However, if the photoelectrons fill a narrow energy interval $\epsilon = \omega \geq \Omega(N + 1/2)$, where the density of the states depends strongly on the energy, the second process becomes predominant. The collisions then occur more frequently when the electron moves along the field, since its energy decreases and the scattering is more effective. Therefore the current produced as a result of an incomplete Larmor circle flows in a direction opposite to the applied field.

4. It should be noted that the coefficient of transverse diffusion of the photoelectrons is always positive, since it is necessary to substitute $f(\epsilon)$ in (4) in lieu of $-\partial f(\epsilon)/\partial\epsilon$. Physically this is connected with the fact that in the diffusion process the electric field does not influence the collision act [4]. At the same time, the diffusion coefficient, as well as the conductivity, will experience oscillations with a period (8).

5. We emphasize that the negative-resistance model with impurity scattering, which we investigated, is not the only one, since the effect is connected only with the singularity of the state density (a mechanism with scattering by optical phonons is possible). The considered situation can apparently be experimentally realized in pure p-InSb.

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CONCERNING THE TRANSFORMATION OF PHOTON PAIRS INTO HADRONS AT HIGH ENERGIES

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In this letter we consider $\gamma\gamma$ interaction at high energies on the basis of the model of vector dominance, which has recently come into wide use.

This model makes it possible to relate the process $\gamma + \gamma \to \rho^0 + \rho^0$ at high energies with the $\rho^0\rho^0$ scattering process:

$$\frac{d\sigma}{d\Omega}(\gamma\gamma \to \rho^\circ\rho^\circ) = g^4_{\gamma\rho}\frac{d\sigma}{d\Omega}(\rho^\circ\rho^\circ \to \rho^\circ\rho^\circ), \qquad (1)$$

where we have for the $\gamma\rho$-transition constant $g^2_{\gamma\rho} \approx 0.5\alpha$ $(\alpha = 1/137)$.

Assuming that the $\rho\rho$ scattering amplitude at high energies is pure imaginary, we obtain

$$\frac{d\sigma}{d\Omega}(\gamma\gamma \to \rho^\circ\rho^\circ)|_0 = \frac{g^4_{\gamma\rho}}{16\pi^2}k^2\sigma^{(t)2}_{\rho\rho}(k), \qquad (2)$$

where $\sigma^{(t)}_{\rho\rho}$ is the total cross section of the $\rho\rho$ interaction and k is the three-dimensional momentum in the c.m.s. $(m_\rho/2k \ll 1)$. The quantity $\sigma^{(t)}_{\rho\rho}(k)$ for large k can be obtained with good approximation by assuming that the contribution of the Pomeranchuk pole predominates in it. Using the residue factorization theorem and assuming for $\sigma_{NN}^{(t)}$ and $\sigma_{\rho N}^{(t)}$ the respective values 39 and 31.3 mb obtained from experiments on ρ^0-meson photoproduction [1], we get $\sigma_{\rho\rho}^{(t)} = 25$ mb. This yields

$$\frac{d\sigma}{d\Omega}(\gamma\gamma \to \rho^\circ\rho^\circ)|_0 = 0{,}16\ k^2\ \mu b/sr, \tag{3}$$

where k is in GeV throughout.

As expected on the basis of the idea of vector dominance, $\gamma\gamma$ collisions that lead to the creation of vector mesons at small angles behave at high energies like hadron elastic scattering processes, and should prevail over lepton electromagnetic processes.

Applying similar considerations to the $\gamma\gamma$ scattering process at high energies, we can obtain*

$$\frac{d\sigma}{d\Omega}(\gamma\gamma \to \gamma\gamma)|_0 = 2\cdot 10^{-6} k^2\ \ \mu b/sr. \tag{4}$$

For comparison we present the analogous quantity corresponding to the ordinary $\gamma\gamma$ scattering diagram with an electron loop:

$$\frac{d\sigma}{d\Omega}(\gamma\gamma \to \gamma\gamma)|_0 = 1{,}05\cdot 10^{-7}\ k^{-2}(\ln k + 7{,}6\ )^4\ \ \mu b/sr. \tag{4'}$$

If we assume again that the amplitude of the elastic scattering of the vector mesons by one another, in terms of which we express in our case the $\gamma\gamma$ scattering amplitude, is pure imaginary, then we get from (4) for the $\gamma\gamma$ interaction cross section (more accurately, for its hadron part), regardless of k ($k > 1$)*

$$\sigma_{\gamma\gamma}^{(t)} \approx 0.013\ \mu b. \tag{5}$$

We present, again for comparison, the cross section of pair production by photons ($k > 1$):

$$\sigma_{\gamma\gamma\to e^+e^-}(k) \approx 0.12\ k^{-2}(\ln + 7.8)\ \mu b. \tag{5'}$$

In spite of the peculiar character of the obtained results (1) - (5), they can hardly be of direct experimental interest in the nearest future. Nonetheless, it is of interest to ascertain whether the results obtained, particularly (5), change the situation concerning the absorption of photons of very high energy in intergalactic space.

As is well known [2-5], the most effective source of absorption of high-energy photons ($E = 10^{12} - 10^{24}$ eV) in a "photon gas" is the pair-production process

$$\gamma(E) + \gamma(\epsilon) \to e^+ + e^-,$$

where E and ϵ are respectively the energies of the incoming γ quantum and that from the gas in the l.s. This process is particularly important for photon absorption in the recently discovered [6] isotropic thermal emission with $T \approx 3°K$, and also in the extragalactic radio emission [3-5].

If we use our result (5) to estimate the role of the hadron mechanism of γ-quantum absorption, then we can easily obtain for the absorption probability P per unit length $P_T \approx 1.5 \times 10^{-29}$ cm^{-1} (absorption by photons of "relict" radiation [4]) and $P_R \approx 3.2 \times 10^{-30}$ cm^{-1} (absorption by photons of extragalactic radio emission [5]). For photons with $E > 7 \times 10^{23}$ eV, the contribution of the hadron mechanism prevails over the contribution made to P_T by the pair-production process, and does not vary with energy.

We see that the mechanism under consideration does not change essentially the question of the absorption of photons in the universe for reasonable values of the γ-quantum energies.

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* In the estimate (4) we confined ourselves only to the most intense $\gamma\rho$ transition. Inclusion of $\gamma\omega$ and $\gamma\varphi$ transitions leads to an increase in the cross sections in (4) and (5) by approximately 30%.

ION-CYCLOTRON INSTABILITY IN A PLASMOID

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Plasmoids obtained in pulsed plasma injectors usually contain ions having a considerable thermal scatter both in the longitudinal and transverse directions, with $T_{\parallel i} \sim T_{\perp i}$. It is shown in this paper that motion of such a plasmoid along a homogeneous magnetic field excites in the latter, under certain conditions, ion-cyclotron oscillations that lead to a "conversion" of the transverse thermal energy of the ions into energy of longitudinal translational motion. Such a "conversion" can cause an appreciable decrease of the energy of the transverse motion of the tions, compared with the energy immediately after the emission of the plasmoid from the injector.

We confine ourselves for simplicity to the one-dimensional problem, i.e., we assume that the parameters of the plasmoid depend only on the coordinate x directed along the magnetic field. We assume further that at the initial instant of time the ion temperature greatly exceeds the electron temperature. Under this condition, the electric fields produced in the plasma do not influence the motion of the ions, i.e., each ion emitted from the injector moves along the magnetic field with constant velocity (we neglect pair collisions). The presence of initial thermal scatter of the ions causes the plasmoid to spread apart in the course of time, and its characteristic length L increases like $L \simeq L^{(0)} + v_{Ti}^{(0)}t$, where $L^{(0)}$ is the initial length of the plasmoid and $v_{Ti}^{(0)}$ is the initial thermal velocity of the ions.

It is easy to see that during the process of the spreading of the plasmoid, the scat-