$\Delta\omega$ —width of dispersion of optical branch.

We seek the solution of (1) in the form

$$F_k^x = \sum_G f^x(G)\exp(-ikG).$$

Substituting (3) and (6) in (1) we obtain

$$f^x(G) = 0 \qquad G \neq g,$$

$$f^x(G) = \frac{-i\hbar^{-1}J(g)\,g_x\exp(-S_T(g))}{W(0) - W(g)} \quad G = g, \qquad (7)$$

where **g** is the vector joining the given atom with the nearest neighbor. We thus obtain ultimately[3)]

$$\sigma_B = \frac{ne^2\beta}{\hbar^2}\sum_g \frac{J^2(g)\,g_x^2\exp(-2S_T(g))}{W(0) - W(g)}$$

$$\approx ne^2\beta\frac{J^2a^2}{\hbar^2}\frac{\Delta\omega}{\omega_0^2}\eta_1^{-4}e^{-2S}\,\mathrm{sh}^2\,p_0. \qquad (8)$$

Estimates show that when $T_1 < T < T_0$

$$\sigma_H/\sigma_B \approx \left[\frac{J^2}{S(\hbar\omega_0)^2}\mathrm{sh}^{-2}\,p_0\right]^2 \ll 1.$$

It follows from (8) that the expression for the mobility has the form

$$\bar{u} = u\frac{\Delta E_p}{kT}\frac{\Delta E_p}{\hbar\bar{W}} = \frac{e}{kT}\frac{\langle v_x^2\rangle}{\bar{W}}, \qquad (9)$$

where $\Delta E_p \approx J\exp(-S_T)$ —width of polaron band and $u = ea^2/\hbar = 0.1\,(a/a)^2$ cm²/V-sec has the dimension of mobility, where $a_0 = 10^{-8}$ cm. For broad bands ($\Delta E_p \gg kT$) we have $\langle v_x^2\rangle/kT \approx 1/m^*$, i.e., (9) goes over into the usual expression for the mobility, suitable for the condition $\hbar\bar{W}/kT \ll 1$. The region of applicability of (9) is not confined to this condition, and (9) can be used if

$$\eta_1 \ll 1, \qquad \eta_2' \ll 1, \qquad T_1 < T < T_0.$$

We have $\Delta E_p/kT \ll 1$ by virtue of the condition $\eta_4 < 1$, while the ratio $\Delta E_p/\hbar\bar{W}$ can be arbitrary. This ratio increases sharply with decreasing temperature. When it exceeds unity the wave vector **k** becomes a "good" quantum number.

Thus, in the case of narrow bands and weak interaction with the scatterers ($\Delta E_p/\hbar\bar{W} > 1$, $\Delta E_p/kT < 1$) formula (9) applies to the mobility, as before. However, as the effective interaction between the polarons and the polarization phonons weakens, scattering by impurities or acoustic phonons may enter into play, and this changes the temperature variation of the mobility in the region of lower temperatures ($T \ll T_0$). We have left out of the Hamiltonian the terms responsible for the relaxation of the optical phonons, i.e., we have assumed that they always have a Planck distribution, and the effect of mutual dragging can be neglected.

[1)]The first line of Eq. (36) of [3], for $T \gg T_0$, contains an error. Actually the estimate of the ratio $r_{2k}^{x(1)}/r_{2k}^{x(0)}$ coincides with the result for $r_{1k}^{x(1)}/r_{1k}^{x(0)}$ in the second and third lines of (36).

*cth = coth.

[2)]It is stated mistakenly in [3] that when $T \gg T_0$ the probability W_{pk} is independent of p and k, i.e., the arrival terms in (1) are equal to zero. This, however, does not change the estimate of the order of smallness of σ_B when $T \gg T_0$, which was carried out in [3] without account of arrival.

†sh = sinh.

[3)]The estimate of σ_B in [2] is incorrect, since $W^{(2)}$ is mistakenly replaced by $W^{(0)} \ll W^{(2)}$.

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Translated by J. G. Adashko
64

BARYON MOMENTUM SPECTRUM IN INELASTIC COLLISIONS BETWEEN FAST PIONS AND NUCLEONS

V. S. BARASHENKOV, D. I. BLOKHINTSEV, E. K. MIHUL,[1)] I. PATERA, and G. L. SEMASHKO

Joint Institute for Nuclear Research

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IT was established in recent investigations[1-2] that the momentum spectra of Λ and Σ hyperons, produced in inelastic π^-p collisions at energies T ~ 10 BeV, have two maxima: for T = 7 BeV one in the region p ~ 0.8 BeV/c and the other at p ~ 1.6 BeV/c (see Fig. 1). The recoil nucleons have similar spectra[3]. We shall show below that such a "double-hump" baryon spectrum is the direct consequence of resonant interaction between the primary π^- meson and the intermediate particle that transfers the main part of the interaction in primary πN collisions.

Let us consider the production of Λ hyperons

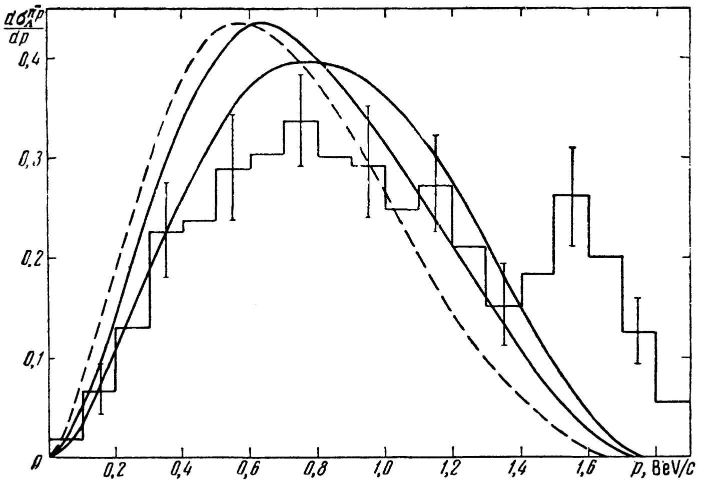

FIG. 1. Momentum distribution of Λ hyperons. The solid curves indicate the distribution calculated for the extreme values of the choice of cross sections $\overline{\sigma_t^{\pi\pi}}$, $\overline{\sigma_t^{\pi K}}$, and $\overline{\sigma_\Lambda^{KN}}$. The dashed lines show the distribution calculated from the statistical theory of multiple particle production. The histogram represents the experimental data[2]. All curves are normalized to the cross section $\sigma^{\pi^- p} = 0.4 \times 10^{-27}$ cm².

in π^-p interaction at T = 7 BeV. In the one-meson pole approximation, when the interaction is transmitted by only one intermediate particle, the production of Λ hyperons is described by diagrams M_1, M_2, and M_3 on Fig. 2. Using standard methods (see [4,5]) it is possible to express the corresponding differential cross section

$$\frac{d\sigma_\Lambda^{\pi^- p}}{dp} = \frac{d\sigma^{(1)}}{dp} + \frac{d\sigma^{(2)}}{dp} + \frac{d\sigma^{(3)}}{dp}$$

in terms of the total ππ and πK interaction cross sections $\sigma_t^{\pi\pi}$ and $\sigma_t^{\pi K}$ and in terms of the differential cross sections $\partial^2\sigma_\Lambda^{\pi N}(p, \theta)/\partial p\partial\theta$ and $\partial^2\sigma_\Lambda^{KN}(p, \theta)/\partial p\partial\theta$ for the production of Λ hyperons in πN and KN interactions.

Since the last two cross sections are contained under integral signs, the specific form of their angular and momentum dependences weakly influences the cross section $d\sigma^{\pi^- p}/dp$. We therefore can calculate these cross sections using much cruder approximations. We have carried out this part of the calculations with the aid of the statistical theory of multiple particle production. (The results of the calculations remain practically unchanged if the angular dependence of the cross sections in the integrand is determined from interpolation of the experimental data.) All the calculations were made with an electronic computer.

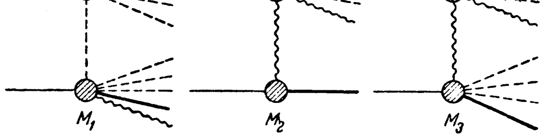

FIG. 2. The production of Λ hyperons in the one-meson approximation; thick lines denote a Λ hyperon, thin lines – a proton, and dashed lines – a pion.

If we recognize that in the energy region T ~ 1—3 BeV, which is of greatest interest to us, the average values of the cross sections $\overline{\sigma_t^{\pi\pi}}$ and $\overline{\sigma_\Lambda^{KN}}$ are 30—50 and 5 mb respectively (see [4,6,7]) then the total cross section for the production of Λ hyperons in π^-p interactions at T = 7 BeV, which is equal to

$$\sigma_\Lambda^{\pi^- p} \equiv \int dp \cdot d\sigma_\Lambda^{\pi^- p}/dp = 1.5 \cdot 10^{-3}\overline{\sigma_t^{\pi\pi}} + 1.8 \cdot 10^{-2}\overline{g^2_{KN\Lambda}}\,\overline{\sigma_t^{\pi K}} + 1.4 \cdot 10^{-3}\overline{\sigma_t^{\pi K}}\,\overline{\sigma_\Lambda^{KN}} \ [\mathrm{mb}]$$

agrees with the experimental value (~ 0.4 ± 0.1 mb[8]), if the average cross section of the πK interactions is $\overline{\sigma_t^{\pi K}} \approx$ 10—30 mb ($g^2_{KN\Lambda} \sim 1$ is the KNΛ-interaction constant). It must be noted that the inaccuracies in the cross sections $\overline{\sigma_t^{\pi\pi}}$ and $\overline{\sigma_\Lambda^{KN}}$ affect little the value of $\sigma_\Lambda^{\pi^- p}$, since the relative contribution of the cross sections $\sigma^{(1)}$ and $\sigma^{(3)}$ is small.

It is seen from Fig. 1 that the Λ-hyperon momentum spectrum calculated from the pole theory agrees better with the experimental histogram than that calculated from statistical theory; however, no choice of the constants $\overline{\sigma_t^{\pi\pi}}$, $\overline{\sigma_t^{\pi K}}$, $\overline{\sigma_\Lambda^{KN}}$, and $g^2_{KN\Lambda}$ can yield a theoretical spectrum with two maxima that coincide with the experimental ones.

Nor is the agreement with experiment improved by cutting off the permissible values of the 4-momentum of the intermediate particles (transition to long-range peripheral collisions). In this case the theoretical cross section in the region of the second maximum turns out to be of the same order as the experimental one only if the cross sections $\sigma_t^{\pi\pi}$, $\sigma_t^{\pi K}$, σ_Λ^{KN}, and the constants $g^2_{KN\Lambda}$ are two or three orders larger than the estimates indicated above. Such a picture seems fantastic.

The theoretical and experimental momentum spectra of the created Λ hyperons can be reconciled by making more detailed assumptions concerning the cross section of the πK interaction. This is due to the fact that the cross section $\sigma_t^{K\pi}$ does not enter in the expression for $d\sigma^{(2)}/dp$ under the integral sign (see the analogous formula (4) in [4]). Since the contribution of the cross section $\sigma_\Lambda^{(2)}$ is the basic one, the summary momentum spectrum of the Λ hyperons turns out to be quite sensitive to the energy dependence of the πK-interaction cross section.

In order for the theoretical spectrum to have a second maximum that agrees with experiment, it is necessary to assume that there is resonant πK interaction in the energy interval 0.6—1.2 BeV. This corresponds precisely to the resonances of M and K observed in many investigations[2)] near 0.73 and 0.89 BeV. If $\sigma_{res}^{K\pi}/\sigma_t^{K\pi} \sim 10-20$, then theory and experiment are in good agreement.

Estimates of the contribution of multimeson intermediate states, carried out in the resonance approximation (more on this approximation in [9]), have shown that within the accuracy limits of modern experimental data it is possible to neglect the contribution of multi-meson states.

The "double hump" spectrum of Σ hyperons is similarly explained.

The second maximum in the recoil-nucleon spectrum can be attributed to resonant $\pi\pi$ interaction. In this case the predominant collisions at high energies are πN collisions, described by means of a diagram in which the pions are produced only in the upper node. This deduction agrees with the results which we obtained previously[4] by a somewhat different method.

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1)Institute of Nuclear Physics in Bucharest.

2)If the beam of initial negative pions is sufficiently monoenergetic, it is possible to determine in this manner the energy dependence of $\sigma_t^{\pi K}$ in the region of both resonances.

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65

CONCERNING ONE REACTION WITH COLLIDING ELECTRON BEAMS

V. D. MIKHAĬLOV

Moscow Institute of Physics and Engineering

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EXPERIMENTS with colliding electron beams have recently been widely discussed in the literature. Several experiments are already being prepared in a number of laboratories. The colliding beam technique also uncovers new experimental possibilities for μ-meson physics. Thus, it has been proposed[1] to use colliding electron and positron beams to investigate μ-meson pair production in electron and the positron annihilation: $e^+ + e^- \to \mu^+ + \mu^-$. This process can be used to determine the form factor of the μ meson, the radiative corrections, and to solve other problems concerning the μ meson.

However, it is technically much more difficult to obtain colliding electron-positron beams than electron-electron beams, and although the cross section for μ-meson pair production in electron scattering on electrons (σ_{sc}) at relatively low energies is much smaller than the cross section for the μ pair production in electron-positron annihilation (σ_{an}), the latter decreases with increasing energy while σ_{sc} increases. However, σ_{sc} increases more slowly for large angles ($\sim \pi/2$) (see below) and also at high energies, where σ_{sc} is of the order of σ_{an}. In the range of large angles ($\sim \pi/2$), which is most interesting for the experiments with colliding beams, we have nevertheless $\sigma_{an} > \sigma_{sc}$. With increasing energy, the range of angles for which $\sigma_{an} > \sigma_{sc}$ decreases. It is therefore interesting to determine quantitatively for which energies and at what angles the cross section for μ-meson pair pro-