It should be noted that an experimental investigation of the flux of radioactive isotopes will yield new information on the parameters of the region where cosmic rays are generated on the sun (such as n_H and l). The half-life of the nuclei in question is sufficiently large (53.6 and 77.3 days for beryllium and cobalt, respectively) to permit their observation on their earth orbit.

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POSSIBILITY OF OBSERVING A NEW TYPE OF PHOTOCONDUCTIVITY INDUCED BY THE ACTION OF STRONG LIGHT ON CARRIERS

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Submitted 22 August 1967
ZhETF Pis'ma 6, No. 8, 834-836 (15 October 1967)

Nonlinear optical effects connected with semiconductor carriers have been recently predicted [1-3]. Wolff and Pearson [1] calculated the harmonic generation resulting from the nonlinear dependence of the electron velocity v on the quasimomentum p in a nonparabolic (np) band $H_0(p)$. Patel, Slusher, and Fleury observed this effect [4].

We wish to call attention to the fact that the nonlinear dependence of v on p leads to the appearance of a new photoeffect. If a sample carrying a direct current $j_0 = \sigma E_c$ is exposed to light, then an additional direct current $J_{np} \sim E_0^2 E_c$ is induced in it (E_c is the constant field and $E_0 \cos \omega t$ is the electric vector of the light). The current J_{np} can be calculated by the density-matrix method. We present a solution of the equation for the statistical operator $\hat{\rho}$ of an electron in an electric field of arbitrary magnitude and for an arbitrary dispersion law $H_0(p)$:

$$\hat{\rho} = \exp[-H_0(\hat{p} - \Delta p)/kT], \quad \Delta p = \int_{t_0 \to -\infty}^{t} dt' F(t'). \tag{1}$$

Here F(t) is the force acting on the electron and Δp is the increment of momentum acquired by the electron from the instant t_0 when the field is turned on.

We consider a case when the deviation of the dispersion from parabolic is described by Kane's model [1] and take into account the term $-p^4/4m^2 eg$ in the expansion of $H_0(p)$ (m is the electron effective mass and E_g is the width of the forbidden band). We calculate the current $J_c = ne\mathrm{Sp}\hat{v}_c\hat{\rho}/\mathrm{Sp}\hat{\rho}$, including only terms that describe the effect of interest to us:

$$J_{np} = -\frac{e^2 E_0^2}{2\omega^2 m E_g}(1 + 2\cos^2\theta) J_0. \tag{2}$$

θ is the angle between the vectors of the constant and alternating fields. The increase of the momentum under the influence of the force eE_c is limited here by the momentum relaxation time. If we focus the radiation of a Q-switched CO_2 laser, we can obtain an appreciable photocurrent J_{np}. For $m = 0.01m_0$, $E_g = 0.23$ eV, $\lambda = 10\ \mu$, and $E_0 = 10^5$ V/cm we obtain $J_{np} = -0.3J_0$ ($\theta = 0$).

This effect can be separated from the photoconductivity connected with electron "heating." The increment of the average electron energy in the field of the wave is determined by the mechanisms of light absorption by the electron and subsequent transfer of energy to the lattice. If both processes occur as a result of an interaction between the electron and optical vibrations, then we obtain from the energy-balance equation the rough estimate $\Delta\epsilon \sim e^2E_0^2/m\omega^2$. Since τ_p depends on the electron energy, we get an additional dependence of the current J_{np} on the light intensity. This dependence can be neglected if $\Delta\epsilon < \epsilon_0$ (ϵ_0 is the Fermi energy or $3kT/2$). In the foregoing numerical example, this inequality is satisfied for the degenerate case when $\Delta\epsilon \sim 0.2$ eV if $E_0 \lesssim 10^5$ V/cm and for $\Delta\epsilon \sim 0.02$ eV if $E_0 \lesssim 10^4$ V/cm. The mobility $e\tau_p/m$ depends on the electron energy via the relaxation time and the mass. Owing to the dependence of τ_p on $\Delta\epsilon$, a photocurrent proportional to $\Delta\epsilon/\epsilon_0$ is produced, and the dependence of m on $\Delta\epsilon$ leads to a photocurrent proportional to $\Delta\epsilon/E_g$ (in (1) T is the temperature of electron-gas "heating"). The energy increment $\Delta\epsilon$ does not depend on θ, since the electrons are heated only by the light (the field E_c is weak). Therefore, the photocurrent due to "heating" drops out of the difference between the photocurrents at $\theta = 0$ and $\theta = \pi/2$. We note that in principle, another method of eliminating the "heating" effect is possible, namely the use of very short light pulses of duration shorter than the electron heating time.

Owing to the nonlinear dependence of the hole velocity on the momentum [3], an effect similar to that considered above should be observed in p-type germanium and silicon.

I am grateful to E. I. Rashba and V. I. Mel'nikov for useful remarks.

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CONTRIBUTION TO THE THEORY OF THE INTERMEDIATE STATE OF CURRENT-CARRYING SUPERCONDUCTORS

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Submitted 24 August 1967
ZhETF Pis'ma 6, No. 8, 836-841 (15 October 1967)

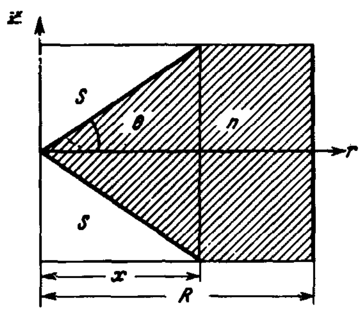

Fig. 1

As shown by London [1], a periodic structure (intermediate state) is produced in a superconductor under the influence of an electric current exceeding the critical value $J_{c0} = cH_cR/2$ (H_c is the critical magnetic field and R is the radius of the sample); one period of this structure is shown in Fig. 1. The macroscopic description used in [1], corresponding to the condition $\theta \to 0$, makes it possible to calculate the resistance of the sample, but not the angle θ. The accuracy of the macroscopic description is thus left undetermined. In this paper we cal-