OSCILLATING MAGNETOSTRICTION OF TIN SINGLE CRYSTAL

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We investigated the quantum size oscillations of a tin single crystal in a magnetic field. This effect was observed earlier in other substances, which are listed in [1]. The measurements were made on a spherical sample of 1 cm diameter at 1.4°K, in a field ~10 kOe, using a dilatometer [2]. Figure 1 shows schematically the measuring resonator of the dilatometer. A change in the diameter of sample 5 bends a thin membrane 3, which is the bottom of a capacitance-loaded coaxial resonator 2. This resonator is connected in the feedback circuit of an auto-oscillator operating in the 3 cm band, whose frequency is thus altered. The frequency deviation, which is proportional to the elongation of the sample, is registered with a multichannel storage unit [3].

The measurement results were approximated by least squares, with a computer, by harmonic functions of specified frequencies. The values of the frequencies were made more precise during the course of the calculation, and as a result we obtained the amplitudes and phases of the harmonic functions and their variances. A sample plot of the size oscillations is shown in Fig. 2. The results of the experimental data reduction (the amplitude of the oscillations in a 9700-Oe field) are given in the table. The symbols for the extremal cross sections are the same as in [4].

$\Delta\ell$ ‖ axis	H ‖ axis	Extremal section	Striction amplitude, Å
[100]	[001]	δ_1^1 (fund. freq.)	0.585 ± 0.005
[100]	[001]	δ_1^1 (sec. harm.)	0.030 ± 0.006
[100]	[010]	r_2^1	0.107 ± 0.003
[001]	[010]	r_2^1	0.037 ± 0.001

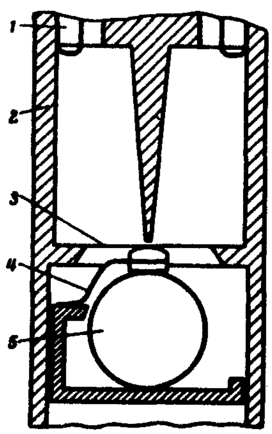

Fig. 1

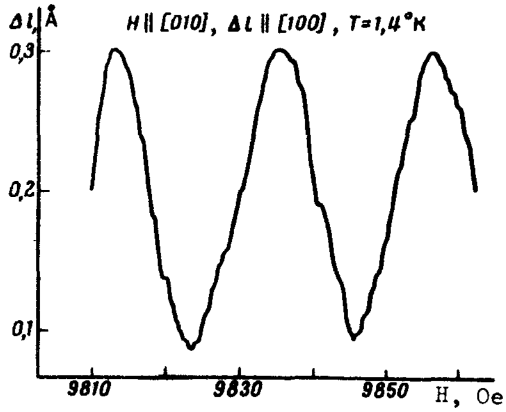

Fig. 2

Fig. 1. Measuring resonator of coaxial type with capacitive load: 1 - coupling line, 2 - body of resonator, 3 - membrane, 4 - spring, 5 - sample.

Fig. 2. Partial plot of size oscillations of an Sn crystal.

From the obtained values of $\Delta\ell$ we can find the dependence of the cross-section area S of the corresponding part of the Fermi surface on the components of the stress tensor σ_{ik}, inasmuch as (see [5, 6])

$$u_{ik} = -\left(\frac{\partial\Phi}{\partial\sigma_{ik}}\right) = \frac{\partial \ln S}{\partial\sigma_{ik}} HM$$

Here u_{ik} is the strain tensor, Φ the oscillating part of the thermodynamic potential, and M the oscillating magnetic moment. The ratio

$$\frac{\partial \ln S}{\partial\sigma_{ik}} \Big/ \frac{\partial \ln S}{\partial\sigma_{\ell m}} = u_{ik}/u_{\ell m}$$

is determined directly from experiment and is independent of M. Thus, for example, for the section τ_2^1 (electron surface in zone VI) we obtain

$$\frac{\partial \ln S}{\partial\sigma_{100}} \Big/ \frac{\partial \ln S}{\partial\sigma_{001}} = -2{,}9 \pm 0{,}2.$$

The dependence of S on the stresses is usually extracted from direct experiments on the influence of the pressure ($10^2 - 10^4$ kg/cm^2) on the Fermi surface of a metal [7]. The advantage of the dilatometric measurement method lies in the fact that the investigated sample is not subjected to strong mechanical stresses. Thus, in the described experiments, the forces exerted on the sample by the holder (Fig. 1) did not exceed the weight of the sample. The Dingle temperature, which characterizes the quality of the crystal and is determined experimentally from the field dependence of the oscillation amplitude, was approximately 0.02 - 0.05°K for the sample employed.

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PRODUCTION OF A RELATIVISTIC PLASMA BY ADIABATIC COMPRESSION IN A PLASMA-BEAM SYSTEM

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Interaction of an electron beam with a cold plasma in an adiabatic trap with a large mirror ratio gives rise to a high-temperature electron component that is retained in the trap for a long time [1]. Under certain conditions, it