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STUDY OF Λ -NUCLEON INTERACTIONS IN DEUTERIUM

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STUDY OF A-NUCLEON INTERACTIONS IN DEUTERIUM^{*} J. A. Kadyk, J. H. Chan, P. Gaposchkin, and G. H. Trilling Department of Physics and Lawrence Radiation Laboratory University of California, Berkeley, California 94720

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I. INTRODUCTION

An experiment has been performed to study principally the inelastic Λ nucleon reactions up to a momentum of about 1500 MeV/c, using the LRL 25-inch bubble chamber filled with deuterium. The technique used is the same as used for study of Λ interactions in hydrogen,¹ viz., use of an internally-mounted platinum plate as a target for a K⁻ beam. The results presented here, based on an analysis of 90,000 pictures, are preliminary, and confined to the study of reactions:

$$\Lambda d \rightarrow \Sigma pp \qquad (1)$$

and
$$\Lambda d \rightarrow \Lambda pp\pi / . \qquad (2)$$

The use of deuterium as the medium for inelastic Λ interactions is motivated by several factors. The rates of reactions (1) and (2) are expected to be enhanced by virtue of charge independence by a factor of 2 over the corresponding analyzable Λp reactions, $\Lambda p \rightarrow \Sigma^{0}p$ and $\Lambda p \rightarrow \Lambda p\pi^{0}$. Furthermore, reaction (1) is enhanced by an additional factor of 1.5 since all Σ^{-} particles decay visibly. Finally a better kinematic fit to the interaction should result from the higher constraint class of (1) and (2); namely 3 constraint, rather than 1C and 0C respectively for the hydrogen reactions.

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II, SCANNING AND MEASURING CRITERIA; TOPOLOGIES

The film was scanned for events with topologics having a V^{O} or a Σ^{-} decay associated with a production vertex in the liquid. The production vertex in deuterium may have 1, 2, or 3 prongs. The one-prong events which have not yet been analyzed contain mainly events of the following type:

$$\Lambda d \to \Lambda pn \tag{3}$$
and $\Lambda d \to \Lambda d$.

In order to obtain as clean a sample of events as possible the following requirements were imposed:

(a) All events were restricted to an appropriate fiducial volume.

(b) The Σ^{-} track was required to be at least 2 mm in length.

(c) Events were required to satisfy 3C kinematic fits at the interaction vertex. The incident Λ^{0} line of flight was determined as described for our hydrogen experiment; and, in the case of two-prong events (spectator missing) a spectator with momentum components $p_{x} = p_{y} = 0 \pm 30$ and $p_{z} = 0 \pm 40 \text{ MeV/c}$ was assumed.

(d) Because of confusion between 2-prong Σ pp events and Λ° decays in which the π goes a short distance and scatters without leaving a visible recoil particle, special care was exercised to check that the bubble density of the presumed Σ agreed with the prediction of the fit. Furthermore for these twoprong events, the transverse momentum from the Σ decay was required to be greater than 100 MeV/c. Only 14% of real events and a much larger fraction of the background are eliminated by this cut.

(e) For the $\Lambda \pi$ pp events, in addition to the kinematic fit at the interaction point, the Λ decay was required to satisfy a 3C fit to that interaction point.

Appropriate weighting factors were applied to correct for losses introduced by the cuts described above. The 2-prong and 3-prong events, after these

-2-

corrections were applied, came out about equal in number as expected from the known spectator momentum distributions. At present all our film has been scanned and about 20% has been rescanned. Scanning efficiency corrections based on this rescan have been applied.

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III. RESULTS

After making the preceding requirements, 24 inelastic events remain in the sample, 17 for reaction (1) and 7 for reaction (2). The <u>A pathlength</u> distribution shown in Fig. 1 is derived from free A decays, just as in the hydrogen experiment. The total A pathlength for this experiment was found to be 2100 meters. Two- and three-prong A interaction events have been combined for the momentum and angular distributions shown in Figs. 2-5. In the case of reaction (2), the distributions are in agreement with those from the hydrogen experiment, within the very limited statistics and the average cross section for the $\Lambda p\pi^-$ reaction in the momentum range between 1200 and 1800 MeV/c is:

 $\sigma(\Lambda pp\pi) = 4.1\pm1.5 \text{ mb}$.

Presumably this is a good measure of the cross section for the reaction $\Lambda n \rightarrow \Lambda p \pi^-$. It agrees satisfactorily with the value predicted for this reaction, $6.0\pm2.1 \text{ mb}$, based upon the events $\Lambda p \rightarrow \Lambda p \pi^0$ observed in hydrogen in the same momentum interval and application of charge independence.² In the case of reaction (1), there is a significant deviation in the angular distribution from that observed in hydrogen, the present data being much more strongly forward peaked. In addition, a much smaller cross section is observed. In the momentum range $600-1400 \text{ MeV/c} \sigma(\Lambda d \rightarrow \Sigma p p) = 5\pm2 \text{ mb}$, while charge independence predicts a cross section of $10\pm2 \text{ mb}$, based upon the events $\Lambda p \rightarrow \Sigma^0 p$ in the same momentum range.

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The deficit of Σ^{-} events cannot easily be attributed to scanning bias or stopping Σ^{-} which interact rather than decay. However rough estimates suggest that the small $\Lambda d \to \Sigma^{-}pp$ cross section may be due to reabsorption of the Σ within the same deuteron via the reaction $\Sigma^{-}p \to \Lambda^{0}n$. Thus the overall effect is to decrease the rate of $\Lambda d \to \Sigma^{-}pp$ and increase $\Lambda d \to \Lambda np$.³ Since the reaction $\Sigma^{-}p \to \Lambda n$ has a cross section rapidly increasing with decreasing Σ momentum, the reabsorption effect should be most marked for slow Σ^{-} in good agreement with the observed angular distribution shown in Fig. 4.

We wish to thank Glen Eckman and the 25-inch bubble chamber crew, as well as the Bevatron operations staff for assistance in performing this experiment.

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*Work supported by the U. S. Atomic Energy Commission.

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- 3. Σ -A conversion in deuterium was observed by O. Dahl et al., Phys. Rev. Letters <u>6</u>, 142 (1961) in connection with the reactions $K^{-}d \rightarrow \Lambda \pi^{-}p$ and $K^{-}d \rightarrow \Sigma^{0}\pi^{-}p$.

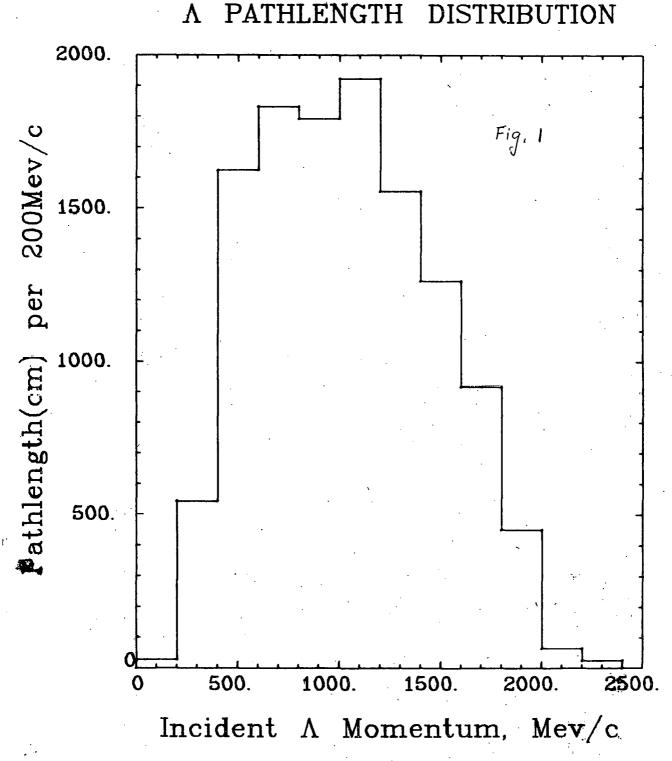
-4-

FIGURE CAPTIONS

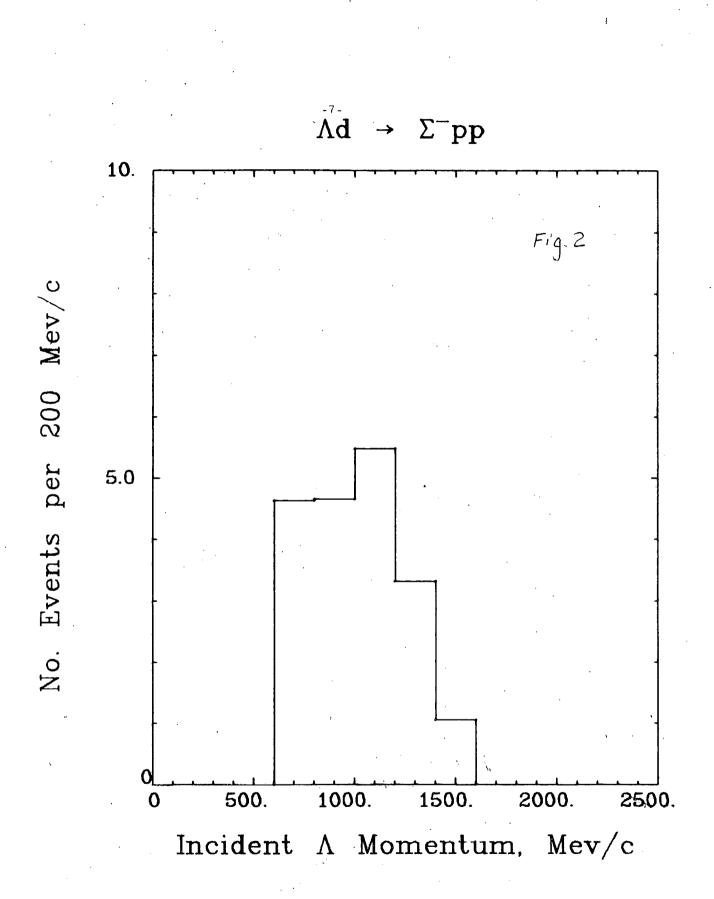
-5-

For each of the two reactions studied, events of the two-prong and three-prong topologies have been combined in the plots shown in Figs. 2-5. Angular distributions are for the Λ -hyperon angle in the Λ -neutron c.m. system, assuming a stationary neutron.

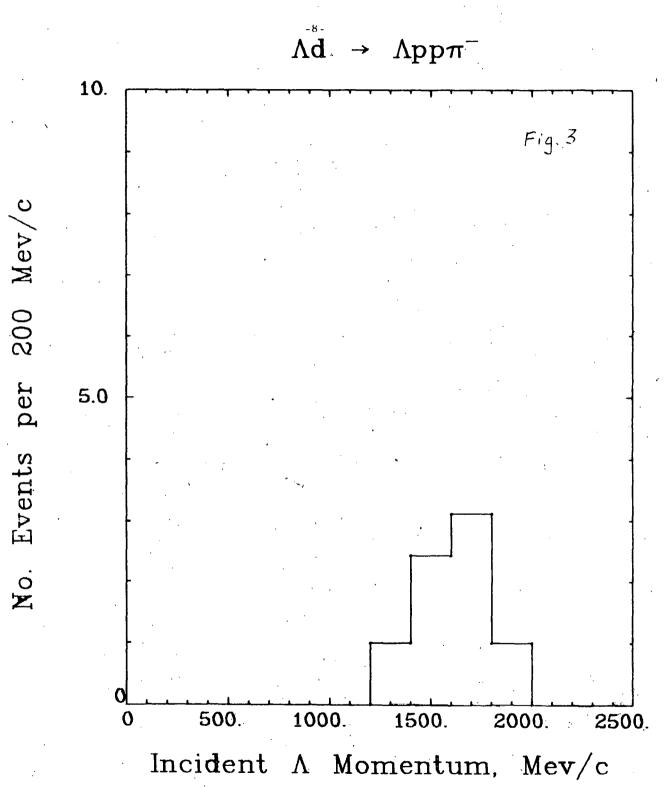
Fig.	1.	Pathlength distribution for a sample of free Λ decays.
Fig.	2.	Momentum distribution for events of the type $\Lambda d \rightarrow \Sigma^{-} pp$.
Fig.	3.	Momentum distribution for events of the type $\Lambda d \rightarrow \Lambda pp\pi^-$.
Fig.	4.	Angular distribution for the reaction $\Lambda d \rightarrow \Sigma^{-} pp$.
Fig.	5.	Angular distribution for the reaction $\Lambda d \rightarrow \Lambda p p \pi^{-1}$.



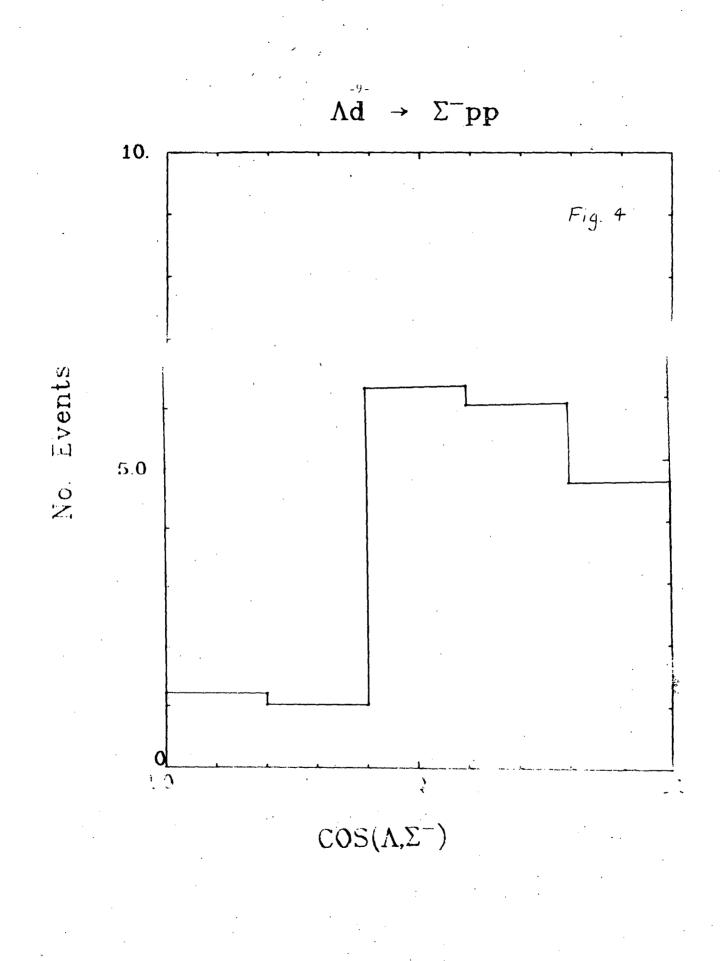
PATHLENGTH DISTRIBUTION

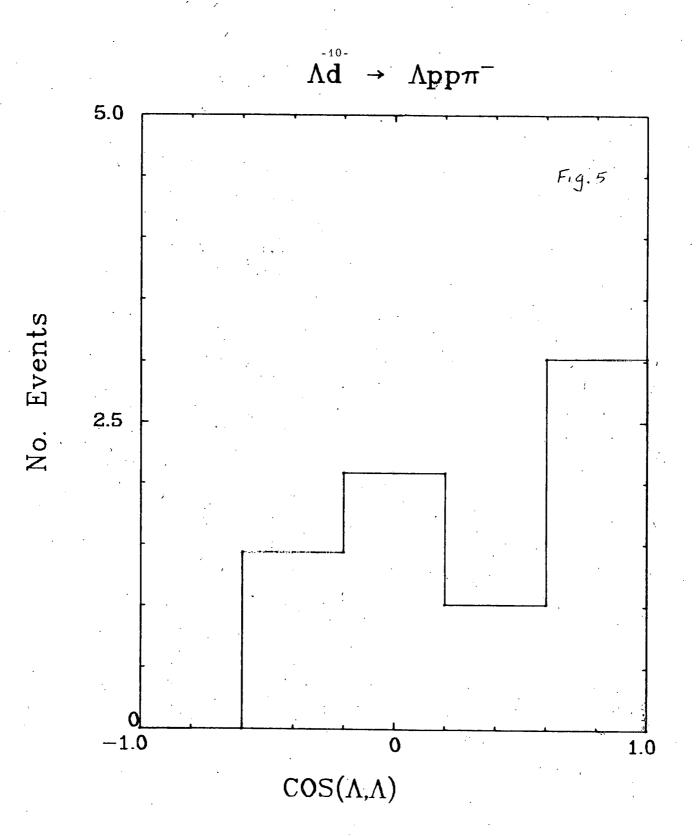


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