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EUROPEAN ORGANISATION FOR NUCLEAR RESEARCH

PHYSICS III COMMITTEE

PROPOSAL FOR THE CONTINUATION OF THE LAUSANNE - MUNCHEN - TORINO - COLLABORATION EXPERIMENTAL PROGRAMME (EXP. SC19):

MEASUREMENTS OF BACKWARD ANGLES CHARGE EXCHANGE DIFFERENTIAL CROSS SECTIONS AT THE SC.

by

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Introduction.

During the last year, we have measured, as proposed in the document PhIII 68/8, the radiative capture ($\pi^- p \rightarrow \gamma n$) and the charge exchange ($\pi^- p \rightarrow \pi^0 n$) differential cross sections at forward angles in the incident energy region between 120 and 270 MeV. From this experiment, absolute cross sections with an overall uncertainty smaller than 8% are being deduced. The preliminary radiative capture results were already presented to this committee and will be soon published (1). The charge exchange data are presently being analysed.

As has been stressed by N. Törnqvist (2), the experimental verification of all consequencies of isospin invariance are not as well tested as is usually believed. The best support comes from the multiplet structure of particles†, from reactions which proceed through only one isospin channel e.g. $p+d \rightarrow {}^3H+\pi^+$ and $p+d \rightarrow {}^3He+\pi^0$. The πN scattering data would be the best verification for reactions proceeding through more than one isospin channel where interference terms between isospin amplitudes appear. As a consequence of charge independence,,the scattering and charge exchange differential cross sections at backward angles, where the electromagnetic corrections are considered to be negligible, should satisfy the triangle inequality:

$$\lambda(\sigma^+, \sigma^-, 2\sigma^{ex}) \leqslant 0$$

where $$\lambda(x,y,z) = x^2 + y^2 + z^2 - 2xy - 2xz - 2yz$$

Since this inequality is only a necessary but not sufficient condition, a significant violation of it very likely implies a large violation of SU_2 , unless the electromagnetic effects are greatly enhanced in backward πN scattering.

Up to 600 MeV, the present experimental data (3) lie systematically outside the allowed region, two or more standard deviations away from the limit. The errors on the absolute charge exchange experimental cross sections are indeed very large ($\sim$ 30 %) and thus one can not draw any definitive conclusions about the possible violation of charge independence.

† from forbidden reactions such as $d+d \rightarrow d+d+\pi^0$,and

We therefore propose for the next stage of our experimental programme to undertake the measurement of the backward charge exchange differential cross sections in the energy range of 120 to 300 MeV.

Including the errors on detector efficiencies which will have to be measured, we intend to reach an accuracy on the absolute values of the cross sections of better than 7 %. When combined with the precise elastic scattering results of D.V. Bugg et al. (4), our results will be precise enough to reach a firm conclusion about charge independence in the πN interaction.

Experimental Arrangement

The experiment should be performed in the former Cambridge-Rutherford π^- beam in the experimental zone outside the neutron hall. The experimental arrangement is sketched in Fig. 1. We intend to use the same liquid hydrogen target as in our previous experiment (dia. 6 cm, length 8 cm). The incident beam will be monitored by a C_1C_2 coincidence, neutral events will be tagged by $C_1C_2\bar{A}$ signals. Beam contamination by electrons and muons will be measured, as before, by using a gas Cerenkov counter for the electrons and a total absorption Cerenkov counter with a liquid FC 75 radiator for muons. The ten existing neutron counters will be used in a time-of-flight spectrometer with a 4 meter flight path. The efficiency of the neutron detectors from 50 to 150 MeV will be measured using neutrons from an internal SC target scattered on hydrogen with momentum determination of the recoil protons using range detectors.

As in our charge exchange experiment at forward angles, the time of flight measurement should be sufficient to select good events. We plan, however, to reduce the background, if necessary, by introducing a γ-detector in such a geometry that, for each detected neutron, it will be hit by one of the γ-rays from the π^0-decay. This detector will be made of successive layers of lead and plastic scintillators. Its efficiency will be measured using the charge exchange reaction, as already done to calibrate the gamma detector of our previous experiment.

We plan to perform the measurements at about ten different incident energies between 120 and 300 MeV. The ten neutron detectors will be placed along a ring as close as possible to the beam axis, corresponding to $\cos\theta_{CM} = -0,95$ (see fig. 1). With a pion intensity of $5.10^4 \pi^-$/sec, the counting rate of charge exchange events is expected to be of the order of 500/hour. Measurement of the absolute cross section with a precision of better than 7% will require 30 data taking shifts. With the additional time for background measurements and detectors and beam calibrations a total of 75 shifts is requested. We should like to have the first shifts in June or July 1970.

References:

(1) Physics III committee document PhIII 69/28, and letter to be submitted to Phys. Lett.

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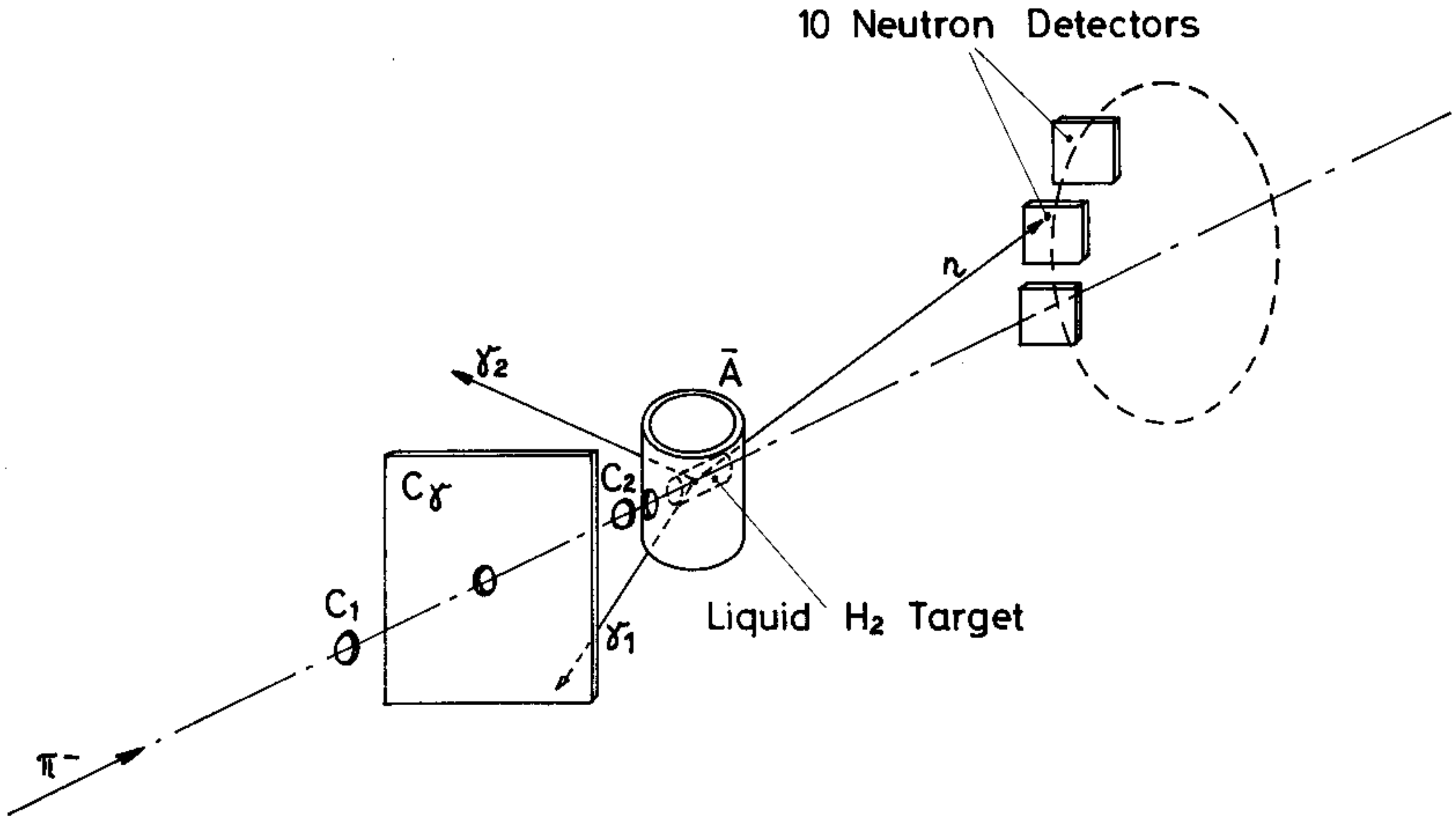
10 Neutron Detectors
n
$\bar{A}$
γ_2
C_γ
C_2
C_1
γ_1
Liquid H_2 Target
π^-

Fig. 1