(Figs. 1 and 2). Application of an external electric field shifts the sphere by $e\vec{E}\tau(\omega)$, so that a fraction of the electrons (on the right hemisphere) falls into the region of more effective interaction with the phonons, compared with the electrons on the left hemisphere, and the electrons lose practically all their momentum and energy as a result of phonon emission. This gives rise to a directed flux of electrons along the field, with a larger momentum $p \sim \sqrt{m\omega}$, which in turn gives rise to the negative current $\vec{j}_-$ (see (9)).

4. Our analysis is valid in electric fields satisfying the inequality $eE\ (\omega) \sqrt{\omega/m} \ll \omega - \omega_0$. For sufficiently large fields this condition does not hold, so that the solution of the problem calls for a separate analysis in this case. However, recognizing that the electric field causes a broadening of the electron distribution by $eE\tau(\omega) \sqrt{\omega/m}$, the results obtained above remain qualitatively valid if we replace in them $\omega - \omega_0$ by $eE\tau(\omega) \sqrt{\omega/m}$.

5. We note that the assumptions that the electron dispersion is quadratic, and that the matrix element of the electron-phonon interaction is independent of the quasimomentum, are not important and have been made only to simplify the derivation. The effect of negative conductivity is due only to the strongly unbalanced distribution of the electron energies and to the threshold character of the interaction between the electrons and the phonons, so that analogous phenomena can take place also in elastic collisions between electrons and atoms in gases.

The authors are deeply grateful to A. M. Afanas'ev for continuous help, and to N. G. Basov, Yu. A. Bykovskii, V. M. Galitskii, and Yu. M. Kagan for an evaluation of the work.

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EXPERIMENTAL OBSERVATION OF FOURTH SOUND IN He^3-He^4 SOLUTIONS

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ZhETF Pis'ma 3, No. 1, 32-35, 1 January 1966

It has been shown theoretically [1-2] and experimentally [3-4] that liquid He^4 can support fourth sound - a special type of wave propagating only through the superfluid component, while the normal component remains immobile. Fourth sound is realized in narrow channels with characteristic transverse dimensions much smaller than the depth of penetration of the viscous wave, $d \ll (2\eta_n/\omega\rho_n)^{1/2}$, where ρ_n and η_n are the density and viscosity of the normal component, respectively, and ω is the oscillation frequency.

The question of existence of waves of this type in He^3-He^4 solutions was recently considered theoretically [5]. It follows from that paper that fourth sound should be observable also in solutions of helium isotopes, but in this case the speed of the fourth sound depends also on the concentration of the solution.

The present investigation was undertaken to check experimentally on the existence of fourth sound in a He^3-He^4 solution.

The main part of the apparatus was a cylindrical resonator, 20 mm in diameter and 10 mm long, filled with a filter of pressed rouge (Fe_2O_3). The powder particles were ~0.5 μ in size, they were compressed at 40 kg/cm^2, and the filter porosity was ~60%. The sound transmitter and receiver were identical capacitor devices placed on opposite sides of the filter. One electrode of each capacitor was of bulky copper, and the other was an aluminum film 4 μ thick deposited on a "lavsan" film 10 μ thick, which served as the dielectric. The resonator was placed in a special vessel, in which the investigated solution was condensed. The vessel was placed in a bath of He^4, the temperature of which was lowered by pumping on helium vapor.

Pulses from a blocking generator, with a rise time 0.1 μsec, repetition frequency 200 cps, duration 2 μsec, and amplitude 400 V were fed from a blocking generator to the transmitter, which was located in the lower part of the filter. The received pulses were amplified and fed to a time-interval meter. The speed of the fourth sound could be determined from the measured time interval necessary for the pulse to traverse the length of the filter. The pulses were quite sharp and usually 6 - 8 reflections were observed.

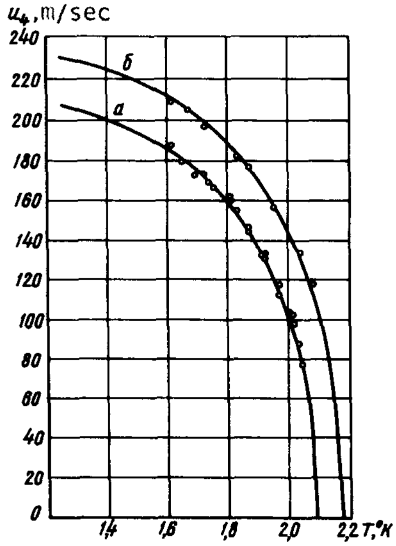
The task of obtaining exact absolute values of the speed of fourth sound is made complicated by the multiple scattering of the sound by the filter particles. It is customary therefore to introduce an empirical correction to take account of this effect. Formulas for the calculation of the correction, based on different scattering theories, are given in [4]. For the filter used by us the correction for multiple scattering turned out to be $n = u_4/u_4' = 1.185$, where u_4 and u_4' are the true and measured speeds of fourth sound.

The procedure described yielded data on the temperature dependence of the fourth sound in pure He^4 (curve b of the figure); these were in sufficiently good agreement with the experimental results [4] and with the theoretical calculations [1-2].

Measurements of the speed of fourth sound in an He^3-He^4 solution with 6.3% He^3 concentration were made with the same filter, the same correction being used for the data reduction.

The results for a solution with the indicated concentration are shown in the figure (curve a), where the solid line corresponds to the calculated values 1) obtained from the formula [5]

$$u_4^2 = \rho_s/\rho\ \left(1 + 2\,\frac{c}{\rho}\,\frac{\partial\rho}{\partial c}\right)\ u_1^2 + (\rho_n/\rho)\ u_2^2 \ ,$$



Speed of fourth sound (u_4) vs. temperature (T): a - in He^3-He^4 solution with 6.3% He^3 concentration; b - in pure He^4. The continuous curves correspond to the theoretically obtained relations [1,2,5].

which is valid for small concentrations and not too low temperatures. Here ρ is the density of the solution, ρ_s the density of the superfluid component, c the He^3 concentration, and u_1 and u_2 the speeds of the first and second sounds in the solution, respectively. The error in the determination of the velocity does not exceed 2%.

It follows from the figure that the experimental results for helium-isotope solutions are in fully satisfactory agreement with the theory [5]. Tentative measurements of the absorption coefficient indicate that it increases rapidly with temperature. This makes measurements near the λ point difficult.

Work is now continuing in broader temperature and concentration intervals, with an aim at obtaining information on the behavior of the He^3 and He^4 atoms in narrow channels.

The authors thank D. S. Sanikidze for a useful discussion connected with the organization of the present work.

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AUTOINIZATION OF FAST LITHIUM-LIKE NITROGEN AND OXYGEN IONS AFTER PASSAGE THROUGH A SOLID

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ZhETF Pis'ma 3, No. 1, 35-40, 1 January 1966

Passage of fast atomic ion-beam particles through matter should give rise to excited ions with an increased probability of electron loss by collision with the atoms of the medium. In addition, electrons may leave the excited particles spontaneously [1] (Auger effect). The experiments described below were set up to observe the increased probability of electron loss by fast ions passing through a medium.