connected with an interaction between the magnetic field of the transport current and the magnetic flux lines of the external field (for example, on one side of the wire, where the field of the current is directed opposite the external field, a process similar to "annihilation instability" takes place [9]).

Work is now continuing and its detailed results will be published later.

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CONCERNING ONE POSSIBLE MECHANISM OF INSTABILITY OF AN ELECTRON PLASMA IN A CRYSTAL

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It has been pointed out in [1] that cyclotron resonance in crystals can be used for frequency conversion in the microwave band. The method proposed for such a conversion is based on the anharmonicity of motion of the carriers (electrons and holes) in the crystal under the influence of a high-frequency electric field, due to deviation of the dispersion - the dependence of the energy on the quasimomentum - from quadratic for these carriers. A similar idea was advanced later by Lax [2], who noted that in the quantum interpretation the frequency conversion mechanism at resonance is connected with the unequal spacing of the Landau levels for particles with nonquadratic dispersion.

In both cited papers, the crystal was regarded as a passive nonlinear ac frequency converter. Yet a crystal with nonquadratic dispersion of the quasiparticles can possess the properties of an active element that transforms dc energy into microwave frequencies.

Indeed, a charged particle with nonquadratic dispersion behaves in a magnetic field like a non-isochronous oscillator whose frequency depends on its total energy. According to [3], an aggregate of such excited oscillators is characterized by a phase instability which leads, under certain conditions, to phase bunching of the oscillators and to induced emission of electromagnetic waves at the cyclotron frequency and its harmonics. The initial oscillations of such oscillators may be incoherent and may become excited under the influence of constant electric and magnetic fields.

The necessary condition for the occurrence of an instability of this type at a frequency ω in a semiconductor plasma with nonquadratic particle dispersion law is a sufficiently long momentum-relaxation time $\tau \gg 1/\omega$ for these particles. Since $\tau \lesssim 10^{-11}$ sec for pure semiconductors at sufficiently low temperatures, this instability can come into play only in the submillimeter or infrared bands.

The most suitable for an experimental study of this effect are semiconductor $A_{III}B_V$ compounds, for example InSb, where the conduction band has a deep energy minimum at $k \simeq 0$, with spherical equal-energy surfaces and nonparabolic dependence of the energy on the quasimomentum k. In n-InSb with minimum impurity content ($\lesssim 10^{14}$ cm^{-3}) the electron relaxation time is maximal at a temperature $T \simeq 60 - 80$°K and amounts to about 5×10^{-12} sec. According to estimates, the growth increment of the high-frequency oscillations in the absence of collisions is approximately $\gamma' \simeq (0.01 - 0.05)\omega$, and when collisions are taken into account $\gamma = \gamma' - 1/\tau$. Therefore in InSb the instability can appear at frequencies $\omega \gtrsim 2\pi \times 10^{12}$ cps. For an electron effective mass $m^* \simeq 0.015m_0$, the value of the magnetic field corresponding to cyclotron resonance at these frequencies is $B \gtrsim 5$ kG.

It is best to carry out the experiment in a semiconductor crystal in the form of a quasi-optical resonator, similar to that used in solid-state lasers. By applying to the cooled crystal resonator a constant electric field of intensity $10^2 - 10^3$ V/cm and placing the resonator in a constant magnetic field with direction normal to the plane in which the high-frequency electric field at the chosen resonator mode is maximal, we can expect induced emission to occur at the cyclotron frequency and its harmonic.

The upper limit of the radiated power can be estimated by assuming that the radiation energy does not exceed the energy of the oscillator motion of the particles. In the case of motion of a particle with charge e in crossed electric and magnetic fields E and B, the latter is of the order of

$$W_0 \simeq \frac{m^*E^2}{B^2} = \frac{e^2E^2}{\omega_H^2 m^*},$$

where ω_H is the gyro frequency of the electron. For $\omega_H > 2\pi \times 10^{2}$ cps, $E < 10^2$ V/cm, and $m^* \gtrsim 0.01m_0$, we have $W_0 \lesssim 10^{-23}$ J, which is lower than the energy at which intense scattering of electrons by optical phonons begins. By limiting the maximum particle density N to satisfy the requirement that the plasma frequency be low compared with the radiation frequency $\omega \simeq \omega_H$ ($N \lesssim N_{max} = \omega_H^2 m^*\epsilon/e^2$), we obtain for the energy of oscillator motion of the particles per unit volume an estimated upper limit

$$W = W_0 N \lesssim W_{max} = \epsilon E^2,$$

where ϵ is the dielectric constant of the medium. The per-unit radiation power, apart from a numerical factor of the order of unity, is equal to

$$P_{\sim} \simeq \frac{1}{\pi} \gamma W \lesssim 10^{-2} \omega \epsilon E^2.$$

A direct current of density I = evN flows in this case through the crystal, and the dissipated per-unit power is P_0 = IE. If $\omega\tau \gg 1$, then the particle velocity coincides in order of magnitude with the drift velocity $v \simeq E/B$ of a free particle in crossed fields, so that

$$P_0 \lesssim \frac{e N_{max} E^2}{B} = \omega \epsilon E^2; \qquad \frac{P_{\sim}}{P_0} \lesssim \gamma/\pi.$$

For E = 10^2 V/cm, $\epsilon = 10\epsilon_0$ (ϵ_0 is the dielectric constant of vacuum), and $\omega = 2\pi \times 10^{12}$ we obtain

$$P_0 \lesssim 10^4 \text{ W/cm}^3, \qquad P_{\sim} \lesssim 10^2 \text{ W/cm}^3.$$

The foregoing estimates allow us to assume that the mechanism considered for the instability of an electron plasma in a crystal can be used to develop sources of coherent radiation in the submillimeter and infrared bands.

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TUNABLE PARAMETRIC LIGHT GENERATOR WITH KDP CRYSTAL

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We present in this communication the results of an experimental investigation that has led to the construction of a continuously tunable parametric generator of coherent light waves in the region of $\lambda \simeq 1\ \mu$, using a KDP crystal. Continuous tuning of the wavelength was effected mechanically in a band from 9575 to 11,775 Å, and the oscillation power reached several kilowatts.

Effective parametric action of light waves (the feasibility of which was theoretically discussed back in 1962 [1-3]) were first observed in 1965 in ADP [4,7], KDP [5,11], and $LiNbO_3$ crystals [6]. In the last two references the reported gain was sufficient to actuate parametric light generators. The generator described in [6] made use of an $LiNbO_3$ crystal and the tuning was by varying the crystal temperature. With an aim at broadening the frequency band