from this system to the laboratory system

$$E = (\omega_1 + z_1 k_1) E_0 / \sqrt{s_1}, \quad \omega_1 = \frac{s_1 + m_\pi^2 - m_\Delta^2}{2\sqrt{s_1}}, \quad k_1 = \sqrt{\omega_1^2 + m_\pi^2}$$

leads to the aforementioned "self-similarity"

$$\epsilon = \frac{\omega_1}{\sqrt{s_1}} + \frac{k_1 z_1}{\sqrt{s_1}}$$

and to the distribution (6).

The π^- spectra obtained with the aid of the "exact" formulas (1) - (4) (for $\theta_1 = 0$) and with the aid of the approximate formulas (5) - (7) are shown by the solid and dashed lines in Fig. 2, respectively, where $\gamma = 0$ and $\lambda = 0.01$, following averaging of (4) and (6) over m_2^2 with a weight function $\Phi = \Phi_2(m_2)$ with a = 1. They are very close to each other and agree well with the experimental data [1].

The spectra of K^{-1} and $\bar{p}$ are similarly plotted on Fig. 2. In both cases, good agreement with experiment is obtained at $\gamma = 0.5 - 0.2$ with $\lambda = 0$ and with a large coefficient a in $\Phi_2(m_2)$. As seen from Fig. 2, the spectra shift regularly with increasing θ_1.

Besides Fig. 1a, contributions are made by the diagrams of Fig. 1d and Fig. 1e with several "jets" of particles. Allowance for these contributions leads to a steeper decrease of the spectra (since these diagrams enrich their parts), and possibly does not disturb the agreement with experiment, producing only a small change in the parameters, viz., an increse of λ in the case of π and a decrease of γ in the cases of K^- and $\bar{p}$.

Vertices of type (2) play an important role in high-energy physics - their variation and magnitudes determine, particularly, the contribution [3] of branch cuts to the total interaction cross sections.

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GYROTHERMAL EFFECT IN CRYSTALS AT LOW TEMPERATURES

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The purpose of this paper is to call attention to a new effect, namely that a crystal can rotate under the influence of a temperature gradient. For example, if a potential difference is produced on the ends of a long rod with thermally insulated lateral surface, then the rod will acquire an angular momentum M directed along its axis and proportional to the resultant heat flux q

$$M = \beta q .$$

We call the quantity M the gyrothermal coefficient of the rod.

As shown in [1, 2], the phonon gas that transfers the heat along the long rod rotates at low temperatures, i.e., its stream lines form helices that wind around the rod axis. The rotation of the phonons in an ideal crystal does not lead to rotation of the body as a whole. This is seen, for example, from the fact that in a crystal in which heat flows the tensor of the momentum flux density is symmetrical [1]. As indicated in [3], at low temperatures defects and impurities in quantum crystals must be regarded as quasiparticles. If their atomic concentration is small, then they have little influence on the phonon motion and are dragged by the phonons, acquiring a drift velocity

$$v_i = v_p \left(1 + \frac{\tau_{ip}}{\tau_{ib}}\right)^{-1},$$

where v_p is the phonon drift velocity, and τ_{ip} and τ_{ib} are the relaxation times of the impurities on the phonons and on the boundaries. (For concreteness, we shall speak of impurities, although the entire reasoning holds also for defects.) The rotating phonons impart to the impurities an angular momentum of the order of $m_i v_i d$ per impurity atom, where m_i is the impurity mass and d is the transverse dimension of the rod. According to the angular momentum conservation law, the crystal lattice acquires an equal and opposite momentum. The corresponding angular velocity is of the order of cv_i/d, where c is the ratio of the total mass of the impurities to the mass of the entire rod. At sufficiently high temperature gradients v_i can approach the speed of sound. Therefore, in spite of the necessary smallness of c, the effect may be large (much larger than the Einstein -- de Haas effect). The foregoing estimates pertained to the case of very low temperatures, when the uncertainty in the impurity energy $h\tau_{ip}^{-1}$ is small compared with the width of the impurity band. At higher temperatures, when the opposite inequality holds, the wave function of the impurity does not have time to spread out over the band and is localized [3]. The dragging of the impurities by the phonons is then greatly reduced. Further increase of the temperature makes the over-the-barrier transitions appreciable, so that the diffusion coefficient increases like $\exp(-u/T)$, where u is the height of the barrier. The effect of rotation in this region also increases. The angular velocity has an order of magnitude $cv_p d^{-1} \exp(-u/T)$, since only over-the-barrier particles are dragged. Nonetheless, the effect can be observed also in this region. Symmetry considerations impose certain limitations on the feasibility of relation (1). Since M and q transform under rotations like components of a pseudovector and a vector, respectively, the coefficient β vanishes if there is in the crystal a symmetry plane perpendicular to the rod axis, or if a symmetry plane passes through the axis of the rod and is at the same time a symmetry plane of its cross section, or finally if the crystal has a symmetry center and the section also has a central symmetry.

The investigations [1, 2] pertained to the hydrodynamic regime of heat conduction, i.e., to the temperature range in which the phonon mean free path relative to normal collisions ℓ_N compared with d, and Umklapp processes can be neglected. The cause of the rotation is the nonlocal connection between the heat flux and the temperature gradient. The nonlocality, of course, takes place in the collisionless regime, when $\ell_N >> d$. Thus, the rotation remains at arbitrarily low temperatures. In solid helium samples of the usual size, rotation should exist at $T < 1^{\circ}K$. Unfortunately, we cannot predict accurately the magnitude of the rotation torque, since the degree of localization of the impurities at these temperatures is not known. Measurements of the gyrothermal effect can cast light on this question.

In conclusion we note that, besides the above-described gyrothermal effect, there exists a gyroelectric effect, whereby the flow of electric current through a single-crystal metallic rod in the collisionless or hydrodynamic regime [2, 4] imparts a torque to the rod. Like the phonons, the electron gas rotates as it moves along the rod, and as a result of the conservation of the angular momentum the crystal lattice rotates in the opposite direction. It is probably more convenient to register this effect not by determining the rotation of the rod, but by determining the magnetic field directed along the axis of the rod and produced by the rotating electrons. This field may be appreciable, since a long rod is equivalent to a solenoid with a large number of turns.

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POSSIBILITY OF SUPPRESSING FLUTE INSTABILITY OF A DENSE PLASMA

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Experiments with a rarefied plasma using the "Ogra-2" and "Phoenix" apparatus [1, 2] have confirmed the possibility, predicted in [3, 4], of suppressing flute instability in a plasma with the aid of a feedback system controling the field of the perturbation outside the plasma. At the same time, experiments with "Phoenix" have shown that, owing to the dependence of the transfer function δ (see below) of a real high-frequency circuit on the frequency, oscillations may build up (at sufficiently large δ) at frequencies determined not by the plasma but by the high-frequency system. The plasma instability proper can then be suppressed. This possibility was not taken into account in the elementary theory [4]. The value of δ required for stabilization by the method of [1, 4] increases with plasma density. Therefore, when the system of [1, 4] is used to stabilize a dense plasma, the difficulty caused by the appearance of an additional unstable solution becomes aggravated. It will be shown below that oscillations of a dense plasma can be suppressed without exciting the system at the "extraneous" frequencies, if one "measures" not the perturbation of the electric potential, but the perturbation of the electron (or ion) density. The transfer function of the equivalent circuit responding to perturbation of the potential should depend on the frequency like ω^{-1}.

Let us examine the stability of a cylinder of collisionless plasma of radius a and