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STUDY OF THE POLARIZATION
FOR Λ -HYPERONS PRODUCED
IN $^{12}\text{C-C}$ AND $^{12}\text{C-Ta}$ INTERACTIONS
AT 4.2 GEV/C PER NUCLEON

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A number of papers devoted to the polarization of Λ -hyperons produced both in hadron-hadron and hadron-nucleus interactions has been published in the last few years (see¹⁻⁷ and references therein). The experimental results show that the polarization of Λ -hyperons (\mathcal{P}_Λ) grows with increasing their transverse momentum over a range of 0.3 - 1.0 GeV/c and is practically independent of beam energy^{1,7/}. The dependence of \mathcal{P}_Λ on the atomic weight of the target nucleus is rather weak^{6,7/}. So, in neutron-nucleus interactions at ~ 40 GeV over the range of $0.6 < P < 1.3$ GeV/c, $\mathcal{P}_\Lambda \sim A^B$, where $B = -0.15^{+0.07}_{-0.60}$ /6/.

Experimental investigations of Λ -hyperon polarization are only beginning^{8-10/}. The present paper presents the results of determination for the polarization of Λ -hyperons produced in inelastic CC and CTA interactions at a primary nuclei momentum of 4.2 GeV/c per nucleon.

Methodical problems connected with the selection and identification of Λ -hyperons are reported in /11/.

It is known that the angular distribution of protons from Λ -hyperon decay in the Λ rest system is due to Λ -particle polarization as follows:

$$P(\cos \theta) = \frac{1}{2} (1 + \alpha \mathcal{P}_\Lambda \cos \theta), \quad (1)$$

where θ is the emission angle of the proton in the rest system Λ relative to the vector normal to the Λ production plane,

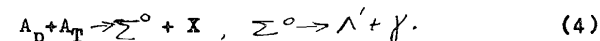
$\vec{n} = (\vec{P}_A \times \vec{P}_\Lambda) / |P_A \times P_\Lambda|$. Here \vec{P}_A and \vec{P}_Λ are the momenta of projectile nucleus and Λ -hyperon, respectively and α is the decay parameter ($\alpha = 0.642 \pm 0.013$). The Λ -hyperon polarization has been defined as

$$\mathcal{P}_\Lambda = \frac{1}{\alpha} \frac{\langle \cos \theta \rangle}{\langle \cos^2 \theta \rangle} \quad (2)$$

It should be noted that the direct Λ -hyperon production is distinguished neither in our experiment nor in the other ones. The polarization has been defined for all Λ 's produced from the reaction



as well as from Σ^0 decay from the reaction



For Λ -hyperons from the latter reaction $\mathcal{P}_{\Lambda'} = -\frac{1}{3} \mathcal{P}_{\Sigma^0}$ /13/. At our energy $\sigma_{\Sigma^0} \approx 1/45$ /14,15/ and at $\mathcal{P}_\Lambda = \mathcal{P}_{\Sigma^0}$ the polarization of the registered Λ -hyperons is expected to be 30% smaller than from reaction(3).

The data on the Λ -hyperon polarization in inelastic and multinucleon* CC interactions as well as in CTA collisions are presented in Table1. It also presents the average transverse momenta of Λ -hyperons and their number, for each type of interaction. All the values of \mathcal{P}_Λ are consistent with zero polarization within errors. The same result has been obtained for Λ -hyperon polarization in inelastic HeLi and central CC, CNe, ONe collisions at 4.5 GeV/c^{19/} as well as in central Ar-KCl interactions at 1.8 GeV/c per nucleon^{8/}.

Looking for a possible \mathcal{P}_Λ dependence on the transverse momentum of Λ -hyperons, all CC events with Λ -particle production were subdivided into three groups: with $P_\perp \leq 0.4$ GeV/c, $0.4 < P \leq 0.6$ GeV/c and $P > 0.6$ GeV/c (up to 1.2 GeV/c). For the same purpose CTA interactions with Λ 's were separated into two groups: with $P \leq 0.4$ GeV/c and $P > 0.4$ GeV/c.

*) Multinucleon CC interactions are characterized by the interaction of, at least, 4 protons from the incident carbon nucleus.

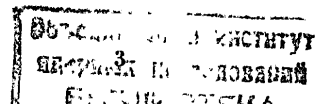


TABLE 1

The polarization for Λ -hyperons in nucleus-nucleus interactions.

$A_p - A_T$	$\langle P_L \rangle$ (GeV/c)	Number of Λ -hyperons	
CC	0.47 ± 0.01	373	-0.09 ± 0.14
CC(mn)	0.53 ± 0.02	161	-0.16 ± 0.20
CTa	0.48 ± 0.03	76	-0.10 ± 0.30
CC CNe, ONe ^{/9/} central	0.59 ± 0.04	100	-0.08 ± 0.25

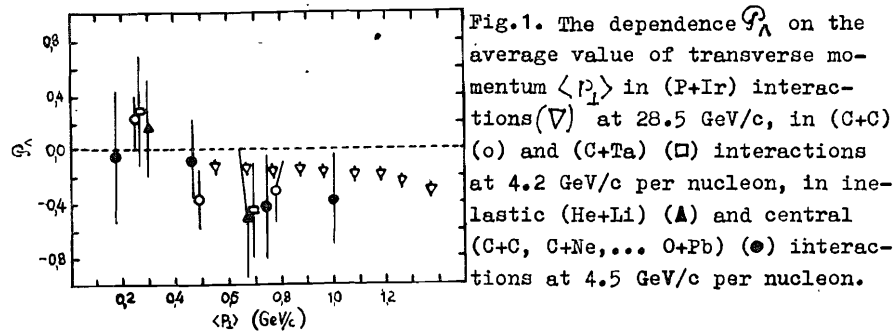


Fig.1. The dependence P_Λ on the average value of transverse momentum $\langle P_L \rangle$ in (P+Ir) interactions (∇) at 28.5 GeV/c, in (C+C) (o) and (C+Ta) (\square) interactions at 4.2 GeV/c per nucleon, in inelastic (He+Li) (Δ) and central (C+C, C+Ne, ... O+Pb) (\bullet) interactions at 4.5 GeV/c per nucleon.

The average values of transverse momentum and Λ -particle polarization are defined in each group. The results are presented in Fig.1. together with the data on Λ -hyperon polarization in inelastic HeLi and central CC, CNe, ONe... OPb collisions^{/10/}. The P_Λ dependence on P_L ($P_L > 0.5$ GeV/c) for pIr interactions at 28.5 GeV/c is shown for comparison^{/2/}. It should be taken into account (although the errors are large) that within a small P_L interval ($P_L < 0.4$ GeV/c) of transverse momenta the Λ -hyperon

TABLE 2

The polarization for Λ -hyperons in nucleus-nucleus interactions as a function of transverse momentum.

$A_p - A_T$	P_L (GeV/c)	$\langle P_L \rangle$ (GeV/c)	P_Λ	N_Λ
CC	$P_L \leq 0.4$	0.25 ± 0.01	0.23 ± 0.20	162
CC	$P_L > 0.4$	0.65 ± 0.02	-0.36 ± 0.17	211
CTa	$P_L \leq 0.4$	0.23 ± 0.02	0.28 ± 0.41	35
CTa	$P_L > 0.4$	0.69 ± 0.05	-0.45 ± 0.39	41

polarization differs from P_Λ in the range of $P_L > 0.4$ GeV/c. The values of P_Λ for these intervals of transverse momentum are given in Table 2. The P_Λ dependence on P_L in CC and CTa interactions agrees with the results obtained for P_Λ in hadron-nucleus^{/1-5/} and nucleus-nucleus collisions^{/10/}. So, the dependence effect of Λ -hyperons polarization on their transverse momentum at 0.3 - 1 GeV/c is valid for nucleus-nucleus interactions.

REFERENCES

1. Heller K., Proceedings of the 6-th International Symposium on High Energy Spin Physics, Marseilles, September 12-19, 1984, p.C2-121.
2. Loumanno F. et al., Phys. Rev. Lett., 1979, v.43, p.1905.
3. Shahbazian B.A. et al., JINR, E1-11519, Dubna, 1978; Temnikov P.P. et al., JINR, P1-12138; Dubna, 1980.

4. Dzhmukhadze S.V. et al., JINR, P1-80-370, Dubna, 1980; Nucl. Phys., 1981, v.33, p.160.
5. Aleev A.N. et al., Nucl Phys., 1983, v.37, p.1480; JINR, E1-82-760, Dubna, 1982.
6. Aleev A.N. et al., JINR, D1-86-550, Dubna, 1986.
7. Panagiotou A.D., Phys. Rev. C, 1986, v.33, p.1999.
8. Harris J. et al., Phys. Rev. Lett., 1981, v.47, p.229.
9. Anikina M. et al., Z.Phys., 1984, v.C25, p.1.
10. Anikina M. et al., JINR, E1-85-578, Dubna, 1985.
11. Iovchev K.J., Kladnitskaya E.N., JINR, P1-86-166, Dubna, 1986.
12. Faccini - Turluer M.L. et al., Zeit.Phys. C, 1979, v.1, p.19.
13. Gatto R., Phys. Rev., 1958, v.109, p.610.
14. Louttit R.I. Phys. Rev., 1961, v.123, p.1465.
15. Bierman E. Phys. Rev., 1966, v.147, p.922.
16. Agakishiev H.N., JINR, P1-82-536, Dubna, 1982; Nucl. Phys., 1983, v.38, p.152; Zeit. Phys., 1983, v. C16, p.307.

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Исследование поляризации Λ -гиперонов,
рожденных в СС- и СТа-взаимодействиях
при 4,2 ГэВ/с на нуклон

Исследовалась поляризация Λ -гиперонов в СС- и СТа-взаимодействиях при 4,2 ГэВ/с на нуклон. Результаты согласуются с зависимостью P_{Λ} от поперечного импульса Λ -гиперонов, полученной для адрон-ядерных взаимодействий.

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Study of the Polarization for Λ -Hyperons
Produced in $^{12}\text{C} - \text{C}$ and $^{12}\text{C}-\text{Ta}$ Interactions
at 4.2 GeV/c per Nucleon

The polarization for Λ produced in CC and CTa interactions at 4.2 GeV/c per nucleon has been studied. The results are in agreement with P_{Λ} dependence on the transverse momentum of Λ -hyperons obtained for hadron-nucleus interactions.

The investigation has been performed at the Laboratory of High Energies, JINR.

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