$$\Phi = -\lambda_1 \{(\sigma_{xx} - \sigma_{yy}) H_x - 2\sigma_{xy}H_y\} - \lambda_2 (\sigma_{xz}H_y - \sigma_{yz}H_x).$$

Hence we find at once the expressions for the magnetic moment in the absence of an external field:

$$m_x = \lambda_1 (\sigma_{xx} - \sigma_{yy}) - \lambda_2\sigma_{yz}, \quad m_y = -2\lambda_1\sigma_{xy} + \lambda_2\sigma_{xz}.$$

Other examples are the antiferromagnetics MnF_2, CoF_2, and FeF_2. In accordance with Ref. 4, their magnetic symmetry class consists of

$$C_2,\ 2C_4R,\ 2U_2,\ 2U_2'R,\ I,\ \sigma_h,\ 2S_4R,\ 2\sigma_v,\ 2\sigma_v'R.$$

This symmetry group leaves invariant the following term in the expression for Φ:

$$\Phi = -\lambda (\sigma_{xz}H_y + \sigma_{yz}H_x),$$

whence we get for the magnetic moment

$$m_x = \lambda\sigma_{yz}, \quad m_y = \lambda\sigma_{xz}.$$

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THE ROLE OF NUCLEONS IN MULTIPLE PRODUCTION OF PARTICLES

A. A. EMEL'IANOV and I. L. ROZENTAL'

P. N. Lebedev Physics Institute, Academy of Sciences, U.S.S.R.

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In the processes of multipole production of particles in collisions of high-energy nucleons with nuclei, nucleons play a special role compared to mesons.

In addition to the obvious differences caused by conservation of nuclear charge and different masses of nucleons and mesons, one should note a less obvious characteristic which is essential in a hydrodynamical description.[1] For energies of the incident nucleon $E_0 = 10^{12} - 10^{13}$ ev, the temperature of the system at the beginning of the hydrodynamical expansion is $1 - 2\ Mc^2$ (temperature is measured in units of energy; M is the nucleon mass). At the same time, the condition $T \gg \mu c^2$ (μ is the mass of the π-meson) is satisfied. Therefore, at the energies discussed, during the whole process the probability of production of a nucleon-antinucleon pair is very small; in this respect, nucleons and mesons differ essentially. At the present, it is not possible to unambiguously describe this difference of the nucleons in the process. Here we consider a simplified model of the hydrodynamical development of the system, taking into account the special role of the nucleons taking part in the process.[2] *

We consider a given collision of two nucleons. In the interaction between nucleons, a meson cloud is formed, which is contracted by them as if by a piston (the contraction proceeds in a non-adiabatic fashion). As a result, a system is produced in which the kinetic energy is divided between nucleons in a very small volume. It is natural, in the spirit of the whole conception, to postulate that the order of magnitude of the volume V is $(4\pi/3)(h/\mu c)^3\ 2Mc^2/E'$ where E' is the energy of the nucleons in their center of mass system, $h/\mu c$ is the radius of the meson cloud, and the factor $2Mc^2/E'$ takes into account the contraction of the cloud.

In this paper we determine the fraction of the energy carried by the fast nucleon. To obtain this, we consider the relativistic hydrodynamical equations

$$\partial T_{ik} / \partial x_k = 0, \quad T_{ik} = w u_i u_k + p g_{ik},$$

where $w = \epsilon + p$ is the enthalpy, u_i is a 4-velocity; $g_{11} = g_{22} = g_{33} = 1$, $g_{44} = -1$, $x_i = x, y, z, ict$. In the center of mass system, the system considered has the form of a flat disc at the moment of collision; therefore, in the course of the first stage, the hydrodynamical expansion can be considered as one-dimensional (for more details, see Ref. 2).

At the boundary between matter and the nucleon, the solution of Eq. (1) should satisfy the boundary condition

$$M du_1 / dt = p\pi (h/\mu c)^2, \quad u_1 = v / \sqrt{1 - v^2/c^2},$$

where v is the nucleon velocity, p is the pressure on its 'surface,' $\pi (h/\mu c)^2$, the area of the transverse cross section of the nucleon.

A detailed consideration of the process shows that for $E_0 = 10^{11} - 10^{12}$ ev, it is sufficient to obtain a solution for simple waves in the region of nontrivial motion, bounded, on the side of the nucleon, by the region of simple waves and, on the other side, by the stationary plane of symmetry. This circumstance can be explained by the fact that the system starts to decay sooner than the wave, which is reflected by the moving nucleon, arises.

Solving the equation for the motion of the nucleon, one can obtain its energy E_k at the moment the system begins to decay (the decay of the system is characterized by a decay temperature $T_k \cong \mu c^2$). As a result of calculation, we obtained for $E_0 = 10^{11}$ and 10^{12} ev that $E_k \cong 0.3 \times 10^{11}$ and 0.2×10^{12} ev, respectively, in the laboratory system; the dependence on the energy of the fast nucleon can be written in the form

$$E_k / E_0 \sim E_0^{-1/15}.$$

It should be noted, however, that the determination of E_k is very conditional, since at an energy $E_0 \sim 10^{12}$ ev, the number of particles is small and the moment of decay cannot be determined from the local temperature near the nucleon, but from the temperature averaged over the region of space, even though there is only one nucleon. Solving, approximately, the problem for the averaged quantity, it is possible to show that $E_k \cong 0.6\, E_0$.

The energy of the fast nucleons depends appreciably also on the value of the volume V, i.e., $E_k \sim V^{-0.4}$.

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*The experimental data[3,4] also shows the essential difference of the nucleons.

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