ОБЪЕДИНЕННЫЙ ИНСТИТУТ ЯДЕРНЫХ ИССЛЕДОВАНИЙ

Лаборатория высоких энергий

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The purpose of this note is to present the data obtained in studying π^--p interaction accompanied by the production of strange particles. These have been got with a 24-litre propane bubble chamber exposed to the negative pion beam with the momentum of 7 and 8 BeV/c.

To clear up the behaviour of the baryon in inelastic interactions the reaction

$$\pi^- + p \to \Lambda + K + n\pi$$
$$\Lambda \to \pi + p$$

has been used as the simplest one from the point of view of the baryon identification. We have investigated the momentum and angular distributions of Λ°-hyperons and the change in the baryon momentum in the course of the reaction.

For the analysis, 428 events have been used*. The change in the baryon momentum and energy in the c.m.s. has been calculated by the formulae

$$\vec{\Delta} = \vec{p}_p - \vec{p}_\Lambda, \quad \Delta_0 = E_p - E_\Lambda .$$

In Figs. 1,2,3 are given the distributions of the values $|\vec{\Delta}|$, Δ_0, and $M = \sqrt{|\vec{\Delta}|^2 - \Delta_0^2}$ found in our experiments. It should be noted that the numerical values of $|\vec{\Delta}|$ are distributed over a very wide interval. The average values of these quantities for the stars with different number of prongs are the following :

The number	n_s	$\langle M \rangle$ MeV	$\langle \bar{\Delta} \rangle$ MeV/c	$\langle \Delta_0 \rangle$ MeV
70	0	966 ± 100	1086 ± 130	520
232	2	1024 ± 90	1180 ± 90	580
126	4 and 6	1114 ± 120	1334 ± 100	730

As is seen from the Table, the values of $\langle M \rangle$, $\langle \bar{\Delta} \rangle$, $\langle \Delta_0 \rangle$ are increasing monotonously with the increasing number of the charged prongs in a star.

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* In 310 events the Λ°-hyperon was reliably identified, and in 118 events it turned out impossible to distinguish between Λ° and K°. From the comparison of the momentum and angular distributions of the decay products of the non-identified V°-particles with the same distributions for the identified Λ° and K° particles it was established that the part of K°-mesons among the non-identified events does not exceed 20%.

The momentum distribution of Λ^0-hyperons in the c.m.s. is presented in Fig. 4. For comparison in the same Figure are drawn the curves calculated by the statistical theory. One of these curves takes into account the possibility of Y* and K' isobar formation, the second one does not. Both curves are normalized to the histogram area. Fig.4 shows that besides a soft component of the spectrum ($P^* < 1{,}3$ BeV/c), which is in good agreement with the statistical theory, there is also a hard one, which disagrees with the statistical approach. This component of the Λ--hyperon spectrum is presented in the distributions $|\vec{\Delta}|$, Δ_0 and M by the shaded part of the histograms which is referred to the small values.

One can consider conditionally that the events with large $\vec{\Delta}$ correspond, to the central collisions, whereas with small -- to the peripheral ones. It is possible to estimate from the given data that at our energies about 23% of the reactions involving Λ^0-hyperon production occur through the peripheral interactions.

There has been also constructed the distribution $|\vec{\Delta}|$ as a function of the angle θ formed by the proton momentum and $\vec{\Delta}$ in the c.m.s. (Fig.5.). This points out that our events can be devided into two groups One group includes the values $|\vec{\Delta}| >$ 800 MeV/c and $\cos\theta > 0.8$ and the other $|\vec{\Delta}| >$ 800 MeV/c and $\cos\theta > 0$.

The first group incorporates the central collisions, while the second -- peripheral. One may say qualitatively, that in the central collisions the momentum is transferred only at small angles, while for the peripheral interactions this angle may be any you like and lie between 0° and 90°.

We made an attempt to analyse the data which are obtained for the reactions accompanied by the strange particles production at other energies, as well as for the reactions of multiple production not accompanied by strange particles. The distribution of the magnitudes of $|\vec{\Delta}|$ for different reactions is shown in Fig. 6.

Irrespective of the difficulties encounted in comparing these data quantitatively with our results*, one can see that in these cases the distribution over $|\vec{\Delta}|$ is qualitatively alike ours. Moreover, in most of the experiments there exist maxima in the region of small momentum transfer $|\Delta| \sim 500$ MeV/c (just as in our distribution).

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* The comparison is not easy since in each distribution the number of events is small. Moreover, there exists a difficulty in identifying protons in the large momentum region (> 1,2 BeV/c) which lead to the missing of the events in the interval of large values of $\vec{\Delta}$.

Y.Wolf and G.Domokos[1] have calculated the diagram for the process $\pi^- + p \to \Lambda + K^0$ with the K' meson exchange, the resonance interaction in the $\pi K' K^0$ vertex and in the distribution function of a K'-meson being taken into account.

Four assumptions have been made:

K'	scalar	parity in the vertex $PK'\Lambda$	positive
"	"	"	negative
"	vector	"	positive
"	"	"	negative

The curves normalized (up to $M = 630$ MeV) are drawn in Fig. 3.

If the peripheral processes involving the Λ-hyperon and K-meson production occur via a K'-meson, and the distributions over M calculated by the diagram taking into account the generation of additional pions, are little different from the distributions without pions, then the experimental data are in good agreement with the vector variant of a K'-meson.

In conclusion the authors express their deep gratitude to a group of assistants for making necessary measurements and for the help in drawing the graphs, as well as to the workers of the computation division of the Theoretical Physics Laboratory for making the calculations at the electronic computers.

We are very much indebted to I.M. Gramenitsky and V.B. Lubimov for the kindly communicated data by means of which the angular distributions shown in Fig. 6 have been obtained.

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2. Вишки, И.М. Граменицкий, З.Корбел, А.А. Номофилов, М.И. Подгорецкий, Л. Роб, В.Н. Стрельцов, Д. Тувдендорж, М.С. Хвастунов. Препринт ОИЯИ Р-745, 1961.

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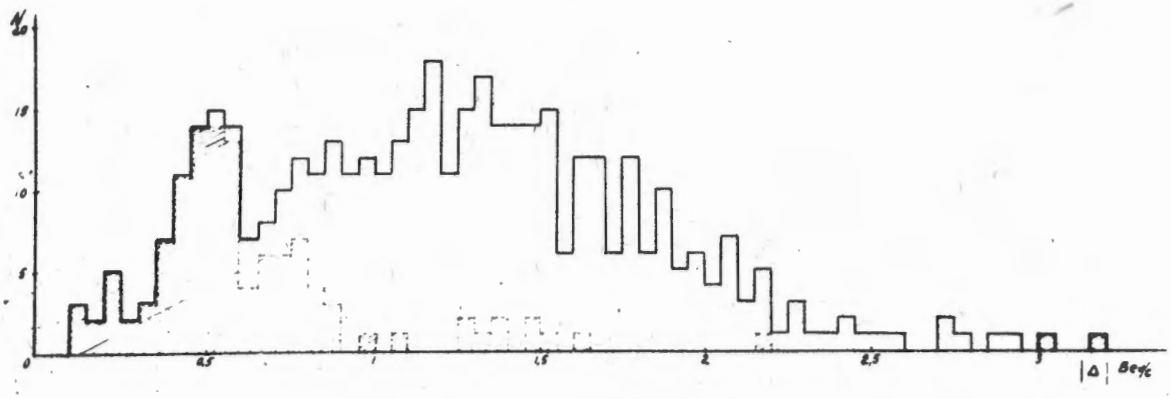


Fig. 1. Spectrum of the varying baryon momenta $|\bar{\Delta}|$ in the c.m.s. $\bar{\Delta} = \bar{p}_p - \bar{p}_\Lambda$

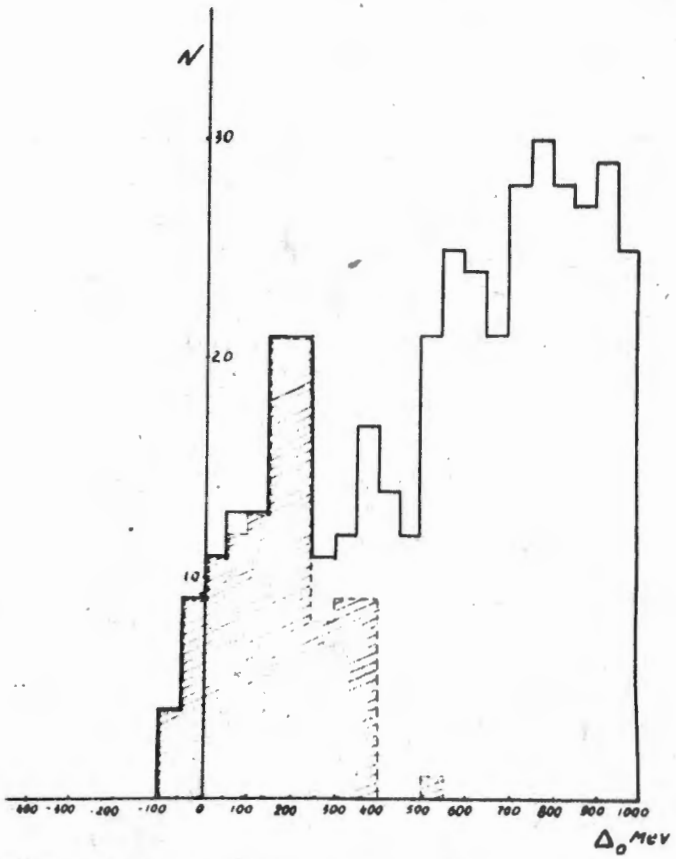


Fig. 2. The distribution of the varying baryon energies in the c.m.s. in the Λ -hyperon production.

$\Delta_0 = E_p - E_\Lambda$

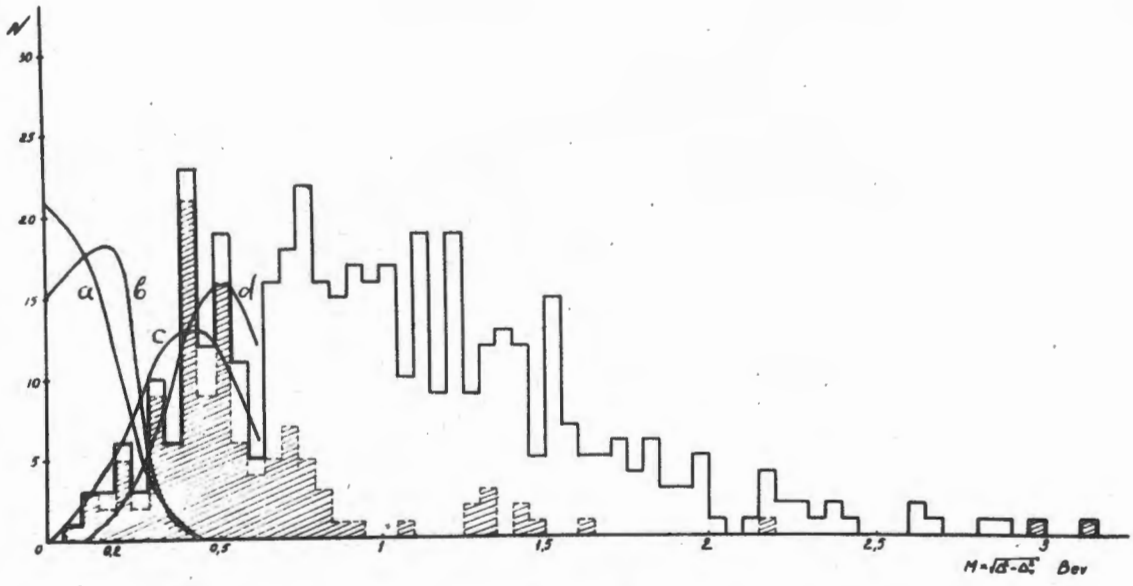


Fig.3. The distribution of the magnitudes $M = \sqrt{|\bar{\Delta}|^2 - \Delta_0^2}$. Theoretical curves (a) and (b) correspond to the calculations taking into account tha scalar K'-particle exchange, (c) and (d) – the vector K-particle exchange. The curves (a) and (c) are calculated under the assumption of the positive parity in the $p\Lambda K'$ vertex, while the curves (b) and (d) correspond to the negative parity in the same vertex.

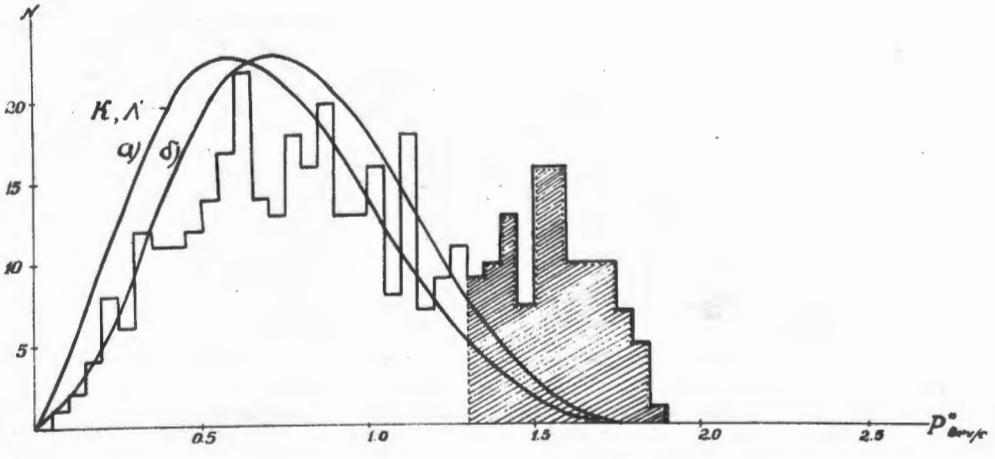


Fig.4. The momentum spectrum of Λ-hyperons in the c.m.s. The theoretical curves are calculated by the statistical theory:

a) with account of the isobar formation Y*, K'

b) without the isobars.

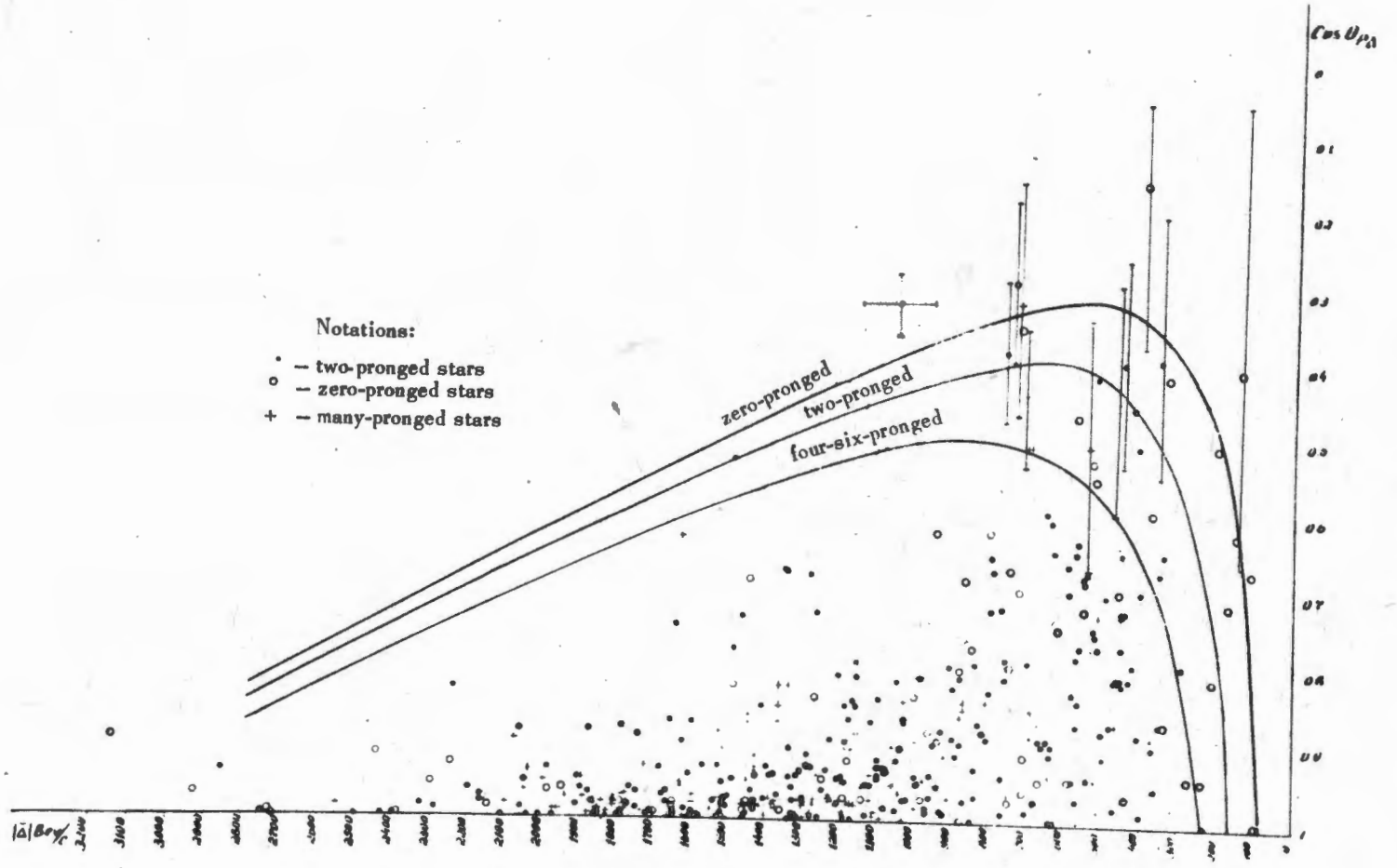


Fig.5. The distribution of the magnitudes of the varying baryon momenta $|\bar{\Delta}|$ as a function of the angle θ between the proton momentum and $\bar{\Delta}$ in the c.m.s. The kinematic curves are drawn for different multiplicities of π -mesons in the reaction $\pi^- + p \to \Lambda + K^o + n\pi$.

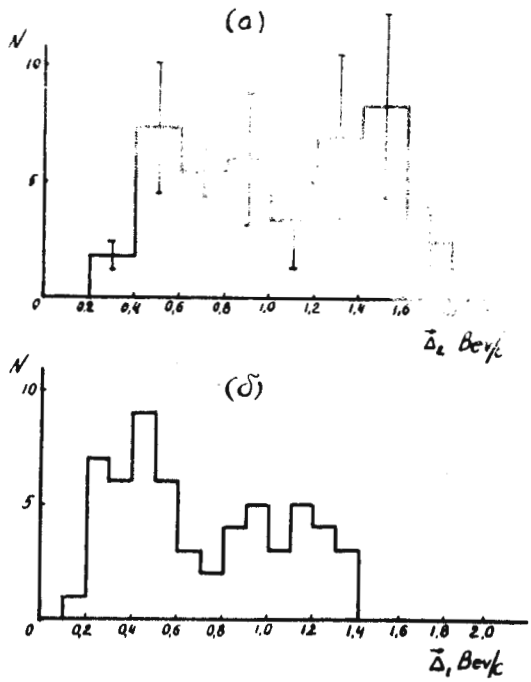
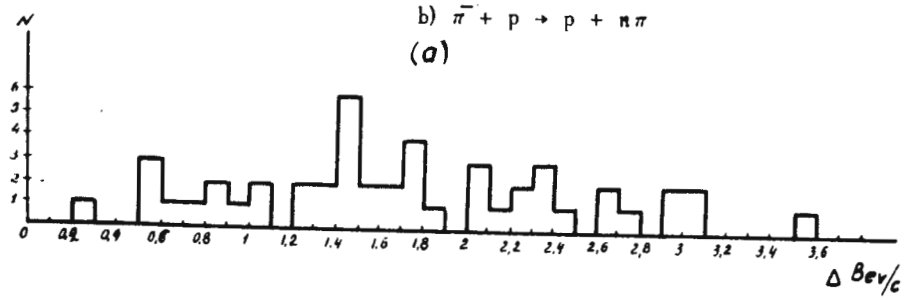


Fig.6. The distribution of the magnitudes of the transferred momenta $|\bar{\Delta}|$ from a proton to a proton in the c.m.s. for the reactions

a) $p + p \rightarrow p + N + n\pi$ /2/

b) $\pi^- + p \rightarrow p + n\pi$



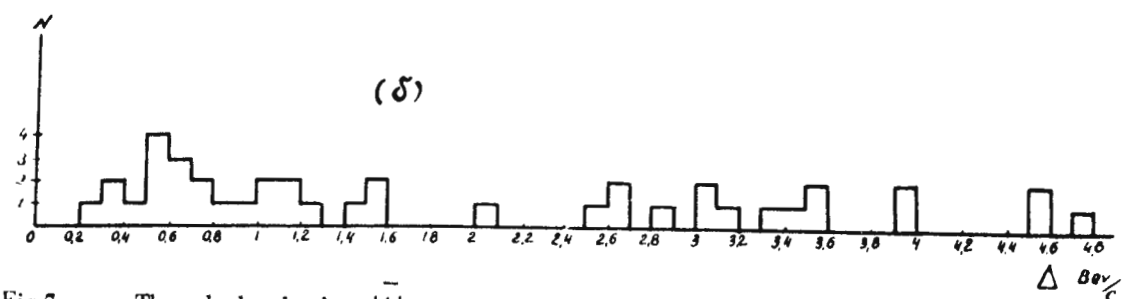


Fig.7. The calculated values $|\bar{\Delta}|$ on the basis of the experimental results obtained at the CERN proton synchrotron.

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a) $\pi^- + p \rightarrow \Lambda + K^\circ + n\pi$

b) $\pi^- + p \rightarrow p + n\pi$