angular momentum; and s the total spin of the system. The corresponding wave function is then given by

$$\psi_{\Lambda\bar{\Lambda}} = \langle JM|\ell m\; s\mu\rangle \langle s\mu|{}^1\!/\!_2\nu_1\;\; {}^1\!/\!_2\nu_2\rangle\, Y_\ell^m(\vartheta,\varphi) f_\ell(r)\, \chi_1\bar{\chi}_2 \,. \tag{4}$$

$\nu_1\nu_2$ are the projections of the Λ and $\bar{\Lambda}$ spins; $\chi_1(\bar{\chi}_2)$ are the Pauli spinors of the $\Lambda(\bar{\Lambda})$. Since the $\Lambda\bar{\Lambda}$ system may be an eigenstate of C, the generalized Pauli principle applies. Assume that particle and antiparticle are two different states of the same particle. Any fermion-antifermion system must be antisymmetric under exchange of the two particles.

Particles and antiparticles have the same space-time properties. C therefore commutes with the generators of the Poincaré group

$$[C,P\mu] = 0 \ , \quad [C,J_{\mu\nu}] = 0$$

as well as

$$[C,\Pi] = 0 \ , \quad [C,T] = 0 \qquad T : \text{time reversal.}$$

However, C anticommutes with charge- and baryon number-operators

$$\{CQ\} = 0 \ , \quad \{CB\} = 0 \ .$$

The two different states of the same particle (describing particle and antiparticle) differ therefore in the sign of q and b.

Thus the generalized Pauli principle is fulfilled if

$$CA(\sigma,r)\ |\Lambda\bar{\Lambda}\rangle = (-1)^{2\sigma}|\Lambda\bar{\Lambda}\rangle \ , \tag{5}$$

where $\sigma = ½$ is the spin of the Λ's. $A(\sigma,r)$ is an operator which exchanges spin and coordinates. It follows from (4) that

$$A(\sigma,r)\psi_{\Lambda\bar{\Lambda}} = (-1)^{\ell+s-2\sigma}\psi_{\Lambda\bar{\Lambda}} \ ,$$

since

$$Y_\ell^m \rightarrow (-1)^\ell Y_m^\ell \qquad \text{for exchange of coordinates}$$

$$\langle s\mu|\sigma_1\nu_1\sigma_2\nu_2\rangle \rightarrow (-1)^{s-\sigma_1-\sigma_2}\langle s\mu|\sigma_2\nu_2\sigma_1\nu_1\rangle \qquad \text{for exchange of spins.}$$

Hence we obtain

$$C\psi_{\Lambda\bar{\Lambda}} = (-1)^{\ell+s}\psi_{\Lambda\bar{\Lambda}} \ . \tag{6}$$

If $|\Lambda\bar{\Lambda}\rangle$ is an eigenstate of C it is also an eigenstate of $A(\sigma,r)$. This follows from Eq. (5). This situation occurs, however, only if the Λ and $\bar{\Lambda}$ have the same polarization. The G-parity is defined by $G = C\cdot e^{i\pi T_2}$. Since the $\Lambda\bar{\Lambda}$ system has isospin zero, it follows trivially that $C_{\Lambda\bar{\Lambda}} = G_{\Lambda\bar{\Lambda}}$.

The parity is clearly given by

$$\Pi|p,J,M;\ \ell,s\rangle = \eta(\Lambda)\eta(\bar{\Lambda})\ (-1)^{\ell}\ |p,J,M;\ \ell\ s\rangle$$

where η are the intrinsic parities. $\Lambda\bar{\Lambda}$ has therefore the parity

$$\Pi = -(-1)^{\ell}\ . \tag{7}$$

Hence it follows that $C\Pi$ is determined by the total spin s of the system

$$C\Pi\psi_{\Lambda\bar{\Lambda}} = (-1)^{s+1}\psi_{\Lambda\bar{\Lambda}} \tag{8}$$

We now give a table of the quantum numbers of the lowest $\Lambda\bar{\Lambda}$ states in spectroscopic notation

	$^1S_0$	$^3S_1$	$^1P_1$	$^3P_0$	$^3P_1$	$^3P_2$
L	0	0	1	1	1	1
S	0	1	0	1	1	1
J	0	1	1	0	1	2
Π	-	-	+	+	+	+
C	+	-	-	+	+	+
$C\Pi$	-	+	-	+	+	+

It would now be easy to transform from this spectroscopic notation to the helicity representation by means of the transformation matrix

$$\langle JM\ell s|JM\lambda_1\lambda_2\rangle = \left(\frac{2\ell+1}{2J+1}\right)^{1/2}\langle \ell o\ s\lambda|J\lambda\rangle\ \langle\sigma_1\lambda_1\sigma_2\lambda_2|s\lambda\rangle,$$

where $\lambda = \lambda_1 - \lambda_2$, $\sigma_1 = \sigma_2 = 1/2$
and $s = 0, 1$.

However, we have already mentioned the reason why we want to keep a notation in terms of eigenstates of C, Π, and $C\Pi$.

Let us now draw a few qualitative conclusions concerning the production process of this $\Lambda\bar{\Lambda}$ system. We assume a π exchange graph which dominates the production. In this case, the upper vertex in Fig. 2a represents a reaction such as $\pi^-\pi^+ \to \Lambda\bar{\Lambda}$ with one pion off the mass shell. Since $G_{\pi\pi} = +1$, the $\Lambda\bar{\Lambda}$ system has to be in a state with $G_{\Lambda\bar{\Lambda}} = C_{\Lambda\bar{\Lambda}} = +1$. Together with parity conservation, our table then gives a selection of triplet states with positive parity and even angular momenta. Within this production mechanism, the quantum numbers of the $\Lambda\bar{\Lambda}$ system are therefore restricted to the sequence

$$J^{\Pi C} : 0^{++}, \quad 2^{++}, \quad 4^{++}, \ldots$$

The consequences of such a restriction are the following:

i) The $\cos\vartheta$ distribution is symmetric even in the case of interferences between different states.

ii) If we neglect absorption effects, the Treiman-Yang angle has an isotropic distribution.

iii) Since the $\Lambda\bar{\Lambda}$ system is produced in an eigenstate of C, the polarizations of the Λ and $\bar{\Lambda}$ have to be equal.

Neither of these criteria are fulfilled experimentally. We therefore conclude that we have to deal with a complicated production mechanism producing our system in a C = +1, as well as in a C = -1 state.

4. THE SPIN DENSITY MATRIX OF THE SYSTEM

In order to obtain some insight in the spin structure of the $\Lambda\bar{\Lambda}$ system, we construct its spin density matrix. Let $\rho_{MM'}$ be the density matrix for the production of a $\Lambda\bar{\Lambda}$ system in a well-defined J-state. The density matrix for the system after an eventual final-state interaction is then given by

$$\rho = \sum_{\substack{MM' \\ \ell\ell' \\ ss'}} \psi_{\Lambda\bar{\Lambda}}(JM\ell s)\ \rho_{MM'}\ \psi^{*}_{\Lambda\bar{\Lambda}}(JM'\ell' s') .$$

Explicitly we get according to Eq. (4) (see also Ref. 4)

$$\langle \nu_1 \nu_2 | \rho | \nu_1' \nu_2' \rangle = \sum_{\substack{MM' \\ \ell\ell' \\ ss'}} \rho_{MM'}\ T_{\ell s}\ T^{*}_{\ell' s'}\ \langle s\mu | \tfrac{1}{2}\nu_1 \tfrac{1}{2}\nu_2 \rangle \langle s'\mu' | \tfrac{1}{2}\nu_1' \tfrac{1}{2}\nu_2' \rangle \langle JM | \ell m s\mu \rangle$$
$$\langle JM' | \ell' m' s' \mu' \rangle \times Y^{m}_{\ell}(\Omega)\ Y^{m'}_{\ell'}(\Omega) . \qquad (9)$$

The angular distribution is now obtained by working out the trace with respect to both spin variables. We also use the following property of the spheric functions

$$Y_{\ell}^{m}(\Omega)\ Y_{\ell'}^{m'}(\Omega) = \frac{\sqrt{(2\ell+1)(2\ell'+1)}}{\sqrt{4\pi}} \sum_{L=|\ell-\ell'|}^{\ell+\ell'} \frac{1}{\sqrt{2L+1}} \times$$

$$\times \langle \ell o \ell' o | L o \rangle \langle \ell m, \ell' - m' | LM \rangle Y_L^M(\Omega) \ .$$

Furthermore, we observe that if we sum over both spin variables we get no contribution of the terms with $S \neq S'$. This is due to the orthogonality of the Clebsch-Gordan

$$\sum_{\nu_1 \nu_2} \langle s\mu | {1/2}\nu_1 {1/2}\nu_2 \rangle \langle s'\mu' | {1/2}\nu_1 {1/2}\nu_2 \rangle \sim \delta_{ss'}\ \delta_{\mu\mu'} \ .$$

The angular distribution has therefore no contribution from interferences between states with different spin (no triplet-singlet interference).

Hence we finally get for the angular distribution

$$I(\Omega) = \mathrm{Tr}_{12} \langle \nu_1 \nu_2 | \rho | \nu_1' \nu_2' \rangle$$

$$= \sum_{\substack{MM' \\ \ell\ell'}} \sum_{\nu_1 \nu_2} \rho_{MM'}\ T_{\ell s}\ T^*_{\ell' s}\ \langle s\mu | {1/2}\nu_1 {1/2}\nu_2 \rangle \langle s\mu' | {1/2}\nu_1 {1/2}\nu_2 \rangle \times$$

$$\times \langle JM | \ell m s\mu \rangle \langle JM' | \ell' m' s\mu' \rangle \times \frac{\sqrt{(2\ell+1)(2\ell'+1)}}{\sqrt{4\pi}} \sum_L \frac{1}{\sqrt{2L+1}}$$

$$\times \langle \ell o \ell' o | L o \rangle \langle \ell m, \ell' - m' | LM \rangle Y_L^M(\Omega) \ . \qquad (10)$$

Due to the fifth Clebsch-Gordan in Eq. (10), the coefficient of Y_L^M is zero if $\ell+\ell'+L$ is odd. If ℓ and ℓ' are both even or odd, L has to be even. This therefore gives a symmetric contribution to the angular distribution. Since $S = S'$, this corresponds to the interference of two states with the same J and the same charge conjugation. If, on the contrary, ℓ is even (odd) and ℓ' is odd (even), L has to be odd, and we therefore obtain an asymmetric contribution to the angular distribution. According to our table of quantum numbers, this corresponds to an interference of states with different charge conjugation C.

Equation (10) is essentially equivalent to Eqs. (1) and (2) if only the orbital angular momenta $\ell = 0,1$ are present. In Eq. (10) we have also terms such as $Y_1^{\pm 1} \sim \sin\vartheta$ which, however, do not seem to be significant in the experimental distribution. We also observe that the presence of a $\cos\vartheta$ term ($C = \pm 1$ interference) implies automatically a $\cos\varphi$ term in the Treiman-Yang distribution. Our angular correlations are therefore consistent with the qualitative theoretical picture described above.

Let us now discuss the polarization. The first question which arises is, whether this $C = \pm 1$ interference is also capable of explaining the polarization.

Hence we look at the separate spin density matrix of the Λ and $\bar{\Lambda}$:

$$\langle \nu_1 | \rho_\Lambda | \nu_1' \rangle = \mathrm{Tr}_2 \langle \nu_1 \nu_2 | \rho | \nu_1' \nu_2' \rangle \tag{11a}$$

$$\langle \nu_2 | \rho_{\bar{\Lambda}} | \nu_2' \rangle = \mathrm{Tr}_1 \langle \nu_1 \nu_2 | \rho | \nu_1' \nu_2' \rangle \ . \tag{11b}$$

The polarizations for each solid-angle interval are then given by

$$I(\Omega)\vec{P}_\Lambda = \mathrm{Tr}_1 \ (\langle \nu_1 | \rho_\Lambda | \nu_1' \rangle \cdot \vec{\sigma}) \tag{12a}$$

$$I(\Omega)\vec{P}_{\bar{\Lambda}} = \mathrm{Tr}_2 \ (\langle \nu_2 | \rho_{\bar{\Lambda}} | \nu_2 \rangle \cdot \vec{\sigma}) \tag{12b}$$

If we work out the traces (11a) and (11b) with the help of the representation (10), we realize that

$$\langle \nu_1 | \rho_\Lambda | \nu_1' \rangle = \langle \nu_2 | \rho_{\bar{\Lambda}} | \nu_2' \rangle \qquad \text{if } S = S' .$$

From this follows

$$\vec{P}_\Lambda = \vec{P}_{\bar{\Lambda}} \ . \tag{13}$$

We conclude, therefore, that the direct terms and the interferences $({}^1S_0, {}^1P_1)$ and $({}^3S_1, {}^3P_3)$ which can already explain the asymmetry in $I(\Omega)$ do not give any asymmetry in polarization.

Indeed, if we remember Eq. (8) and $s = s'$, we see that we only deal with interferences of states with equal $C\Pi$ quantum number. That is, even if we include these interferences we get a final state which is an eigenstate of $C\Pi$. The polarizations have therefore to be equal. In order to explain the asymmetric polarization, we have therefore to look also for interferences with different $C\Pi$ quantum numbers; that is, states with different total spin. If we measure polarization, triplet and singlet terms may interfere, and $\langle \nu_1 | \rho_\Lambda | \nu_1' \rangle$ and $\langle \nu_2 | \rho_{\bar{\Lambda}} | \nu_2' \rangle$ can have contributions from $s \neq s'$ as can be seen in calculating the traces (11a) and (11b).

The interference $({}^1P_1, {}^3P_1)$ that is between the states $|1M10\rangle$ and $|1M11\rangle$ gives, e.g.

$$\langle \nu_1 | \rho_\Lambda | \nu_1' \rangle = -\langle \nu_2 | \rho_{\bar{\Lambda}} | \nu_2' \rangle$$

leading to the polarizations

$$\vec{P}_\Lambda = -\vec{P}_{\bar{\Lambda}} \ .$$

These are, however, interferences between states with different ℓ. They give a contribution to the polarization which, according to Eq. (9), is proportional to

$$\int_\Omega Y_\ell^m(\Omega)\ Y_{\ell'}^{m'}(\Omega)\ d\Omega \cong \delta_{\ell\ell'}\delta_{mm'} \ .$$

Remember that we have only measured the polarization averaged over the angular distribution. This interference therefore gives no contribution to our polarization. The same argument also applies, of course, to the interferences leading to equal polarization of Λ and $\bar{\Lambda}$.

We have therefore to conclude that the asymmetry in the integrated polarization comes from interferences between states with different total angular momenta $(J = J')$ and opposite $C\Pi$, but equal orbital angular momenta $(\ell = \ell')$. These terms are, for example,

$$({}^1S_0,\ {}^3S_1)\ , \quad ({}^1P_1,\ {}^3P_0)\ .$$

These interferences give us finally

$$\langle \vec{P}_\Lambda \rangle = -\langle \vec{P}_{\bar{\Lambda}} \rangle \ . \tag{14}$$

Together with the parallel contributions from the non-interfering terms, any configuration is possible, depending on the production amplitudes for the different states.

Finally, we should like to point out that the treatment of interferences between states with different total angular momenta is outside the framework of the density matrix defined in Eq. (9). A generalization of the density matrix and a method of treating those problems formally has been proposed in Ref. 5.

5. CONCLUSIONS

We have selected from all experimental events of $\pi^- p \to \Lambda\bar{\Lambda}n$ the subset with low momentum transfer from proton to neutron. Those events are probably all produced with the same production mechanism. We have not intended to explore this mechanism. Our main interest was to explain the observed features of the $\Lambda\bar{\Lambda}$ system (angular correlation and polarization) in a purely phenomenological way using only well-established symmetry laws of quantum mechanics. The asymmetry in the cos ϑ distribution and the behaviour of the φ distribution could be directly read off from the spin density matrix of the $\Lambda\bar{\Lambda}$ system. We can interpret this result as a direct consequence of the interference between the C = +1 and C = -1 part of the $\Lambda\bar{\Lambda}$ system. The interpretation of the asymmetry in the integrated polarization was slightly more painful. It must come from an interference between states with opposite CΠ, unequal total angular momenta but equal orbital angular momenta. From this we conclude that the structure of the $\Lambda\bar{\Lambda}$ system produced in this reaction $\pi^- p \to \Lambda\bar{\Lambda}n$ is as complicated as it can be. The only simplification comes from the fact that no high angular momenta are present. However, this is probably only due to the high threshold of this reaction.

I should like to thank my colleagues of the CERN-ETH Group for this nice experiment. I am also very grateful to Dr. W. Beusch, Dr. J. Iliopoulos, and Prof. J. Prentki for discussions on several subjects. I wish to express my appreciation to Prof. P. Preiswerk for the hospitality extended to me at CERN. This work was supported by the Swiss National Science Foundation.

REFERENCES

1. P. Astbury, G. Finocchiaro, A. Michelini, D. Websdale, C.H. West, W. Beusch, B. Gobbi, M. Pepin, E. Polgar and M.A. Pouchon, Nucl. Instrum. Methods 46, 61 (1967).

2. W. Beusch, W.E. Fischer, B. Gobbi, M. Pepin and E. Polgar; P. Astbury, G. Brautti, G. Finocchiaro, J.C. Lassalle, A. Michelini, K.M. Terwilliger, D. Websdale and C.H. West, Phys.Letters 25B, 357 (1967).

3. W. Beusch, W.E. Fischer, M. Pepin, E. Polgar; A. Michelini, D. Websdale and C.H. West, A study of the reaction $\pi^- p \rightarrow \Lambda\bar{\Lambda}n$ at 7 and 12 GeV/c, CERN preprint (submitted to the 14th Int.Conf. on High-Energy Physics, Vienna, 1968).

4. M. Ademollo, R. Gatto and G. Preparata, Phys.Rev. 139, B1608 (1965).

5. W.E. Fischer, an analysis of interfering resonances, CERN preprint (submitted to Nuovo Cimento).

Figure captions

Fig. 1 : Momentum transfer plot for the 12 GeV/c data (79 events), density corrected for detection efficiency.

Fig. 2 : Graphs indicating three possible production mechanisms of a $\Lambda\bar{\Lambda}$ pair:

a) local strangeness and baryon number conservation;

b) local baryon number conservation only;

c) exchange of a complicated baryonic strange system.

Fig. 3 : Invariant mass distribution for events dominated by graph 2a.

Fig. 4 : Conventions for the angles in the "decay" distribution ($\hat{n}$-normal to the production plane, p_π is the direction of the incoming pion).

Fig. 5 : Angular distribution of $\Lambda\bar{\Lambda}$ in their c.m. system for 12 GeV/c events selected for $t(p \rightarrow n) > -2.5$ $(GeV/c)^2$:

a) Jackson angle distribution;

b) Treiman-Yang angular distribution.

Fig. 6 : Coordinate frame for the definition of the polarizations. z is parallel to $\vec{p}_\pi \times \vec{p}_\Lambda$. The Λ and $\bar{\Lambda}$ are transformed to rest along the y-axis in that system.

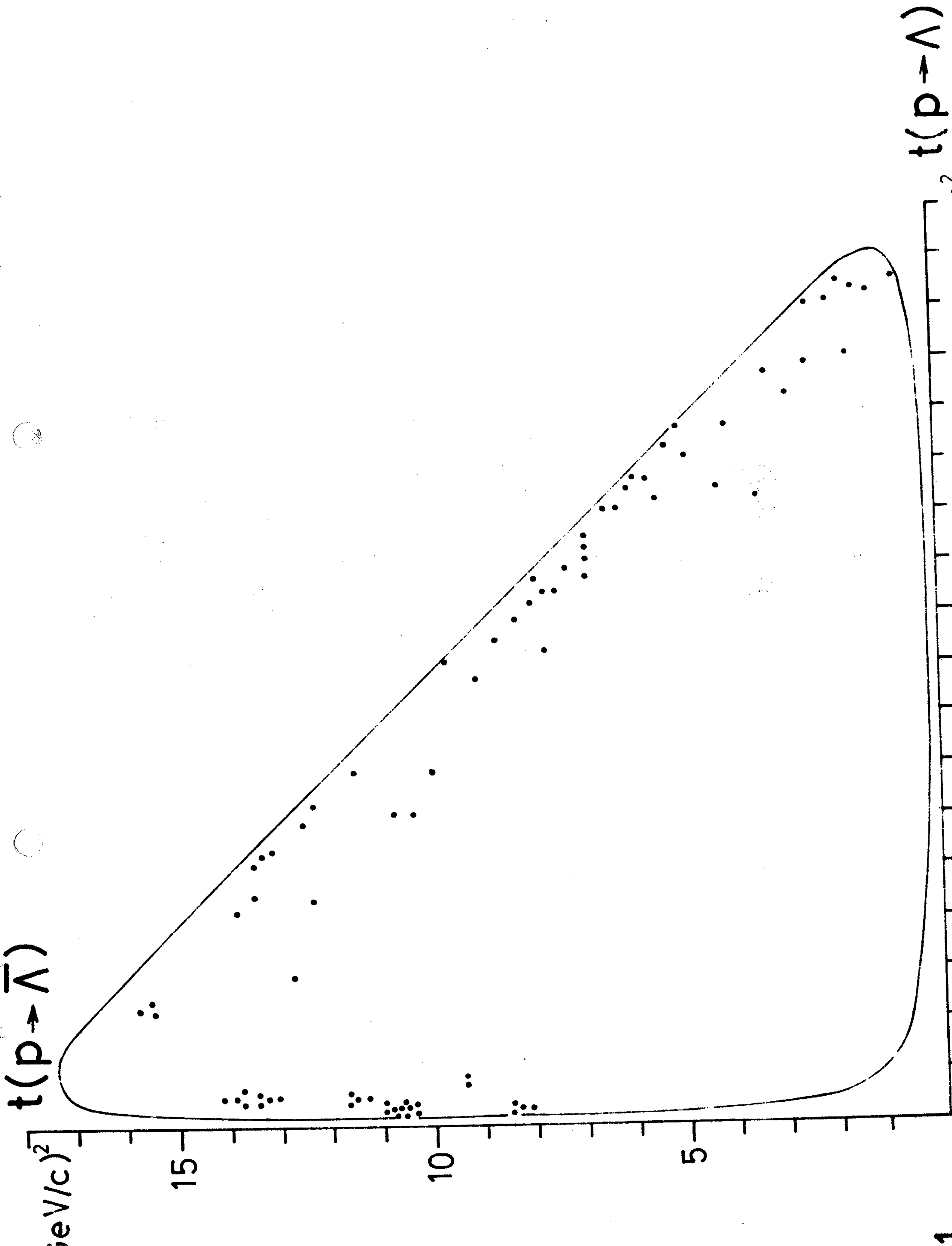

Fig.1

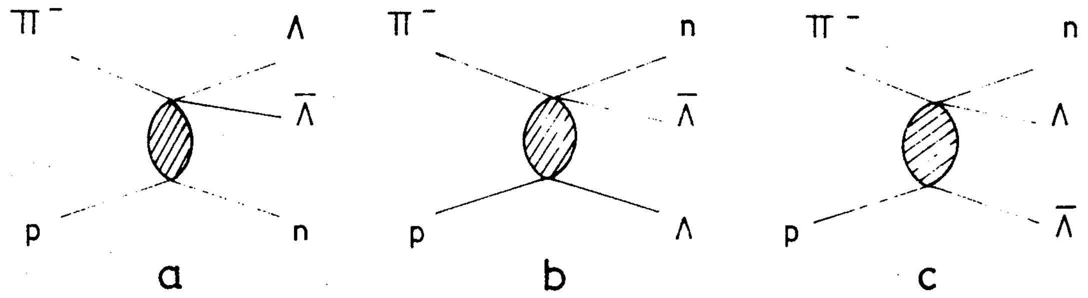

Fig. 2

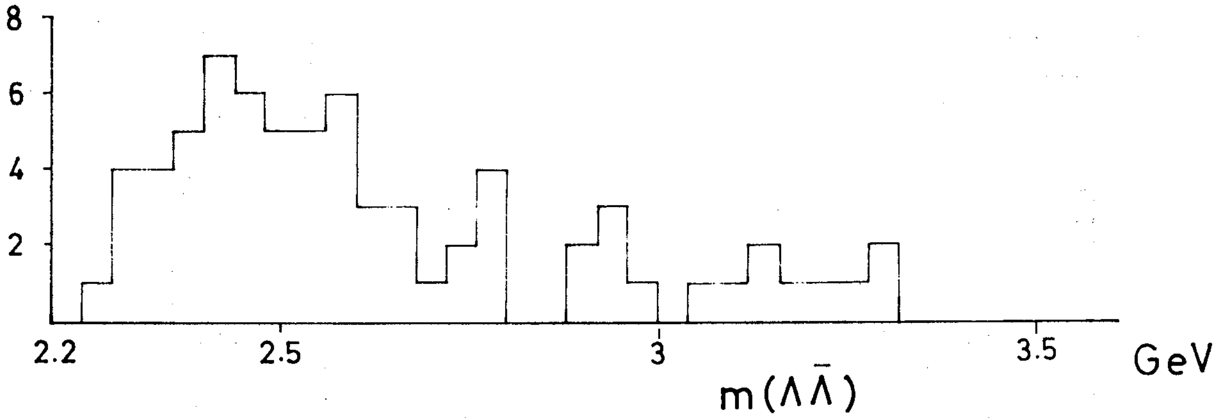

Fig. 3

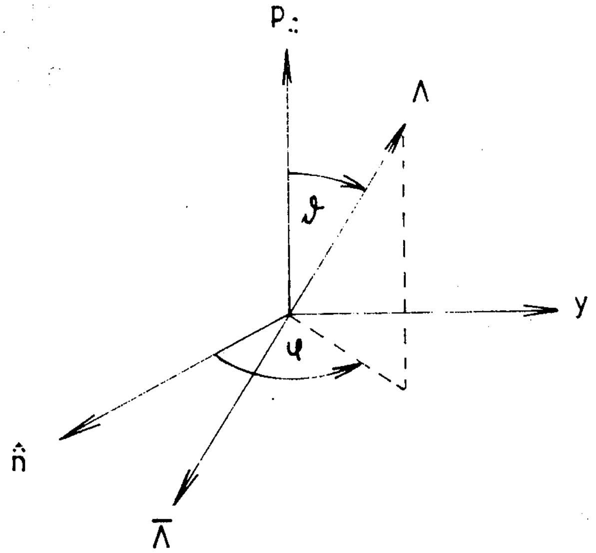

Fig. 4

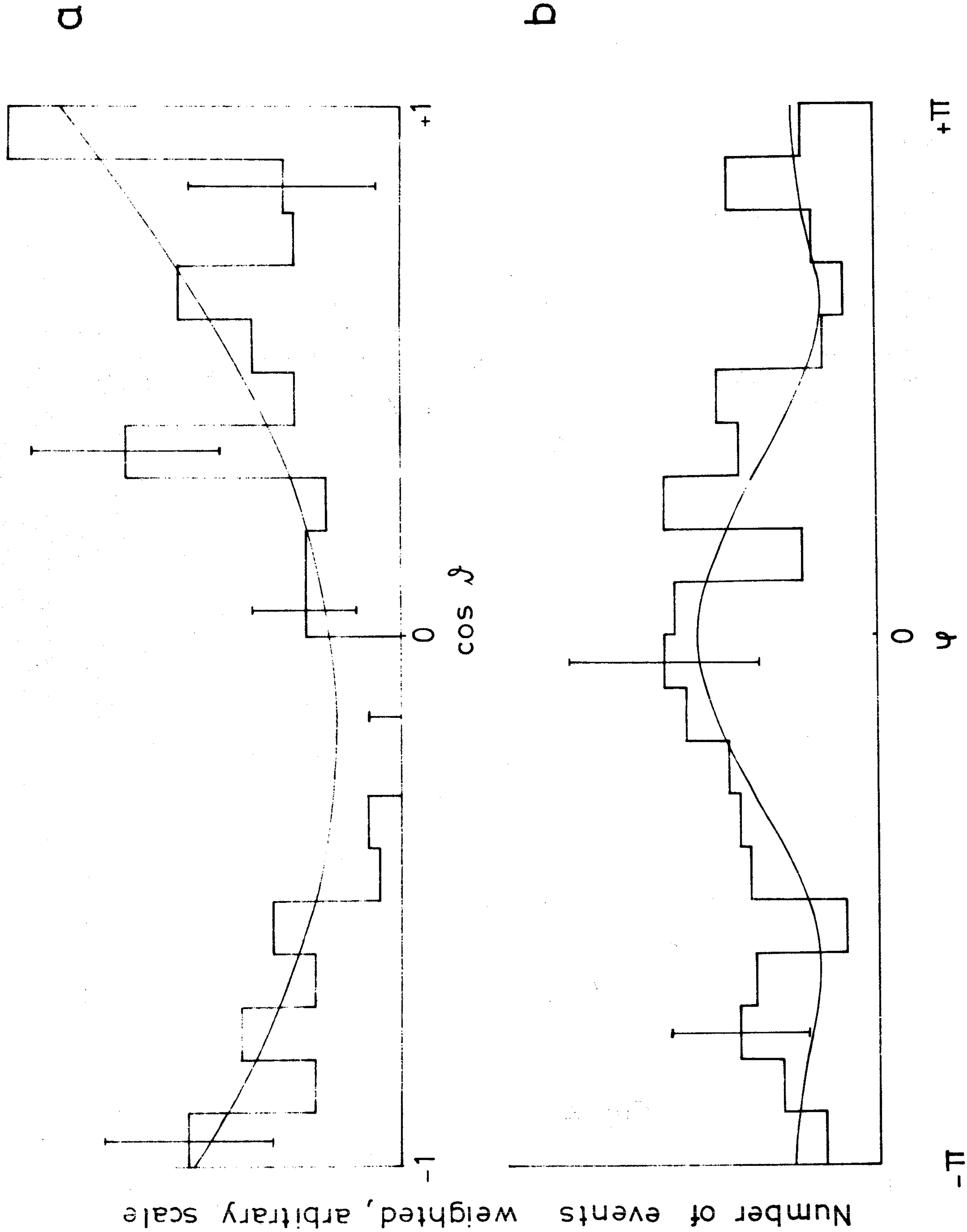

Fig. 5

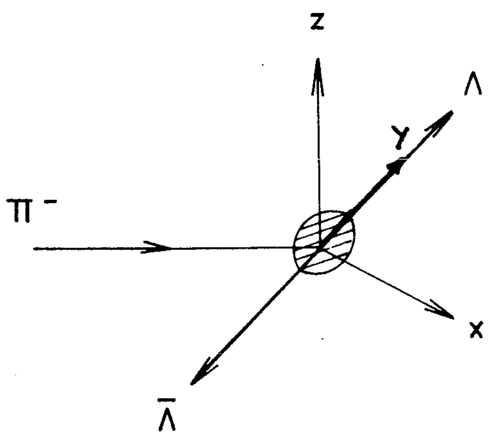

Fig. 6