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Λ-PROTON SCATTERING AT 120-320 MeV/c*

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In this note we present results on Λ-p scattering at a Λ incident-momentum range of 120 to 320 MeV/c. The Λ beam was produced in the Saclay 81-cm hydrogen bubble chamber, exposed to a stopping K^- beam at CERN, through the following reactions:

$$K^- + p \to \pi^0 + \Lambda, \quad (1)$$

$$\to \pi^0 + \Sigma^0, \quad \Sigma^0 \to \gamma + \Lambda, \quad (2)$$

$$\to \pi^+ + \Sigma^-, \quad \Sigma^- + p \to n + \Lambda, \quad (3)$$

$$\to \pi^+ + \Sigma^-, \quad \Sigma^- + p \to n + \Sigma^0, \quad \Sigma^0 \to \gamma + \Lambda. \quad (4)$$

A total of 20 550 frames of the film were scanned twice for visible V^0 decays and for $V^0 + p \to V^0 + p$ events, recognized through the recoil proton. The events suspected as being scattering candidates were measured and passed through THRESH and GRIND fitting programs for final identification. In this way 50 Λ-scatter events with an incident Λ momentum between 120 and 320 MeV/c were found. The following restrictions were imposed on the scattered Λ events: (a) The ranges of the recoil proton and the Λ-decay proton are longer than 1.5 mm each. (b) The flight distance of the Λ before and after the scatter is longer than 1.0 mm. This choice of cutoffs was determined through an experimental study of a nonscattered Λ sample. Forty-four events which satisfied these criteria were accepted for final analysis and are plotted in Fig. 1. The coordinates of each event are the incident Λ momentum and the cosine of its angle in the center-of-mass system.

In the same number of photographs, 18 830 visible V^0 decays were found. Corrections for K^0 contamination (~1 %) and for the various cut-

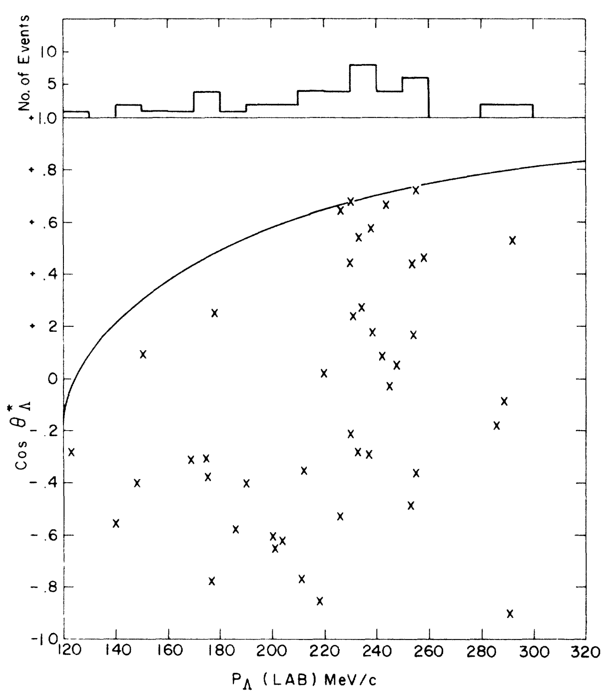

FIG. 1. Cosine of the Λ-scattering angle in the c.m. system vs the incident Λ momentum for all accepted events. The solid line represents the upper bound for $\cos\theta_\Lambda{}^*$ due to the cutoff on the recoil proton.

offs were applied to this sample. The total path length examined in this experiment was evaluated by measuring a random sample of 362 Λ decays. The momentum distribution of these events is consistent with the distribution of Λ hyperons produced in K^--p interactions at rest with a small contribution from K^--p in-flight events. Using a value of 2.51×10^{-10} sec for the Λ lifetime, the total path length of the Λ hyperons observed in this experiment was calculated to be 23 433 cm.

Corrections were applied to the scatter events to account for the various cutoffs. In the correction for the recoil proton cutoff an isotropic distribution of the Λ hyperon in the Λ-p center-of-mass system was assumed. In this way the following cross sections were obtained:

Momentum range (MeV/c)	Mean momentum (MeV/c)	σ (mb)	No. of scatters
120–190	162	118 ± 37	10
190–250	226	100 ± 21	23
250–320	267	67 ± 20	11

The errors are the statistical errors only. The scanning efficiency for the Λ-scattering events was assumed to be the same as for the nonscattered Λ events.

The cross-section values are plotted in Fig. 2, together with other results at comparable and higher momenta.[1-3] The dashed line on Fig. 2 is obtained by a potential scattering calculation following Ram and Downs.[4] In this model the potential $V(r)$ is of the type

$$V(r)=\infty, \qquad r<0.4\text{ F};$$
$$=-U, \qquad 0.4\text{ F}<r<0.4\text{ F}+b;$$
$$=-W\exp[-2(r-0.4)/R], \qquad 0.4\text{ F}+b<r; \qquad (5)$$

where $W=150$ MeV, $R=0.85$ F, $b=1.1$ F, and $V_{l=\text{odd}}=V_{l=\text{even}}$. The U values were taken as $U_{\text{singlet}}=51.2$ MeV and $U_{\text{triplet}}=19.8$ MeV, in agreement with hyperfragment data. The solid line in Fig. 2 represents cross sections derived in the effective-range approximation for pure S-wave scattering.[3] Recently Downs and Phillips[5] calculated Λ-p cross sections at low momenta using Λ-N potentials based on a single-particle-exchange model. The η, K, ω, and K^* particles and a phenomenlogical scalar meson have been considered as the exchanged particles. The cross-section values of Downs and Phillips are very similar to those obtained by potential-scattering calculations (the dashed curve in Fig. 2) and were not drawn here.

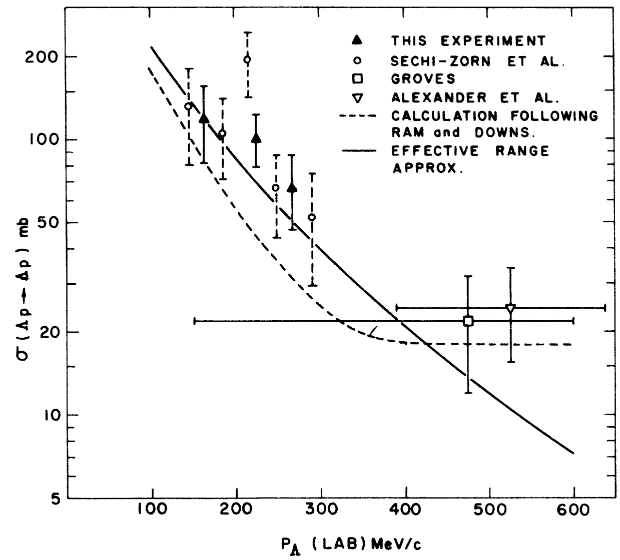

FIG. 2. Λ-p total cross sections.

The results of this experiment are in general consistent with those of Sechi-Zorn et al.[3] In the present results no enhancement in the total cross section at ~200 MeV/c was found. This enhancement did not show up even when we used the same momentum intervals as Sechi-Zorn et al. The total cross section is well described by the effective-range approximation, although one would expect higher waves than the S wave to participate in Λ-p elastic scattering at the higher momentum intervals. On the other hand, the measured cross sections are consistently larger than the cross sections evaluated by potential scattering according to Ram and Downs. A variation of the parameter b from 0.7 F to 1.5 F does not remove this discrepancy.

The number of Λ-scatter events does not permit a detailed angular distribution analysis. However, it was possible to check the consistency of the data with isotropic distribution by computing the forward to backward (F/B) ratio. In calculating the ratio we took into account the variation in path length and total cross section as a function of the Λ momentum. Contributions to the forward value lying in the cutoff region (see Fig. 1) have been accounted for by assuming the forward region $0<\cos\theta^*<1$ to be evenly populated at each momentum. For incident Λ momentum in the range between 220 and 320 MeV/c we obtained $F/B=2.1\pm0.8$. This seems to indicate the presence of higher waves than the S wave in Λ-p scattering at these momenta. At the momentum region 120-220 MeV/c the cutoff region is too large to enable a meaningful F/B ratio calculation. Finally, we looked at the up-down asymmetry $-\alpha P = 2(U-D)/(U+D)$ of the pion in the Λ decay. Only events with an incident Λ momentum between 220 and 320 MeV/c and for which $-0.5 < \cos\theta^* < 0.5$ have been considered. A value of $\alpha P = -0.22 \pm 0.47$ was obtained.

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TOTAL CROSS SECTIONS AND ANGULAR DISTRIBUTIONS FOR $\pi^- + p \to \eta^0 + n$ FROM THRESHOLD TO 1151 MeV*†

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In the experiment reported here we have measured the cross sections and angular distributions for the η^0 in the reaction

$$\pi^- + p \to \eta^0 + n, \tag{1}$$

where $\eta^0 \to 2\gamma$. This is a reaction in which η^0's are produced in a pure $T = \frac{1}{2}$ two-body final state. Unless explicitly stated otherwise, all results refer to the two-gamma decay mode of the η^0, since the experiment was designed to detect only gamma rays.

Data are presented for 10 incident π^- energies. These energies span the region of the second and third pion-nucleon resonances (600 and 900 MeV, respectively), and include the threshold energy for the above reaction. The cross section is found to rise rapidly above threshold reaching a maximum of 0.98 ± 0.08 mb at 659 MeV and then decreasing slowly to 0.38 ± 0.05 mb at 1151 MeV. The angular distributions are isotropic in the region of the 600-MeV resonance, but show forward peaking at 1003 MeV and above.

The two-gamma decay mode of the η^0 is detected in an experimental setup which consists of a small liquid hydrogen target, 5 cm in diameter transverse to the beam and 4 cm along the beam, surrounded by an anticoincidence shield and an array of four spark chambers composed of 50 2-mm thick steel plates (approximately 5.5 radiation lengths). This spark chamber system has been described elsewhere.[1] The system is suitably triggered by an electronic logic which