Inclusive production of Λ^0 hyperons on carbon and xenon nuclei in a region kinematically forbidden for production on free nucleons

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We measured the cross section for the production of Λ^0 hyperons on nuclei in a region kinematically forbidden for the production on a free nucleon. The distribution of the events in momentum-angle coordinates is presented. The function $f=(E/p^2)(d\sigma/dpd\Omega)$ is constructed for three angle ranges. The result of polarization measurement is presented.

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We investigated the inclusive production of Λ^0 hyperons by π^- mesons with momentum 2.9 GeV/c on the nuclei C and Xe in a region that is kinematically forbidden for the production on a free nucleon at rest ($\theta^{\text{lab}}_{\pi^-\Lambda^0}>47^\circ$). A similar effect was already noted in a number of studies.[1]

The results were obtained by reducing 140 000 photographs from the 120-liter propane-xenon chamber (43% wt. C_3H_8 and 57% wt. Xe) of our Institute,[2] placed in an 18.6-kG magnetic field. The chamber was exposed to the π^--meson beam of the proton synchrotron of our Institute.

Under our conditions, the limiting emission angle of the Λ^0 hyperons produced on a free nucleon at rest is equal to 47° in the laboratory frame. Thus, the nucleus participates directly in the production of all the Λ^0 hyperons emitted at large angles ($\theta>47^\circ$).

Altogether we registered in the investigated region 208 V-events from the $\Lambda^0\to p\pi^-$ decays. These included also the Λ^0 hyperons from the Σ^0-hyperon decays. The distribution of the events with respect to the invariant mass of the $(p\pi^-)$ system is shown in Fig. 1a. The production cross section ($p_{\Lambda^0}\geq 200$ MeV/c) per effective nucleus was measured for two angle ranges, and found to be $\sigma=1.83\pm0.46$ mb/nucleus ($47^\circ<\theta<90^\circ$) and $\sigma=0.59\pm0.15$ mb/nucleus (at $\theta>90^\circ$). Figure 1b shows the two-dimensional distribution of the Λ^0 hyperons in angle and momentum coordinates. Of particular interest are the cases in the angle region $\theta>90^\circ$, which seem to correspond to production of Λ^0 hyperons on several nucleons, or even on the nucleus as a whole.

Recently, as a result of an analysis of the data on the

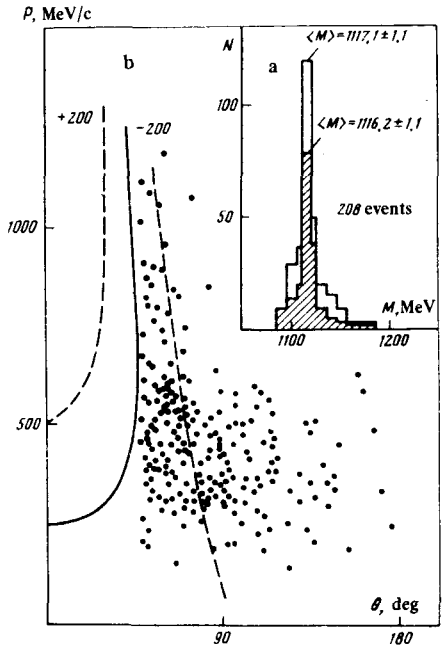

FIG. 1. a) Distribution with respect to the invariant mass of the $(p\pi^-)$ system for cases identified as Λ^0-hyperon decays. The shaded cases are those with stopped protons. b) Distribution of Λ^0 hyperons in the coordinates momentum and emission angle in the l.s. The solid and dashed lines are the kinematic boundaries for the production on a free nucleon at rest and on a moving nucleon (cases with emission angle less than 75° were selected from 40 000 photographs).

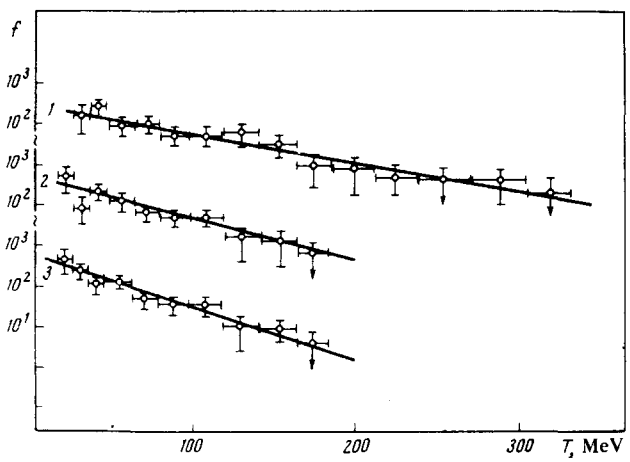

FIG. 2. The function f *vs.* T_{kin} for three ranges of angles (the normalization along the ordinate axis is arbitrary).

inclusive production of particles on nuclei,[3,4] it was observed that the function $f = (E/p^2)(d\sigma/dpd\Omega) = C \times \exp[-T_{kin}/T_0]$. Figure 2 shows the function $f(T_{kin})$ for

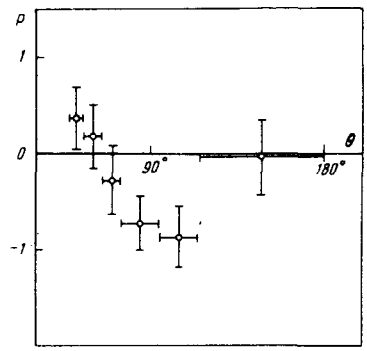

FIG. 3. The polarization $p = (2/a)(N_+ - N_-)/(N_+ + N_-)$ of Λ^0 hyperons *vs.* the emission angle in the laboratory frame. Here $a = 0.645$ and N_+ and N_- are the number of events in which the proton is emitted upward or downward relative to the reaction plane. The positive direction is along the vector $\mathbf{p}_\pi - \times \mathbf{p}_{\Lambda^0}$.

Λ^0 hyperons in three angle ranges: $60° < \theta < 80°$, $80° < \theta < 100°$, and $\theta > 100°$. We see that the inclusive cross section is of the same form $C \exp[-T_{kin}/T_0]$. The values of the slopes are

1. $T_0 = \left(64.6 \pm \frac{7.4}{6.1}\right)$ MeV $\quad 60° < \theta < 80°$

2. $T_0 = \left(42.2 \pm \frac{7.1}{5.2}\right)$ MeV $\quad 80° < \theta < 100°$

3. $T_0 = \left(36.0 \pm \frac{4.7}{3.7}\right)$ MeV $\quad \theta > 100°$

We have also measured the asymmetry in the decays of the Λ^0 hyperons relative to the reaction plane; this enabled us to determine the hyperon polarization. Figure 3 shows the polarization as a function of the emission angle in the laboratory frame.

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