Experimental Study of Parity Conservation in Λ° Production in Carbon Nuclei Using Incident π^- of 2.0 BeV/c Momentum.*

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Parity conservation has been tested for the Λ° production processes: $\pi^-+N\rightarrow\Lambda^\circ$+anything, where the nucleon N is in a carbon nucleus. Approximately 120 000 pictures were taken of the Columbia-BNL 30-in. propane bubble chamber exposed to a π^- beam of 2.0 BeV/c momentum at the Cosmotron. On the basis of 486 events, of which all but 23 were identified without ambiguity as Λ°, no indication of parity nonconservation was found. This result rests on the fact that the average Λ° polarization $\bar{P}$ in the production plane was found to be consistent with the value zero within the statistical error. The values found for two components of $\bar{P}$ in the production plane are: -0.08 ± 0.12 and 0.00 ± 0.12, using the value $+0.63$ for α, the asymmetry parameter.

I. INTRODUCTION

PARITY conservation in strong interactions is experimentally well established for processes not involving strange particles.[1] In those processes involving the production of strange particles from π^- incident on protons, the experimental results are consistent with parity conservation.[2] However, there have been results reported for π^- incident on complex nuclei which are not consistent with parity conservation.[3–5] As a check on these experiments, parity conservation has been tested in the production of Λ° from π^- of approximately 2.0 BeV/c momentum incident on carbon nuclei. Parity conservation is inconsistent with a nonzero component of Λ° polarization in the production plane. Such a component was looked for by using the Λ° decay as an analyzer to find the Λ° polarization P which appears in the usual $1+\alpha P\cos\theta$ distribution for Λ° decay products.

II. SELECTION OF EVENTS

Approximately 120 000 pictures were taken during an exposure of the Columbia-BNL 30-in. propane bubble chamber at the Cosmotron during 1961. The film was scanned for events which had the topology of the two-body decay of a neutral particle. All events excepting those which were definitely not Λ° decays were measured and then fitted using "GUTS", a kinematical fitting program.[6] Fits were made for the following decay hypotheses: $\Lambda^\circ\rightarrow p+\pi^-$ and $K^\circ\rightarrow\pi^++\pi^-$. For an acceptable event chi square for the Λ° decay hypothesis was required to be below a chosen cutoff of 15. About 30% of the events satisfying this criterion also fitted the K° decay hypothesis with an acceptably low chi square. In some cases this led to no ambiguity in identification since the ionization of the positive track could identify it as p or π^+. The remaining ambiguous cases can be a source of systematic bias. If these events are included in the analysis, this could give rise to a possible K° contamination which would distort the angular distribution of Λ° decay products. This is because a K° decay in which the π^+ goes forward in the K° rest system is more likely to fit the Λ° decay hypothesis than a K° decay in which the π^+ goes backward. This problem was eliminated by requiring an acceptable event to have a fitted Λ° momentum below 1 BeV/c. This had the effect of reducing the percentage of ambiguous events to about 5%. Other possible sources of systematic bias were examined and estimated to be unimportant; namely: (1) a variable scanning efficiency dependent on the center-of-mass decay angle, (2) a tendency for a Λ° decay to fit the Λ° decay hypothesis with a chi square dependent on the center-of-mass decay angle. For acceptable events it was further required that there was

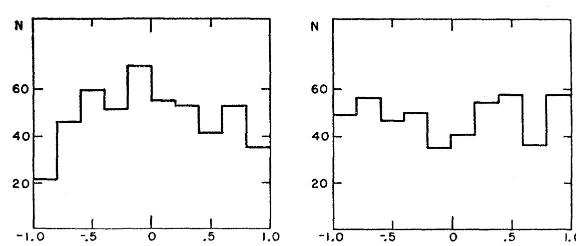

FIG. 1. Number of events per 0.2 interval in cosine against the fore-aft and right-left direction cosines of the π^- direction of flight in the decay: $\Lambda^\circ\rightarrow p+\pi^-$.

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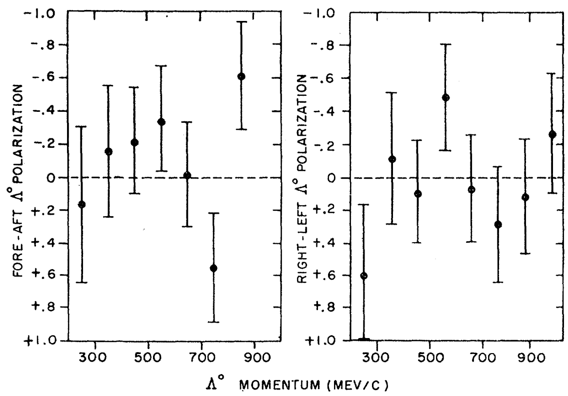

FIG. 2. Fore-aft and right-left components of Λ° polarization for events in 200-MeV/c intervals in Λ° momentum.

visible evidence at the production vertex for the production process occurring in a carbon nucleus.

III. RESULTS

We define the fore-aft and right-left axes in the usual way to be the orthogonal axes in the Λ° rest system which are in the plane of production and are along and perpendicular to the Λ° direction of flight, respectively. The sense of the right-left axis is defined by the vector product: $\mathbf{\Lambda}\times[\mathbf{\Lambda}\times\boldsymbol{\pi}]$, where $\mathbf{\Lambda}$ and $\boldsymbol{\pi}$ refer to the direction of Λ° and incident π^-, respectively.

The fore-aft and right-left angular distributions of 486 acceptable events are shown in Fig. 1. The best-fitting values for the fore-aft and right-left components of the Λ° polarization averaged over Λ° momentum are

$$\bar{P}_{\mathrm{FA}}=-0.08\pm0.12;\quad \bar{P}_{\mathrm{RL}}=0.00\pm0.12,$$

where we have used the value $+0.63$ for α.[7] In Fig. 2 the two components of Λ° polarization are shown as function of Λ° momentum. The near-zero values of Λ° polarization found in this experiment give no indication of parity nonconservation in the process studied.

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Binding Energy of a Λ-Particle in Nuclear Matter and the Λ-Nucleon Interaction*

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The binding energy D of a Λ-particle in nuclear matter is calculated with the independent-pair approximation for seven central two-body Λ-nucleon potentials. These potentials are consistent with the binding energy of ${}_{\Lambda}He^5$ and therefore represent the spin-averaged Λ-nucleon interaction in S states; they have hard cores of radius 0.4 F or 0.6 F and two-parameter attractive wells with ranges suggested by consideration of the two-pion-exchange mechanism. A simple approximation to the Bethe-Goldstone function is suggested; its use permits D and the partial-wave contributions to D to be evaluated easily. When the S-wave Λ-nucleon potentials are assumed to be appropriate to all angular momentum states, the calculated values of D, corresponding to a nucleon density equal to the central density in heavy nuclei, are consistent with empirical estimates in the range 30–40 MeV for most of the potentials considered. If the correct value of D is close to 30 MeV, some reduction in the strength of the longer ranged potentials may be required in odd-parity states (at least in P states) to bring about agreement; for the shorter ranged potentials considered, no such reduction would be required. If the correct value of D is close to 40 MeV, odd-parity suppression would not be indicated even for the longer ranged potentials. The first three partial-wave contributions to D, as well as D itself, are given for each potential, and the dependence of these on the hard-core radius and on the shape and range of the attractive well is discussed.

I. INTRODUCTION

THE binding energy of a Λ-particle in its ground state in nuclear matter is a quantity of some interest in the study of the Λ-nucleon interaction. This binding energy is equal to the well depth D seen by a Λ-

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