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INELASTIC PROCESSES IN HIGH-MOMENTUM TRANSFER COLLISIONS ($50 < |t| < 1,000\ m_\pi^2$)

H.R. Blieden, L. Dubal*), M. Foccaci,
W. Kienzle, F. Lefebvres, B. Levrat*),
B. Maglić and M. Martin*)

The intense high-energy pion beam available at the PS, coupled with spark-chamber techniques, opens the possibility for experimental studies of one of the least investigated phenomena in Particle Physics: inelastic processes at high-momenta transfer in the range $1 < |t| < 20\ (\text{GeV/c})^2$. It appears feasible to investigate detail properties of high-transfer inelastic processes, such as cross-section variation with s and t; meson multiplicities; π/K ratio; effective-mass and missing-mass spectra; and production of unstable bosons and baryons.

We propose an experimental investigation of the type of reaction:

$$\underset{1}{\pi^-} + \underset{2}{P} \rightarrow \underset{3}{P} + \underbrace{k\pi + \ell K\bar{K}}_{4} + \text{neutrals} \qquad (k = 1,2,.. ;\ \ell = 1,2,..)$$

under the following conditions:

i) Only recoil protons of momentum higher than $p_3 \geq 1$ GeV/c are accepted. Their momentum is measured in the magnetic field to an accuracy of 1% to 4%, in the range $1 \leq p_3 \leq 10$ GeV/c. The angle of the proton

*) Laboratoire de Physique Nucléaire de l'Université de Genève

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is measured by wire chambers before and after the magnetic field. The velocity selection by threshold Čerenkov counter and time-of-flight over 10 metres (for $p_3 < 3.5$ GeV/c) is in the trigger requirement.

ii) The momenta of all charged mesons and charged-decay products of K^0 mesons are measured in the magnetic field, to an accuracy of 2 to 10%. Their emission for decay angles are measured by wire chambers and scintillation hodoscopes, which also measure time-of-flight as a redundancy check of their momenta. All measured quantities are digitized and stored on magnetic tapes.

Combined information i) and ii) allows the application of the kinematic fitting procedure, commonly used in bubble-chamber measurements. For example, if there are no neutrals, the missing-mass of the proton must be equal to the (independently measured) effective mass of the charged mesons; in this case the problem is overdetermined, and all components of the reaction can be measured with a high degree of confidence.

However, there is a feature which does not exist in bubble chambers at present. Owing to the electronic measurement of velocities of most or all charged particles, masses of some or all of them will be unambiguously determined, and it is hoped that the "fitting" of the events in which neutrals are emitted will be done with a good level of confidence too.

The experimental set-up, whose general properties were discussed in COVERAN (Memo 65/266/5 of 9 February), is shown in Fig. 1. It will have a geometry covering a solid angle between 1π and 4π, which is accomplished by two large magnets 2 m × 2 m × 1 m to which we shall refer as "target magnet" and "forward magnet".

The liquid hydrogen target, enclosed by wire chambers and scintillation counters, is placed in the centre of the target magnet.

The forward magnet is to measure the recoil-proton momentum. Immediately behind it is the Čerenkov counter (not seen in Fig. 1); three to five metres further downstream is a matrix of several large area (1 m × 1 m) scintillators, presently used in the missing-mass spectrometer to measure time-of-flight.

We intend to use incident pion momenta from 8 to 16 GeV/c. With 10^5 to 10^4 π/burst, it is hoped to measure low cross-section phenomena in the region between 10 nanobarns and one microbarn.

We propose that the experiment be done in two stages.

STAGE 1

(large magnets ordered but not delivered)

We would use the standard CERN 2 m magnet as forward magnet; and the Petrucci 40 cm-gap "sweeper" as target magnet.

The solid angle of this set-up will be only about 3% of the proposed one, so that only the cross-section in the microbarn range will be measurable.

Momentum resolution (± 10 to 50%) of the target magnet will not be able to give a reliable kinematic fit. The system will measure accurately only the missing-mass of the recoil protons, while the effective masses will be obtained in only 10% of the cases. Nevertheless, the physics information on the mass distribution, cross-section as a function of s and t, and charged-meson multiplicities will already be obtainable at this stage.

As our research programme, we intend to follow the production of known resonances as a function of t, from the low t (being investigated by us now), to the highest momentum transfer that we can reach.

At the same time, the experience with wire chambers operating in the magnetic field, and their use in an improvised "fitting procedure" will be gained. The whole system will be connected to CDC 6600 via the SDS 920 computer. The major data storage would be magnetic tapes of the 920, while the 6600 will be used only as a sampling facility.

For Stage 1, we require 60 shifts in the d_{21} beam.

STAGE 2

(two large magnets available and installed)

The final set-up will be used as described above and given in Fig. 1.

The request for PS time allocation will be based on the results obtained in Stage 1.

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