THE CHARGE EXCHANGE $K^- + p \to \overline{K}^0 + n$ AT 9.5 GeV *

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In this paper we present preliminary results from an experiment done with a large magnet spark chamber exposed to a high-energy negative particle beam from the CERN PS. The analysis has yielded so far results of charge exchange scattering of 9.6 GeV/c K^- on a hydrogen target.

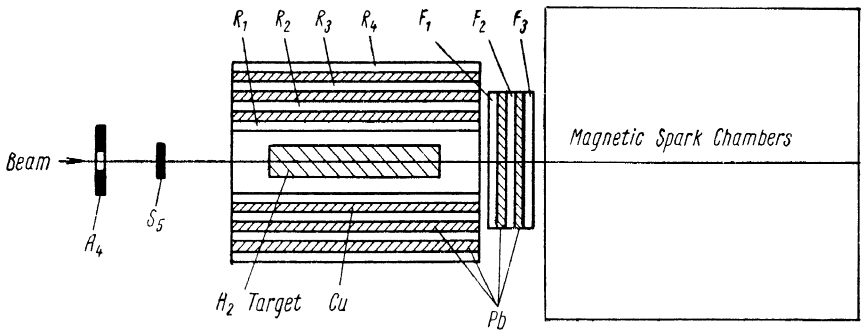

Fig. 1. Schematic drawing of the H_2 target, the anticoincidence system and the magnet spark chamber. Not to scale.

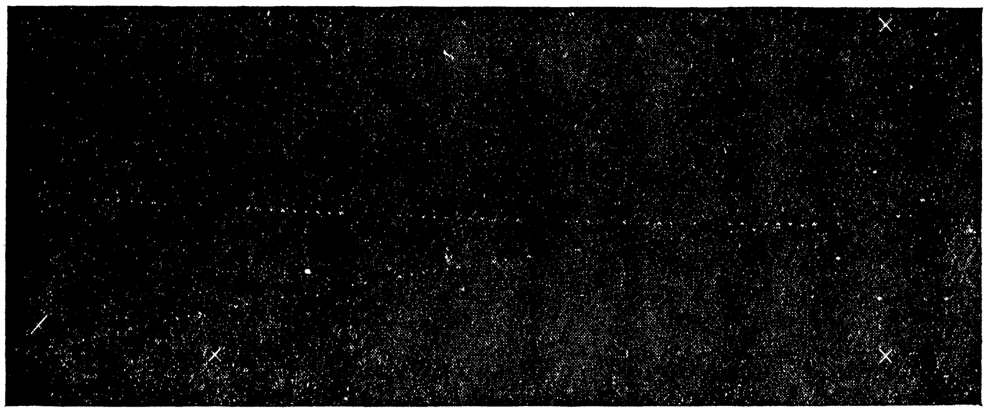

Fig. 2. Typical photograph of a charge exchange K_1^0, decaying inside the magnet spark chamber. The decay takes place in the second of the six twelve gap units.

Fig. 1 shows a schematic drawing of the target, the anticoincidence system and the magnet spark chamber. A Pb-scintillator sandwich with counters R_1, ..., R_4 and F_1, ..., F_3 was used to select events in which no charged secondary or γ-ray was produced. A_4 and S_5 are the last counters of a beam telescope, containing further counters to define the shape of the beam and two threshold Čerenkov counters of the Vivargent-type [1] to select the π^-, K^- and $\bar{p}$ in the beam. The magnet spark chamber has a useful volume of 60 × × 67 × 170 cm³ in a field of 10.7 kg and con-

* Work in part supported by the Swiss National Science Foundation.

tains 72 gaps. The radiation length in the chamber is 30 metres. The typical momentum resolution for tracks of 9.50 GeV/c, 160 cm length, is $\Delta p/p = 0.017$.

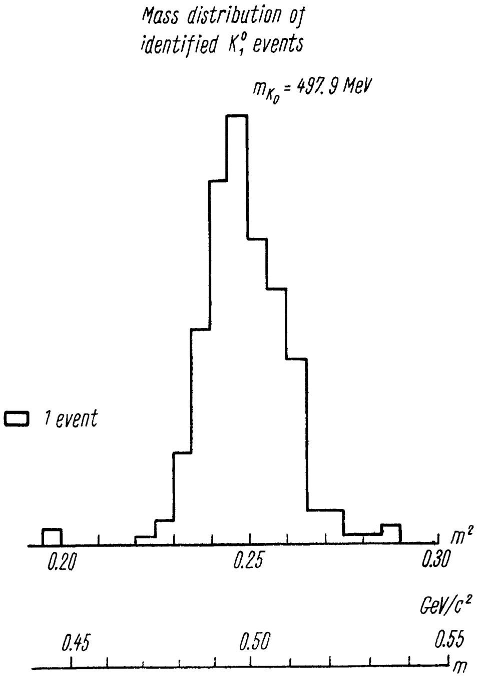

Fig. 3. Mass distribution of K_1^0's from charge exchange. Events with apex in the gap between two units have been excluded.

The efficiency for seeing multiple sparks is better than 60% for 8 tracks. The beam had an average intensity of 1.2×10^5 particles per burst and a $\pi^- : K^- : \bar{p}$ ratio of 1 : 0.0053 : 0.0009; the momentum spread was $\sim \pm 2\%$.

The results presented here are about 3/4 of the data taken in $3\frac{1}{2}$ days in February 1964. Fig. 2 shows a typical K_1^0 decay from a charge exchange event as photographed in the magnet spark chamber. The photographs were measured at CERN on «IEP» and analysed with the REAP — THRESH — GRIND series of computer programmes. Out of 390 events measured for the first time, 285 were identified as charge exchange. For the evaluation of the total cross section 48 events had to be added as a correction for a number of events that failed to give a fit on the first measurement due to mistakes in the measurement.

The charge exchange events were identified by the following criteria: 1) the counter logic must indicate an incoming K^- and no outgoing charged particle or π^0; 2) the V^0 photographed in the magnet spark chamber must fit kinematically the decay of a K_1^0; 3) the momentum and scattering angle of the K_1^0 must fit kinematically the process $K + p \to \bar{K}^0 + n$.

Fig. 3 shows the mass distribution of the K_1^0 mesons selected as charge exchange. The width of $\approx \pm 15$ MeV/c² in the mass distribution for particles of 9.5 GeV/c momentum

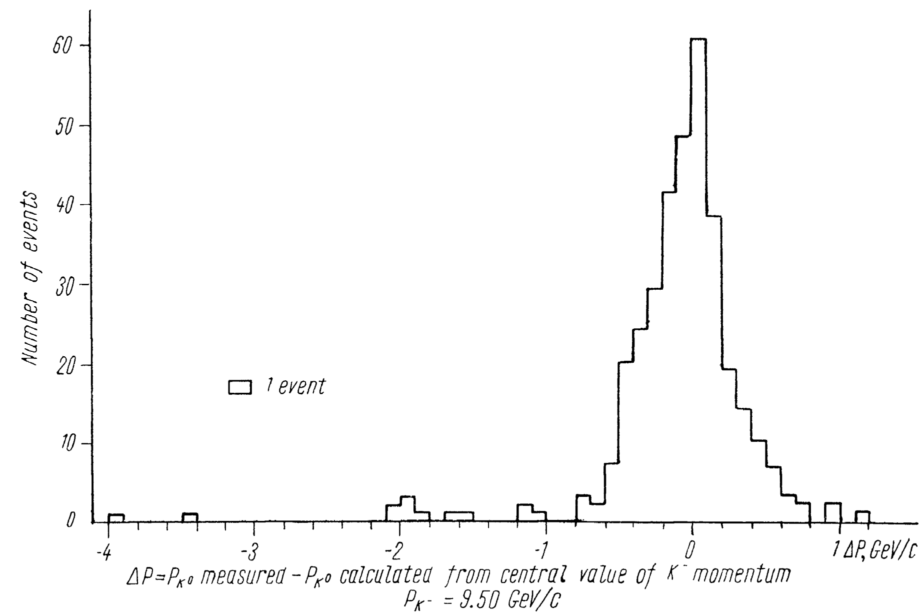

Fig. 4. For description see text.

gives an idea of the over-all precision in the analysis of events photographed in our chamber.

Eighty per cent of the charge exchange events are uniquely identified as K_1^0 mesons; 10% fit either K_1^0 or Λ; 10% fit either K_1^0 or $\overline{\Lambda}$. In fitting an event to the process $K^- + p \rightarrow \overline{K}^0 + n$ and in calculating the momentum transfer we have associated the momentum and direction of the observed K_1^0 with the mean momentum and direction of the beam. In Fig. 4 we give the distribution of the difference between the «measured» momentum of the K_0 (i. e. that derived from the momenta of the secondary particles) and its «computed» momentum (i. e. that derived from its direction of flight and the assumed process $K^- + p \rightarrow \overline{K}^0 + n$).

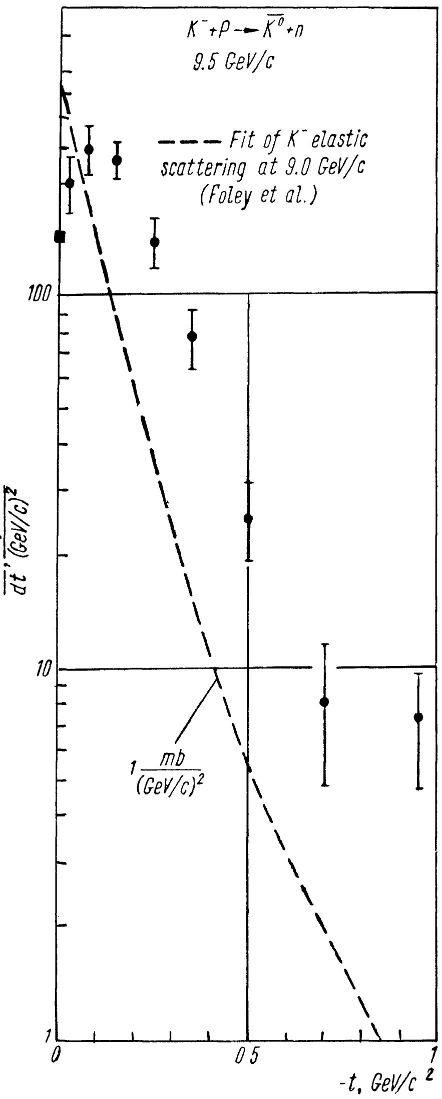

Fig. 5. The differential cross section plotted as a function of t. The indicated errors are statistical. The square at $t = 0$ is the optical theorem point. See text.

For a determination of the charge exchange cross section we had to evaluate the following corrections:

The probability for a K_1^0 decay in our fiducial volume; absorption of the incident K^- in the target; absorption of the $\overline{K}^0$ in the target and in the anticoincidence system; the loss of events due to neutron detection in the anticoincidence counters; the loss of triggers due to chance anticoincidence; this loss, dependent on the beam intensity, was monitored electronically. Runs with the hydrogen target empty showed no charge exchange-like events, corresponding to a background of less than 3%.

We find for the total cross section for K^- charge exchange

$$\sigma_{c.\,e.} = 76 \pm 11 \ \mu b$$

The detection efficiency is substantially constant up to the highest momentum transfer observed ($t = -2.3$ GeV/c^2); at twice this momentum transfer the efficiency has fallen by less than a factor 2. Of course, we cannot exclude the unlikely occurrence of a backward peak which would affect the total cross section cited above. The error quoted includes 7% for statistical fluctuations; the remainder is due to the uncertainty in the applied corrections.

The differential cross section $d\sigma/dt$ is shown in Fig. 5. The error in t is $\Delta t \sim 0.01$ at $t = -0.05$ and increases to $\Delta t \sim 0.06$ at $t = -1.0$ [(GeV/c)^2 units]. For comparison we have drawn into the figure the fit to elastic K^-p scattering given by Foley et al. [2] (note the change of scale). The $d\sigma/dt$ distribution for charge exchange is substantially less peaked than that for elastic scattering. The shape of the curve for low t-values is compatible with constant cross section for $0 \leqslant -t \leqslant 0.2$(GeV/c)^2 but not compatible with an exponential fit in that region.

We also show the point at $t = 0$ derived, using the optical theorem, from results on total cross sections (K^-p and K^-n) presented by T. F. Kycia [3] at this Conference.

REFERENCES

1. Vivargent M. et al. Nucl. Instr. and Methods, **22**, 165 (1963).
2. Foley K. J. et al. Phys. Rev., Lett., **11**, 503 (1963).
3. Galbraith W. et al. International Conference on High Energy Physics 1964, Dubna.