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OBSERVATION OF THE DIFFRACTIVE PRODUCTION OF THE $\Lambda K \pi$ SYSTEM

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ABSTRACT

Coherent production of the $\Lambda K^+\pi^-$ system has been observed on carbon nuclei and on nucleons, at ~ 45 GeV incident neutron energies. The production cross section on nuclei and the decay probability of the n^* system into the $\Lambda K\pi$ final state has been estimated.

АННОТАЦИЯ

Наблюдено когерентное рождение системы $\Lambda K^+\pi^-$ на нуклонах и ядрах углорода при энергиях налетающих нейтронов около 45 Гэв. Дана оценка сечения рождения на ядрах и вероятности распада и в конечное состояние $\Lambda K\pi$.

KIVONAT

Megfigyeltük a $\Lambda K^+\pi^-$ rendszer koherens keletkezését nukleonokon és szén atommagon ~ 45 GeV energiájú neutron nyaláb esetén. Megbecsültük a keletkezési hatáskeresztmetszetet valamint az n^* rendszer bomlásának valószinüségét a $\Lambda K\pi$ végállapotba.

In this paper we report experimental results on the reactions:

$$n + C \longrightarrow n^{*} + X \qquad /1a/$$

$$n + N \longrightarrow n^{*} + X \qquad /1b/$$

where the n^{*} system produced diffractively decays into the

$$n^{*} \longrightarrow \Lambda^{0} K^{+} \pi^{-} \qquad /2/$$

final state.

The experiment has been performed using the neutral beam of the 70 GeV protonsynchrotron of Serpukhov and the BIS on-line magnetic spectrometer [1]. This latter /Fig.1/ consists of an analysing magnet of 1.5 m length and an aperture of 0.3 x 1.1 m^2; 3 x 3 and 5 x 3 wire chambers upstream and downstream the magnet, respectively, to measure the momentum and direction of the secondaries produced in the interactions of the incoming neutrons inside a 5 cm long carbon target. A 1.2 m long decay zone between the target and the spark chambers enables one to detect lambdas via their charged decay mode:

$$\Lambda^{0} \longrightarrow p \pi^{-}. \qquad /3/$$

The trigger performed by three walls of scintillation counter hodoscopes /FI, GI and GII/ required essentially that at least three charged particles traverse the spectrometer.

More than 2million triggers have been registered on magnetic tapes corresponding to an integrated luminosity of $\sim$ 0.2 event/nb in order to look for production of narrow width strange final states. The result of this study will be published elsewhere. Out of the four-prong events the spectrometer selected a considerable fraction of those corresponding to reactions /1, 2,3/, where the n^* has been produced diffractively. Here we describe the analysis of these events.

After geometrical reconstruction proper geometrical and kinematical cuts were applied to select events with at least one lambda and two additional tracks emerging from the target. Use was made of the good spatial and mass resolution of the spectrometer, which amounts to $\pm$ 2 mm in the transverse, to $\pm$ 3 cm in the longitudinal direction with respect to the beam, and to 3 MeV FWHM for the lambda mass, respectively. The usual geometrical reconstruction [2] should have been supplemented by a special filter procedure which ensured that except few cases a physical spark enter only once in an event. In about 80% of the cases the lambda particle could have been uniquely selected, for the remaining 20% that $p\pi^-$ pair was chosen which gave the closest invariant mass to the lambda mass. 236 events were retained in this way. In the majority of these events only two tracks have been found which originated from the target and accompanied the lambda. This is illustrated in Fig. 2 where the number of events is plotted against the number of zero total charge (lambda + two prongs) combinations per event. The distribution can be understood in terms of the small acceptance of the spectrometer for centrally and backward produced secondaries as well as of limitations in multitrack efficiency. It indicates, however, that a considerable part of the observed events should be diffractively produced n^*'s decaying into the $\Lambda K^+\pi^-$ final state.

In the following we assume that the positive particle is kaon and the negative one is pion and select those where the total energy of the $\Lambda K\pi$ system is close to the incident beam energy, i.e. exceeds 35 GeV. We define:

$$\Theta^2 = p_\perp^2 / p^2, \qquad /4/$$

where $p_\perp$ and p are the resultant transverse and total momentum of the $\Lambda K\pi$ system. The acceptance corrected Θ^2 - distribution is shown in Fig. 3. The number of events decreases exponentially with increasing Θ^2 and one can observe an excess of events near to the forward direction. This latter can be interpreted as $\Lambda K\pi$ events produced coherently on carbon nuclei and on nucleons. The remaining part contains incoherent $\Lambda K\pi$ or coherent $\Lambda K(n\pi)$ $(n \geq 2)$ events with one or several charged particles lost and missidentified $\Lambda\pi\pi$ events. A linear extrapolation of the latter events to $\Theta^2 \approx 0$ /line b in Fig. 3/ allows one to estimate the number of coherently produced events to be 70 ± 10. The error already accounts for the uncertainty in the background estimation. Using this number together with the integrated luminosity and an avarage detection probability of (2 ± 1)% we estimate the coherent production cross section of the $\Lambda K^+\pi^-$ system on carbon nuclei and on nucleons to be (18 ± 10) μb by 45 GeV incident neutrons.

Our statistics does not allow to separate in a model independent way the two components of the coherent events, namely those which are produced on the carbon nuclei /$\mathcal{N}$/ from those produced on nucleons /N/. Simple geometrical considerations would give a ratio $\sigma_{\mathcal{N}}^{tot}/\sigma_{N}^{tot}$ $\sim A^{2/3} \sim 5$. It is certainly an upper limit since high mass systems /above the threshold/ are relatively more abundantly produced on nucleons than on nuclei in order to preserve coherence. A better estimate can be obtained from the average observed slope /line a in Fig. 3/ which suggests a $\mathcal{N}$: N mixture of $\sim 3 : 1$ if we assume that coherent events on nucleons have an exponential t-dependence with slope ~ 5 GeV^{-2}. We take this last value and assume that the inclusive cross section of the n^{*} system produced in nN collision for $|x| \geq 0.9$ does not vary with energy and is the same as obtained for the p^{*} system in pN collision [3], namely (7 ± 1) mb. Then the n^{*} decay branching ratio into the $\Lambda K \pi$ channel turns out to be

$$\frac{n^{*} \longrightarrow \Lambda K^{+} \pi^{-}}{n^{*} \longrightarrow \text{all}} = \left(0.7 \begin{array}{l} +1.2 \\ -0.6 \end{array}\right) ‰$$

REFERENCES

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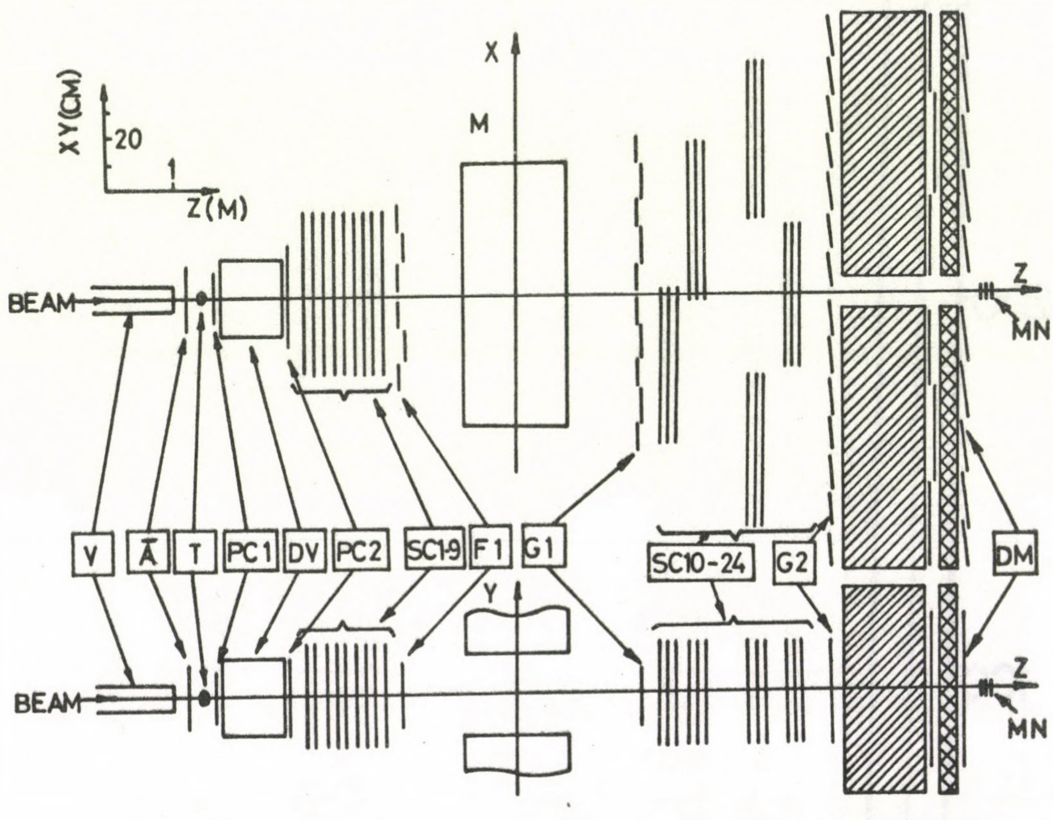
Figure Captions

Fig.1 The layout of the spectrometer. V: collimator, $\bar{A}$: anti counter, T: target, PC: proportional chambers, DV: decay volume, SC: wire spark chambers, F,G: scintillation counter hodoscopes, DM: muon identifier, M: magnet, MN: monitor counter

Fig.2 Distribution of the zero total charge two-prong combinations per event detected by the spectrometer together with a lambda particle

Fig.3 θ^2 - distribution of the $\Lambda K\pi$ system corrected for the acceptance. The solid lines represent:
a - events produced coherently on carbon nuclei and on nucleons; b - incoherent and missidentified events



X Y (CM)
20
1
Z (M)
X
M
BEAM
BEAM
Z
MN
Z
MN
V
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T
PC1
DV
PC2
SC1-9
F1
G1
SC10-24
G2
DM
Y

Fig. 1.

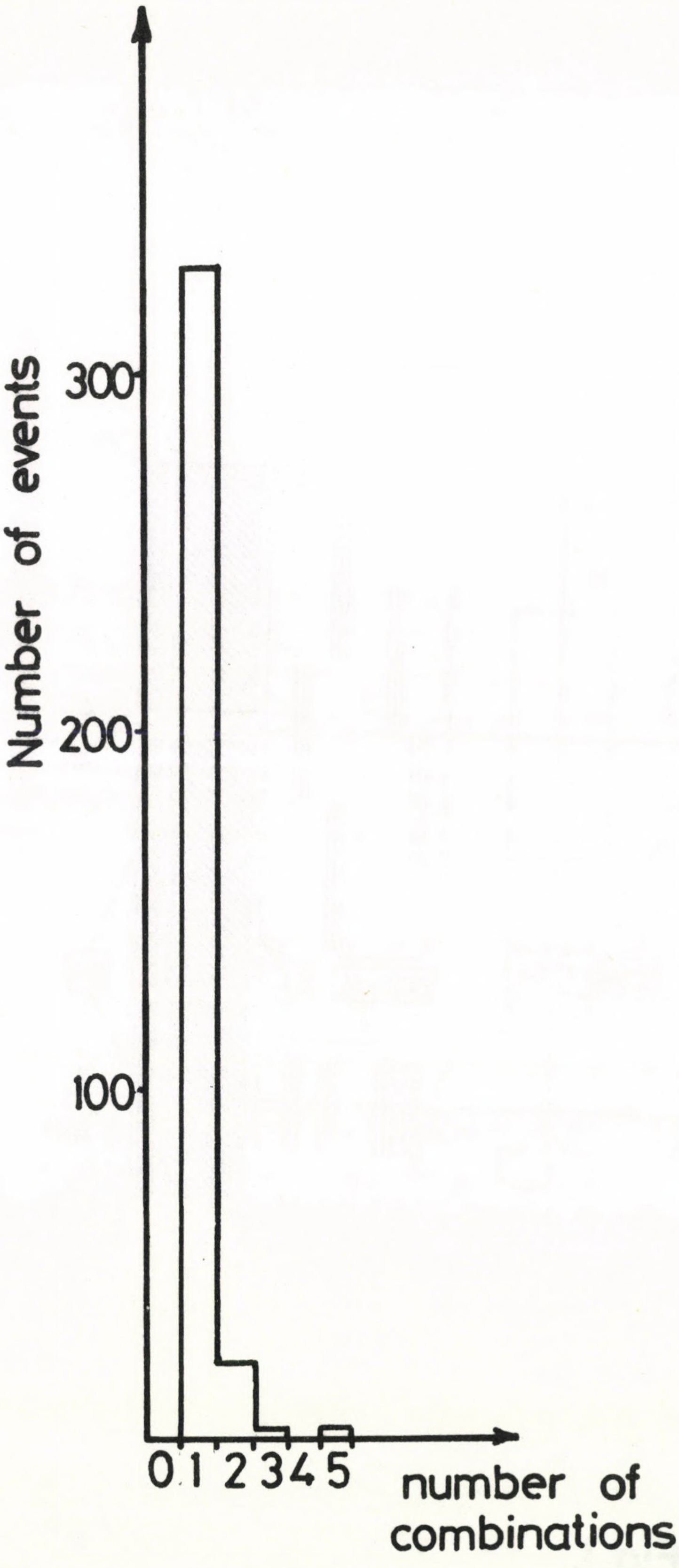

Fig. 2.

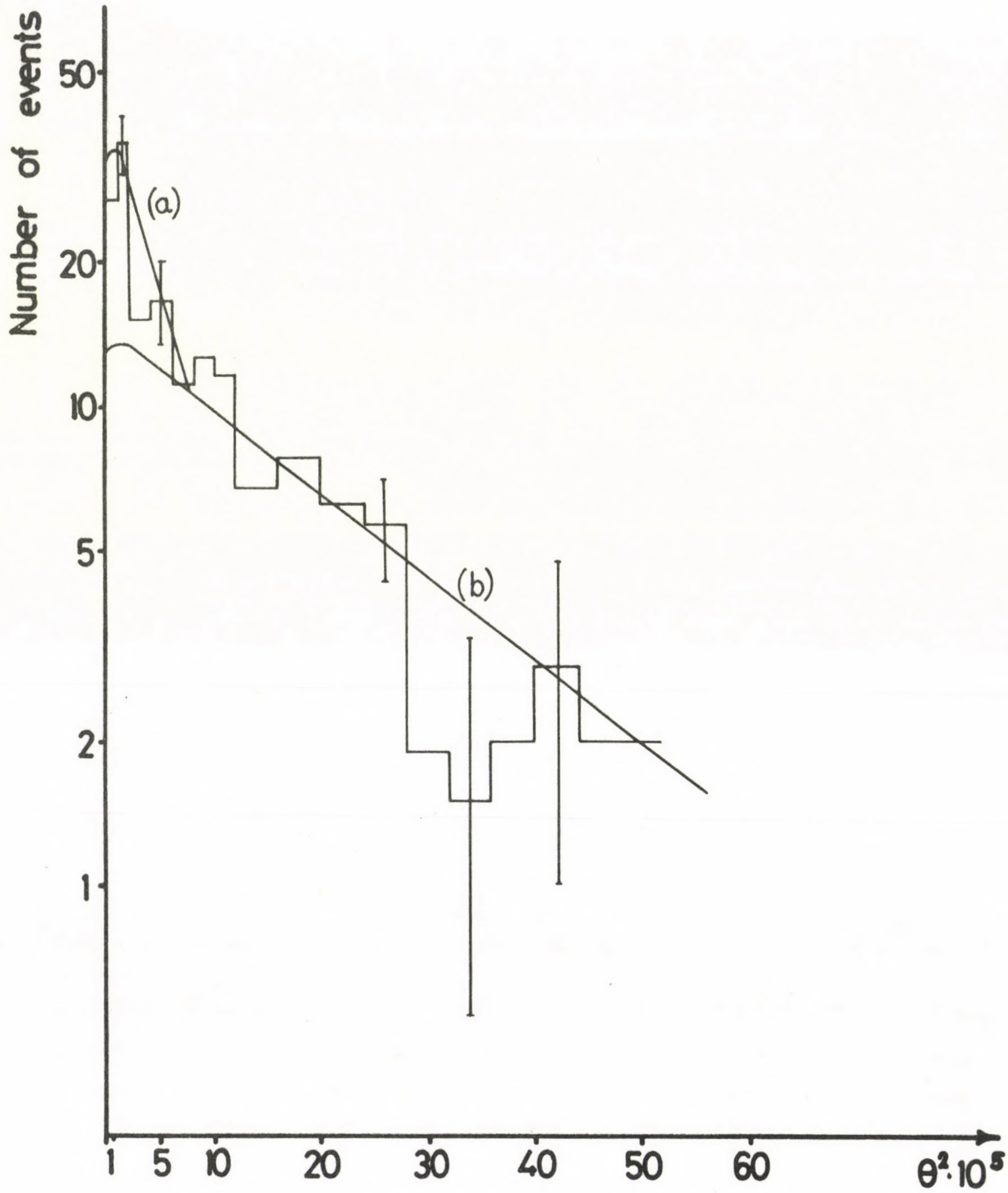

Fig. 3.

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