Control experiments with molecular crystals and polymers whose molecules contain no closed electron delocalization loops or have additional intramolecular degrees of freedom (paradichlorobenzene, hexamethylbenzene, oxyacetate of beryllium, paraffin, polyethylene, etc.) disclosed full reversibility of the transition of the NMR signal through a weak field.

The observed irreversibility of the transition of the NMR signal through a weak field indicates that in fields $H \gg H_{loc}$ (H_{loc} = local magnetic fields) the condition $T_2 \ll T_1$ is not sufficient for the existence of a spin temperature in fields with $H < H_{loc}$.

The effect observed by us can be qualitatively treated as an indication that in our samples of naphthalene, biphenyl, and anthracene energy is effectively pumped out from the nuclear-spin system into the lattice when $H < H_{loc}$. A theoretical and experimental study of this effect is being continued.

We are grateful to A. I. Kitaigorodskii for continuous interest, A. P. Amiton, B. A. Kvasov, N. O. Okulevich, and N. I. Okhlobystin for help with the measurements, and to R. M. Myasnikov and L. A. Fedorov for supplying the samples.

[1] R. V. Pound, Phys. Rev. 81, 156 (1951).
[2] E. M. Purcell and R. V. Pound, ibid. 81, 279 (1951).
[3] A. Abragam, The Principles of Nuclear Magnetism, Oxford, 1961.

EXCITATION OF STANDING SOUND WAVES IN Bi BY AN ELECTROMAGNETIC METHOD

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We report here the results of preliminary experiments in which we observed excitation of sound in Bi by an electromagnetic wave incident on its surface.

The Bi sample constituted single crystals in the form of discs (18 mm dia, thickness d ~ 1 mm). They were placed inside an inductance coil, with which they were cooled to helium temperatures, at which the electron mean free path in the samples reached 0.5 mm. The coil together with the sample served as the inductance of the tank circuit of an rf oscillator placed on the upper cover of the Dewar. In addition to the coil and a fixed capacitor, the circuit included a blocked semiconductor diode. The dependence of the barrier capacitance of its p-n junction on the blocking voltage made it possible to vary smoothly the oscillation frequency, and also to modulate it sinusoidally at a frequency φ = 19 Hz. The oscillator output was detected and fed to a narrow-band amplifier with synchronous detector, tuned to double the modulation frequency 2φ. As a result, the output signal was proportional to $\partial^2R/\partial f^2$ (R = real part of Bi sample surface impedance). The dependence of $\partial^2R/\partial f^2$ on f was investigated in the interval 1 - 10 MHz. The skin depth at these frequencies was of the order of 10^{-3} cm.

In magnetic fields on the order of 10 - 100 Oe and parallel to the coil axis, a group of equidistant peaks appeared on the $\partial^2R/\partial f^2$ curves, separated by frequency intervals larger by one order of magnitude than the width of each individual group. The magnitude and direction of the magnetic field affected only the amplitudes of the peaks, the positions of which remained unchanged. Figure 1 shows a sample of one of the line groups, and Fig. 2 shows schematically the arrangement of such groups on the frequency scale, for the same sample.

Using the values of the speed of sound in Bi at low temperatures [1], it would be easy to show that the peak position is determined by the condition for the occurrence of standing sound waves in the sample. The dashed lines in Fig. 2 denote the natural frequencies of the sample, calculated from the formula $\nu = mS/2d$ (S = speed of sound propagating along the C_3 axis, longitudinal (S''_l) or transverse (S_{sh}); m = 1, 3, 5 ...). A similar picture is obtained for samples of other thickness. A decrease of 1.5% of the sample thickness (by etching) produced a corresponding frequency shift of the lines. The shaded column in Fig. 2 shows the position of group 7_l prior to etching. The fine structure of the lines is apparently due to the presence of a set of modes connected with lateral surfaces of the plate. These individual resonances can be resolved. The width of the individual line is determined by the Q of the acoustic resonator. Special experiments have shown that this Q is of the order of 10^4 for a freely supported sample.

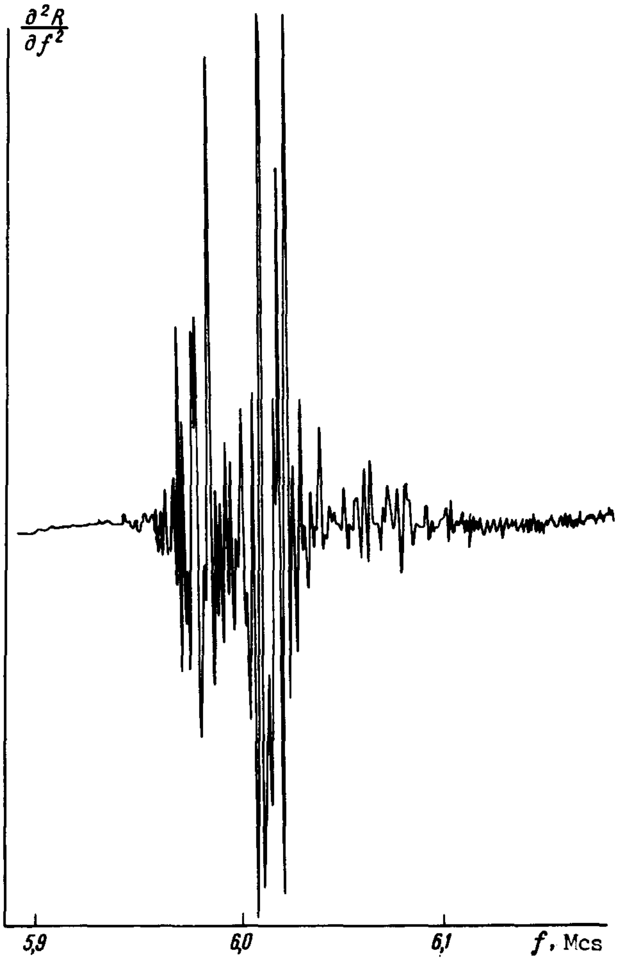

Fig. 1. Variation of surface impedance upon excitation of standing sound waves. d = 1.18 mm, T = 2°K.

The line intensity increases with increasing magnetic field. At $H \sim 150$ Oe the sound oscillations became so intense, that the Bi plate locked-in on the oscillator frequency, in analogy with the behavior of quartz-stabilized oscillators.

It could be assumed that the occurrence of sound oscillations is due to a periodic pressure force $F = \underset{\sim}{j} \times \underset{\sim}{H}/c$ acting on the surface of the metal (j = skin current, H = constant magnetic field), and to the specific low damping of the sound. A similar phenomenon was already observed in [2]. This assumption, however, is not easily reconciled with the following experimental facts:

1. The sound is excited only at low temperatures, and a lowering of the temperature

from 4.2 to 2°K increases the intensity of the effect by nearly 5 times. Such a dependence can obviously not be attributed to changes in the damping of sound with change in temperature [3].

2. We were unable to excite in similar fashion sound oscillations in an indium plate (d = 0.3 mm) in either the normal or superconducting state, although in the latter case there was no electronic sound attenuation at all.

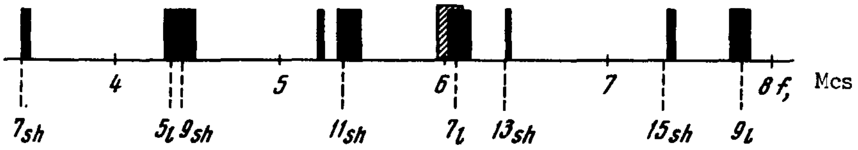

Fig. 2

This gives grounds for suspecting that the observed excitation of sound in Bi is due to some specific mechanism. The mechanism whereby sound is excited when direct current flows through Bi is known [4]. It is possible that a similar mechanism - emission of sound as a result of large electron drift velocity - exists also in the anomalous skin effect. Estimates show that the average skin-current density in our experiments reached 1000 A/cm^2, leading to an average drift velocity $\bar{v} = i/ne$ on the order of 10^5 cm/sec. Further experiments are needed to clarify the sound-excitation mechanism.

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[1] Y. Eckstein, A. W. Lawson, and R. H. Reneker, J. Appl. Phys. **31**, 1534 (1960).
[2] S. I. Aksenov, B. A. Vikin, and K. V. Vladimirskii, JETP 28, 762 (1955), Soviet Phys. JETP **1**, 609 (1955).
[3] D. H. Reneker, Phys. Rev. **115**, 303 (1959).
[4] L. Esaki, Phys. Rev. Lett. **8**, 4 (1962).

FERROELECTRIC EFFECT IN A LASER BEAM

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A powerful laser beam produces by electrostriction a strong deformation in a crystal. This results in an electric field that is constant in time. In piezoelectrics the field is due to the piezoelectric effect and can be comparable in magnitude with the amplitude of the electric field of the light beam. In this case, breakdown phenomena and destruction of the