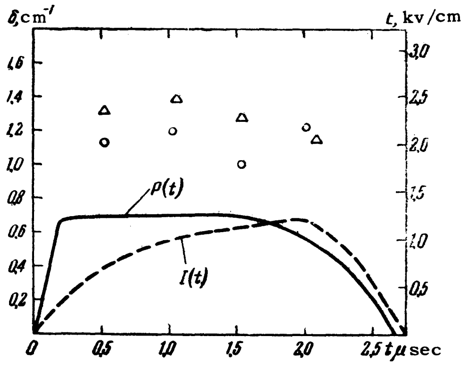


P (t) – oscillogram of the power; I (t) – oscillogram of the intensity; $\delta$ – half-width of the Stark line; E – amplitude of the electric field; o – 4 mm. Hg; $\Delta$ – 23 mm. Hg.

the electric field inside the plasma remains essentially constant. On the other hand the luminous intensity, which may be interpreted as reflecting the time behavior of the electron density, shows the monotonic increase of the latter.

These results indicate that in this experiment we are dealing with the stage of discharge formation which precedes the establishment of the stationary state conditions; in the steady state the electric field is considerably smaller.[3]

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## *A GENERAL FORMULA FOR THE ELECTROMAGNETIC SCATTERING OF TWO DIFFERENT PARTICLES OF SPIN 1/2*

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IN view of the possibilities for experiments on the scattering of $\mu$ mesons by nucleons it is desirable to generalize the formula for the scattering of high-energy electrons by nucleons (the Rosenbluth formula) in two ways: first, to take account of the mass of the incident particle, and second, to postulate for this particle also an internal structure described by form factors $F_\mu(q^2)$ and $\Phi_\mu(q^2)$.

The charge-current density both for the nucleon and for the incident particle is taken in the form

$$\bar{u}_2 Q u_1, \quad \text{where } Q_i = \gamma_i F(q^2) + i\Phi(q^2)[\gamma_i, \hat{q}],$$

q is the four-vector momentum transfer; $u_2$ and $u_1$ are spinors. The square of the matrix element, averaged over the initial spin states and summed over the final spin states, is given by

$$|\mathfrak{M}|^2 = \frac{1}{E_1E_2E_1'E_2'q^4}\Big\{\frac{1}{4}F_\mu^2F_N^2[-q^2(M^2+\mu^2)+2(p_1\cdot p_1')^2 + 2(p_1\cdot p_2')^2] + F_\mu^2\Phi_NF_NMq^2[q^2-2\mu^2] + F_\mu^2\Phi_N^2[M^2q^4 + 4q^2(p_1\cdot p_2')(p_1\cdot p_1') - 4q^2M^2\mu^2] + F_N^2\Phi_\mu F_\mu \mu q^2 \times [q^2-2M^2] + 12\Phi_N\Phi_\mu F_NF_\mu M\mu q^4 + 4\Phi_N^2\Phi_\mu F_\mu \mu q^4 \times [4M^2 - \tfrac{1}{2}q^2] + F_N^2\Phi_\mu^2 q^2[q^2\mu^2 + 4(p_1\cdot p_1')(p_1\cdot p_2') - 4M^2\mu^2] + 4\Phi_NF_N\Phi_\mu^2Mq^4[4\mu^2 - \tfrac{1}{2}q^2] + 4\Phi_\mu^2\Phi_N^2q^4 \times [4M^2\mu^2 - (M^2+\mu^2)q^2 + 2(p_1\cdot p_1')^2 + 2(p_1\cdot p_2')^2 - \tfrac{1}{4}q^4]\Big\}.$$

The primed quantities refer to the incident particle, the unprimed to the nucleon.

The differential cross-section is

$$\frac{d\sigma}{d\Omega} = \frac{e^4}{(2\pi)^2 v_{\mathrm{rel}}}|\mathfrak{M}|^2\rho, \quad \text{where } \frac{e^2}{4\pi} = \frac{1}{137}, \quad v_{\mathrm{rel}} = \frac{p_0}{E_0}.$$

In the laboratory system we have

$$E_1 = M, \quad E_2 = W, \quad E_1' = E_0, \quad E_2' = E;$$
$$(p_1\cdot p_1') = -ME_0, \quad (p_1\cdot p_2') = -ME, \quad q^2 = 2M(W-M);$$
$$\rho = p_\mu^2 WE/(p_\mu E_n - Ep_0\cos\vartheta).$$

The magnitude of the momentum and the energy of the scattered meson are given by[1]

$$p_\mu = p_0\frac{(E_0M+\mu^2)\cos\vartheta + E_n\sqrt{M^2-\mu^2\sin^2\vartheta}}{E_n^2 - p_0^2\cos^2\vartheta};$$
$$E = \frac{E_n(E_0M+\mu^2) + p_0^2\cos\vartheta\sqrt{M^2-\mu^2\sin^2\vartheta}}{E_n^2 - p_0^2\cos^2\vartheta};$$
$$E_n = E_0 + M = E + W; \quad p_0^2 = E_0^2 - \mu^2.$$

In the case in which the mass of the incident particle can be set equal to zero the expressions become much simpler:[2]

$$\frac{d\sigma}{d\Omega} = \Big(\frac{e^2}{8\pi E_n}\Big)^2\frac{1}{\sin^4(\vartheta/2)}\Big[1+\frac{2E_0}{M}\sin^2\frac{\vartheta}{2}\Big]^{-1}\Big\{F_\mu^2\cos^2\frac{\vartheta}{2} \times \Big[F_N^2\Big(1+\frac{q^2}{2M^2}\tan^2\frac{\vartheta}{2}\Big) + \Phi_NF_N4\frac{q^2}{M}\tan^2\frac{\vartheta}{2} + \Phi_N^2 4q^2 \times \Big(1+2\tan^2\frac{\vartheta}{2}\Big)\Big] + \Phi_\mu^2\Big[4F_N^2q^2 - \Phi_NF_N\frac{8q^4}{M}\sin^2\frac{\vartheta}{2} + 16\Phi_N^2q^4\Big(\cos^2\frac{\vartheta}{2} + \frac{q^2}{4M^2}\sin^2\frac{\vartheta}{2}\Big)\Big]\Big\}.$$

Setting $F_\mu = 1$, $\Phi_\mu = 0$, $\Phi_N = \kappa F_{2N}/4M$, we get the previously mentioned Rosenbluth formula.

In conclusion I express my thanks to I. L. Rozental' for a discussion.

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## *CONCERNING THE IMPACT OF SOLIDS AT HIGH VELOCITIES*

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WHEN a solid body strikes a solid barrier at a speed exceeding several km/sec, a strong shock wave is produced in the body and in the barrier, and destruction of the crystalline lattices of the colliding bodies begins on the front of this wave. At speeds on the order of 10 km/sec and higher, (say when a meteorite strikes the surface of the moon or of an asteroid), the result is evaporation of the striking body and partial evaporation of the struck medium.

The pressure on the front of the shock wave drops sharply with increasing distance to the point of impact, and the evaporation of the medium on its front ceases and is replaced by melting and simple crushing of the medium. Strong crushing stops almost always when the mass energy density on the front of the shock becomes less than a certain value that characterizes the "strength of the medium" $\epsilon$. The evaporated and finely fragmented medium continues to move expands, and exerts an explosion-like effect.

Since the effect of the explosion is analogous in this case to the effect of the well-studied explosion of high explosives, such as TNT, it is advantageous to introduce the so-called TNT equivalent. The equivalent mass of an explosive substance is determined by the obvious relation

$$m_s = \eta E_0 / Q = \eta M_0 u_0^2 / 2Q,$$

where $E_0$ is the initial energy, $M_0$ the mass of the striking body, $u_0$ the impact velocity, $\eta$ the efficiency of utilization of the energy, and $Q$ the caloric content per gram of explosive. At high impact velocity ($u_0 > \sqrt{\epsilon}$) the mass $M$ expelled from the medium by the explosive exceeds considerably the incident mass, and therefore the momentum $J$ of the expelled medium (normal projection) also exceeds considerably the initial momentum $J_0 = M_0 u_0 \cos\theta$, where $\theta$ is the angle (measured from the normal) at which the impact takes place.

Experiments and corresponding computations have shown that the exploded and expelled mass equals $M \approx E_0/\epsilon$. Since the momentum of the expelled mass is $J \approx \sqrt{ME_0}$, then obviously

$$J = BE_0 / \sqrt{\varepsilon}.$$

Here the coefficient of proportionality $B$ is found essentially by experiment. This coefficient can be easily related with the strength properties of the medium.[3]

The relation

$$J_0 / J = 2\cos\theta \sqrt{\varepsilon} / Bu_0$$

is small at large initial impact velocities (when $u_0 > \sqrt{\epsilon}$). Consequently, the total momentum acquired by the medium during the impact and subsequent explosion depends essentially on the explosion momentum and is practically independent of the angle of the impact. At cosmic impact velocities, on the order of 30 or 40 km/sec, $J$ exceeds $J_0$ by one order of magnitude.

The foregoing effects fail to apply only at very large values of the angle of incidence $\theta$, when the normal velocity component is small.

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