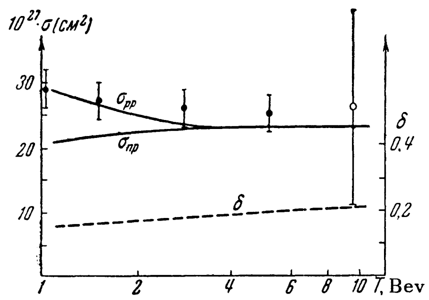

Relative energy losses δ and effective cross sections for meson production in the periphery collisions of nucleons: σ_{pp} — proton with proton; σ_{np} — neutron with proton. Experimental points are taken from Ref. 6.

other[1] is assumed small which, it appears, is valid for nucleons of energy $E \leq 10$ Bev, since the interaction cross section of such nucleons $\sigma_{NN} \approx 30 \times 10^{-27}\,\text{cm}^2 < \pi(2R)^2$.

Secondly, the interaction of the core of the fast nucleon with the cloud of the stationary one[3] by (K, π) – interaction was take into account. In the rest system of the fast nucleon this interaction occurs as (π, K) – interaction with cross section σ_1. Here the relative energy losses of the fast nucleon, expressed in the laboratory system, are made up of the losses $\delta_2^{\pi} \approx \gamma(1-\beta)\delta_1 \approx \delta_1/2\gamma$ in the production of π-mesons and $\delta_2^N \approx \delta_1^2/2\gamma(1-\delta_1)$ in nucleon recoil.

Since the meson field functions employed correspond to the exchange of one π-meson by the interacting nucleons, the cross sections for production of π-mesons in both processes are added together, and the relative energy losses are averaged

$$\sigma = 2\sigma_1; \quad \delta = (\delta_1/2)\,[1 + 1/2\gamma\,(1-\delta_1)].$$

The best agreement with experiment is obtained for a radius of the nuclear core $r = \hbar/m_K c \approx 2\hbar/Mc$ and a coupling constant $g^2 = 15$ (see figure). Here the cross section for central collision of the nucleons (with impact parameter ($b \leq r$) $\delta_{KK} \approx \pi r^2 = 5.6 \times 10^{27}\,\text{cm}^2$ constitutes about 20% of the total cross section for inelastic collisions, which coincides with the experimental estimate of Smorodin and others.[5] The relative energy losses of the fast nucleon in the periphery collisions also agrees with experiment.[5] It is essential that they are completely independent of the magnitude of the coupling constant.

In conclusion I should like to express deep gratitude to Prof. D. I. Blokhintsev for valuable advice and interest in this work.

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REMARKS ON ELASTIC SCATTERING OF RELATIVISTIC PARTICLES IN MATTER IN THE STEADY STATE

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LET us consider a steady stream of some type α of positive-rest mass particles scattering in a substance by means only of elastic collisions. These particles are unstable and can be absorbed by the substance. Ordinarily the velocities of the particles comprising the substance are much less than those of the particles of type α. Let us therefore assume that the particles of matter are at rest. Under these conditions, in the rest system of the matter, the kinetic equation of motion of the particle flux in the substance[1] can be written in a form which is identical to the nonrelativistic kinetic equation, namely

$$\boldsymbol{\nu}\nabla\Psi + (\partial/\partial\boldsymbol{\nu})(\boldsymbol{\eta}\Psi) + \nu\Psi/l = \int \Psi^{*}\nu^{*}\sum_i \rho_i h_i(\nu^{*}, \nu)\,\delta(\cos\theta_0 - \mu_i)\,d\boldsymbol{\nu}^{*} + q; \quad \Psi^{*} = \Psi(\mathbf{r}, \boldsymbol{\nu}^{*}), \ \boldsymbol{\nu} = (2E/p^2)\,\mathbf{p}, \tag{1}$$

where E is the kinetic energy, and $\mathbf{p}$ is the momentum of the particles of type α. During the intervals between collisions, the motion of the particles of type α is given by the equations

$$\frac{dx}{\nu_1} = \frac{dy}{\nu_2} = \frac{dz}{\nu_3} = \frac{d\nu_1}{\eta_1(\mathbf{r}, \boldsymbol{\nu})} = \frac{d\nu_2}{\eta_2(\mathbf{r}, \boldsymbol{\nu})} = \frac{d\nu_3}{\eta_3(\mathbf{r}, \boldsymbol{\nu})} = \frac{d\tau}{1 - \nu^2/4c^2}; \tag{2}$$

where τ is the proper time for this particle, and c is the velocity of light. For Eq. (1), only the first five of Eqs. (2) are relevant.

In any region D of the variables $\mathbf{r}$ and $\boldsymbol{\nu}$, the number of particles of type α is

$$\int_D \Psi(\mathbf{r}, \boldsymbol{\nu})(1 + \nu^2/4c^2)\,d\mathbf{r}\,d\boldsymbol{\nu}, \tag{3}$$

while the number of such particles created in this region per unit time is

$$\int_D q(\mathbf{r}, \boldsymbol{\nu})\,d\mathbf{r}\,d\boldsymbol{\nu}; \tag{4}$$

where $\rho_i = \rho_i(\mathbf{r})$ is the density of particles of type i in the substance,

$$1/l = m/pT_0 + \sum_i \rho_i\sigma_i(\nu);$$

$\sigma_i(\nu)$ is the total interaction cross section between particles of type α and those of type i, $1/T_0$ is the probability for spontaneous decay of the particles of type α per unit proper time, θ_0 is the angle between ν^* and ν,

$$\mu_i = \frac{m + m_i}{2m}\frac{\nu}{\nu^{*}} + \frac{m - m_i}{2m}\frac{\nu^{*}}{\nu}; \tag{5}$$

and m_i is the rest mass of a particle of type i. The function $h_i(\nu^*, \nu)$ is related to the differential scattering cross section of particles of type α with energy E^* by a particle of type i at rest in the following way:

$$d\sigma_i = h_i(\nu^{*}, \nu)\,\delta(\cos\theta_0 - \mu_i)\,d\nu_1\,d\nu_2\,d\nu_3. \tag{6}$$

For instance, isotropic scattering in the center-of-mass system corresponds to

$$h_i(\nu^{*}, \nu) = \frac{\sigma_{si}(\nu^{*})}{4\pi}\,\frac{(m + m_i)^2 - (\nu^{*2}/4c^2)(m - m_i)^2}{m m_i \nu\nu^{*2}}\,\frac{1 - \nu^{*2}/4c^2}{[1 - \nu^2/4c^2]^2}, \tag{7}$$

where σ_{si} is the scattering cross section for particles of type α by those of type i. The integral in Eq. (1) is taken over the region $\nu^* < 2c$.

Equation (1) has been considered in detail elsewhere[2] in treating the scattering by matter of a stream of nonrelativistic particles with $\eta = 0$ and the scattering being isotropic in the center-of-mass system.

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