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PROPOSAL FOR AN EXPERIMENT TO STUDY Ξ^- CAPTURE EVENTS IN EMULSIONS.

by

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1) Purpose of the experiment.

The main object of this experiment would be to obtain a better value for the strength of the Λ-Λ interaction by observation of the decays of double hyperfragments[1) 2)].

2) Summary.

On the basis of the characteristics of Ξ^- produced by 1.4 GeV/c K^- mesons in the Ecole Polytechnique Heavy Liquid Chamber[3)], it is calculated that an area scan of emulsions exposed close to a target (which may be part of the emulsion stack) in a pencil K^- beam of this momentum would find Ξ^- capture events at the rate of 1 per 2 scanner days. An exposure for 2×10^7 K^- would give some 250 events. Beam requirements do not seem unreasonable. A request is made for the allocation of three shifts for tests in the high intensity counter beam to be constructed this spring. The test stacks should themselves yield a satisfactory number of events for immediate study.

3) Analysis of the bubble chamber events.

Ξ^- production takes place in C_2F_5 Cl at the rate of 1.6×10^{-3} per K^- interaction, at 1.4 GeV/c[3)]. The rate should increase with K^- momentum up to 1.6 GeV/c. 186 cases of Ξ^- production have so far been studied. Each observed event was weighted according to the probability that the Ξ^- would come to rest in emulsion. The fraction of all Ξ^- produced which would stop within a cylinder about the incident K^- beam was calculated as a function of the radius of the cylinder. The result depends upon estimates

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of scanning bias. A most pessimistic assumption, that scanning inefficiencies are largely due to events with fast Ξ^- being missed, leads to a total capture rate of 3.7%. 1.7% of the Ξ^- produced would stop in the region contained between two cylinders of radius 3mm and 9mm respectively. If there is no scanning bias the total capture rate is 6.1% with 3.3% between the two cylinders. If the scanning efficiency is over-estimated, more Ξ^- will be produced. An underestimate of the efficiency is equivalent, for our purposes, to the pessimistic assumption about bias made above.

4) Experimental arrangement.

A possible arrangement is shown in figure 1. A pencil K^- beam enters and leaves the stack through a tunnel; the target material is at the centre of the stack. Area scanning is carried out in the appropriate region for stars produced by stopping, heavy particles. If background conditions are unfavourable, scanning can be carried out for obvious double or triple-centred events. A scanning rate of $\sim 1cm^2$ per scanner day should be possible.

For a target length of 10 cm, the cylindrical region is 12cm long and 450 cm^2 of 600µ emulsion have to be searched. If we take emulsion as target material, a Ξ^- production rate of 1.6×10^{-3} and a capture rate in the region to be scanned of 2.5%, an irradiation to 2×10^7 K^- mesons will give 260 events, or 1 per 1.7 cm^2 of 600µ emulsion.

Other geometrical arrangements such as tilting the emulsion plane relative to the incident K^- beam, thereby reducing the dip angle of the Ξ^- in half the events, are possible. Target materials other than emulsion could be used. (Hydrogen does not seem to be a good target: only 2% of Ξ^- produced on free protons would come to rest in emulsion). Any stack should be big enough for good measurements to be made on the products of the Ξ^- interaction.

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5) Beam.

An electrostatically separated K^- beam of 1.5 GeV/c momentum is to be constructed in the March Shutdown. 5000 K^- per 10^{11} circulating protons could be obtained with a solid angle of 8.3×10^{-4} steradians and momentum bite of ±2.5%. Image size would be big and separation poor. However, the magnification from target to image is approximately unity, and for a small solid angle and momentum bite a beam not much larger than the target could be produced with high intensity. Possible values are a momentum bite of ±.25%, image 3mmx2mm, 500 K^- per 10" circulating protons. Separation should be good. Some 3.6×10^7 K^- per shift could be obtained.

6) Test exposures.

The first aim would be to determine the range of exposure intensities giving acceptable background conditions in the region to be scanned. For this purpose the beam could be tuned to π^- mesons, and test plates used. Approximately 1 shift would be required for this work. If it appeared from the results of the test exposure that an acceptable beam could be obtained (diameter, beam tail, π/k ratio) of sufficient intensity to give 10^7 K^- per shift, a further two shifts* would be used to expose stacks of different geometrical arrangements to determine the best conditions for the Ξ^- capture events. A π/k ratio 1 would be adequate, as it would only reduce the rate of finding Ξ^- events by a factor of two below that with a pure beam, for the same background intensity.

If the test stacks do not contain sufficient Ξ^- capture events but indicate that the experiment would be possible with, e.g., a more pencil-like K^- beam, a further request for time would be made.

7) Manpower.

This proposal is submitted in the name of the European K^- collaboration. There is sufficient scanning-power available even should the estimates of scanning rates be optimistic by a large amount.

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[1] M.Danysz et al. PRL 11, 29, 1963

[2] M.Danysz et al . Nuc. Phys. 49, 121, 1963.

[3] Data kindly supplied by the Bergen-CERN-Ecole Polytechnique-UCL collaboration, Chamber filling C_2F_5Cl

* Two shifts with full intensity on target. If there are other users of target one, the effective number of shifts would be reduced.

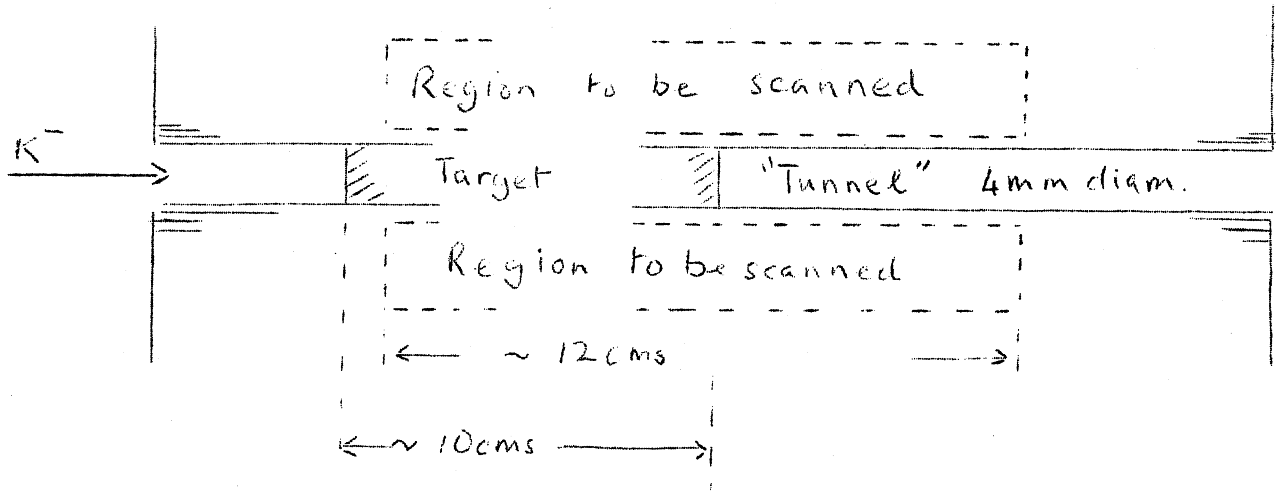
Region to be scanned
K⁻
Target
"Tunnel" 4mm diam.
Region to be scanned
~ 12 cms
~ 10cms

Fig 1.