$$R_H = \frac{6}{t_0}, \quad \epsilon = -\frac{\lambda_N}{2t_0}.$$

t_0 and λ_N are free parameters. The figure shows plots of the function $(1 - F)q^2$, constructed with the aid of (10) and (11) for certain values of the parameters λ_N and t_0. For comparison, the same figure shows the experimental data obtained from e-p scattering for the quantity $(1 - F)q^2$ and the curves (dashed) with the aid of which these data were approximated in [1].

Thus, the existence of the virtual level in the p-wave of a two-pion system can lead to the occurrence of a proton halo (and just as well to a pion halo). We note that this level, if it does exist, should become manifest also in the processes $\pi\pi \rightarrow \pi\pi$, $\gamma\pi \rightarrow \pi\pi$, $\pi N \rightarrow \pi N$, $\gamma N \rightarrow \pi N$, etc., a study of which, in principle, could yield information concerning this level in addition to data on e-p scattering.

In conclusion we note that virtual levels can exist in principle in a three-pion system, leading to the existence of a halo of the isoscalar part of the nucleon.

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PHOTOCURRENT IN A SEMICONDUCTOR WITHOUT A SYMMETRY CENTER

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We report in this note that, unlike usual photoconductivity, a photocurrent is produced in a semiconductor without a symmetry center also in the absence of a constant field. Indeed, in a crystal without a symmetry center, a connection is possible between the current and the electromagnetic field; this connection is quadratic in the field and is described by a cross-conductivity tensor $\sigma_{\mu\alpha\beta}(\omega_1, \omega_2)$. Then the photocurrent is given by the tensor [1]

$$\sigma_{\mu\alpha\beta}(\omega, -\omega) = \frac{e}{2\hbar}\sum_{nk} f_n(k)\nabla_k^{\mu}\chi_{\beta\alpha}^{nk}(\omega). \tag{1}$$

Here μ, α, and β - projections on the x, y, and z axes, e and h - electron charge and Planck's constant, $f_n(\vec{k})$ - the Fermi function normalized to the total number of electrons, n and $\hbar$k - number of the band and the quasimomentum, $\chi_{\beta\alpha}^{nk}(\omega)$ - linear susceptibility of the Bloch electron in the state $|n\vec{k}\rangle = u_{nk}\exp(i\vec{k}\vec{r})$ with energy $\epsilon_n(\vec{k})$, and ω - frequency.

The nonlinear mechanism leading to the aforementioned tensor is the combined motion of the electron, namely the interband-intraband motion [1]. Since $f_n(\vec{k})$ is even, the tensor (1) vanishes when $\alpha = \beta$ as $\vec{k} \rightarrow -\vec{k}$, regardless of the crystal symmetry type.

We consider further the particular case of a wave propagating along the z axis, with $E_x = E_0 \cos \omega_t$ and $E_y = E_0 \cos (\omega t + \varphi)$, where E_0 is the field amplitude and φ the phase shift. For concreteness we assume that the semiconductor has one partly-filled conduction band (c-band) and the remaining valence bands are completely filled (v-bands). Then the contribution to the valence bands is additive, and we can confine ourselves to calculation of the maximum contribution, putting $\omega \sim \omega_g$ and $\omega \ll \omega_g'$, where ω_g and ω_g' are respectively the energy gaps between the c-band and the band under consideration, and between the c-band and the discarded valence bands. Replacing the summation over k by integration with the distribution function for a strongly degenerate semiconductor, we obtain for the photocurrent density

$$j_\mu = \frac{ie^3 n_0 \sin\phi\, E_0^2}{4\hbar^2}\left(\frac{\partial M_{xy}}{\partial k_\mu}\right)\left[\frac{\omega_g - \omega + \Delta(k_F)}{(\omega_g - \omega + \Delta(k_F))^2+\gamma^2} - \frac{\omega_g + \omega + \Delta(k_F)}{(\omega_g + \omega + \Delta(k_F))^2+\gamma^2}\right], \tag{2}$$

where n_0 is the electron density, γ is the phenomenologically introduced damping constant, k_F is the quasimomentum corresponding to the band-filling limit, and the derivative of the quantity

$$M_{xy}(\mathbf{k}) = \Omega^x_{cv}(\mathbf{k})\,\Omega^y_{vc}(\mathbf{k}) - \Omega^y_{cv}(\mathbf{k})\,\Omega^x_{vc}(\mathbf{k})$$

is taken at $k = 0$ and $\Delta(k_F) = (\hbar/2m^*_{cv})k_F^2$. It is seen from (2) that j_μ is proportional to $\sin \varphi$, i.e., the photocurrent depends strongly on the relative phase shifts between the electric field components. $j_\mu \to 0$ when $\omega \ll \omega_g$ and j_μ increases with increasing ω and decreases like $1/\omega$ when $\omega \gg \omega_g$. The maximum value of j_μ is determined also by the quantity $\Delta(k_F)$, which is connected with the finite width of the filled section of the c-band. The indicated features of the phenomenon make it possible to observe it experimentally. Let us estimate the effect, using the parameters of GaAs, namely $\omega_g = 2.1 \times 10^{15}$ rad/sec ($\hbar\omega_g = 1.37$ eV) and $n_0 = 5 \times 10^{17}$ cm^{-3}. At a frequency $\omega = 1.8 \times 10^{15}$ rad/sec ($\hbar\omega = 1.17$ eV, neodymium laser), the shift $\Delta(k_F)$ and the broadening γ can be neglected even at room temperature, and as a result we have

$$j_z \approx 3 \times 10^6 E_0^2 \text{ g}^{-1/2}\text{-cm}^{1/2} \tag{3}$$

In (3), E_0 is a dimensional unit in the cgs esu system. In the practical unit system we get $j_z \sim 1$ A/cm^2 at $E_0 \sim 10^4$ V/cm. It is convenient to introduce $E_z^{eff} = j_z/\sigma_0$, where σ_0 is the static conductivity. Then the potential difference between the faces of a single crystal of length l along the z axis is $U = E_z^{eff} l$. When $l = 0.1$ cm and $\sigma_0 \sim 10^2$ ohm^{-1}cm^{-1} we get $U \sim 10^{-3}$ V, i.e., a readily observable quantity. For a semiconductor with a narrow forbidden band, such as InSb, a suitable source may be a CO_2 laser ($\lambda = 10.6$ μ). Application of a magnetic field $\vec{H}$ leads to new singularities of the photocurrent. In particular, photocurrent directions $\mu \neq z$ become possible even for cubic crystals. We note here that for the z-component we have $j_z' = (j_z/n_0)Z(\zeta)$, where $\zeta = \epsilon_F/\hbar\omega_c$, $\omega_c = eH/mc$ is the cyclotron frequency, m is the effective mass in the conduction band, and ϵ_F is the Fermi level reckoned from the bottom of the band. $Z(\zeta)$ is the number of states per unit volume having an energy lower than ϵ_F and, as is well known, oscillates as a function of H^{-1}. Thus, photocurrent oscillations take place in a magnetic field.

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* The matrix elements $\Omega_{cv}(\vec{k})$ are defined, for example, in [1]. We are considering crystals with $\Omega_{cc}(\vec{k}) = 0$.

METHOD FOR DIRECT OBSERVATION OF THE GIANT MAGNETIC FIELDS PRODUCED AT A NUCLEUS BY A HOLE IN THE K SHELL

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The probability that a nucleus will emit a particle or a quantum in a certain direction depends, in the general case, as is well known, on the angle between this direction and the nuclear spin I ($I \geq 1$). For this reason, in the case of a nuclear decay sequence $A^a \to B^b \to C$ the spins I_B of the intermediate nuclei B are not isotropically distributed in space relative to the preferred direction of the registration of particle a. The anisotropy of the orientation of the spins I_B causes in turn the probability W of coincidence of the registration of two particles a and b by two counters C_a and C_b to depend on the angle θ_{ab} between the emission directions:

$$W(\theta_{ab}) = \sum_{l=0}^{l_{max}} a_l \cos^{2l}\theta_{ab},$$

where I_{max} is double the value of the smallest of the three quantities I_a, I_b (the angular momenta carried by the particles a and b), and I_B.

This correlation between the directions of a and b is upset (perturbation of the angular correlations) when a noticeable precession of the magnetic (or quadrupole) moment of the intermediate nucleus B can be produced during its lifetime τ_B in the magnetic (or inhomogeneous electric) fields by the molecular or crystalline environment of the nucleus. In the presence of such a precession, the nucleus B will "forget", by the instant of the emission of b, the direction of I_B at the instant of emission of a and formation of B. The sensitivity of experiments aimed at the observation of the perturbed angular correlations ensures the possibility of investigating on their basis local magnetic (H_N) and electric (q_N) fields at the nuclei if $\omega_B\tau_B \gtrsim 0.01$ (ω_B - precession frequency of I_B), corresponding to $\tau_B \gtrsim 10^{-11}$ sec for the customary values $H_N \approx 10^5$ Oe and $q_N \approx 10^{18}$ V/cm^2 (see [1], Part II, Sec. 8).

The cited values of the local magnetic fields at the nuclei are much lower than the maximum possible ones that are realizable in the presence of a hole in the K shell.