on the magnetic field intensity, for those magnetic fields at which resolution of the central doublet takes place (lower curve).

It can be concluded from the character of the plots in Fig. 2 that the quadrupole effects of second order are responsible for the observed broadening and splitting.

According to the theory of quadrupole effects of second order, for an axially symmetrical TEFG [2], the magnitude of the splitting of the central component, at magnetic field intensities $H_0 \approx 2$ kOe, should amount to 47 kHz, and should decrease like $1/H_0$ with increasing magnetic field. It is seen from the data of Fig. 2 that the distance between the peaks of the doublets in the 2 kOe field equals only 23 kHz, which is half the calculated value. In addition, the shape of the resonant absorption (Fig. 1) does not correspond to the theoretically expected one. It can therefore be concluded that there is no axial symmetry of the TEFG at the locations of the vanadium nuclei in V_3Si.

Since a theoretical calculation of the form of the central component of polycrystalline samples in the absence of axial symmetry of the TEFG has not been performed, it is impossible to take into account second-order quadrupole effects in the determination of the Knight shift. However, it follows from the theory [3] that the quadrupole effects of second order do not affect the positions of the satellites, so that the Knight shift can be roughly estimated from the position of the symmetry center of the latter. The Knight shift determined in this manner turned out to be 0.48 ± 0.03% at 78°K and independent of the magnetic field intensity. This magnitude is in good agreement with the results of an investigation of nuclear magnetic resonance of V_3Si in a field of 14 kOe [1].

[1] W. E. Blumberg, J. Eisinger, V. Jaccarino, and B. T. Matthias, Phys. Rev. Lett. 5, 149 (1960).
[2] R. W. Pound, Phys. Rev. 79, 685 (1950).
[3] G. M. Volkoff, Can. J. Phys. 31, 820 (1953).

OBSERVATION OF NON-EXTREMAL SECTIONS OF THE FERMI SURFACE IN SIZE-QUANTIZED BISMUTH FILMS

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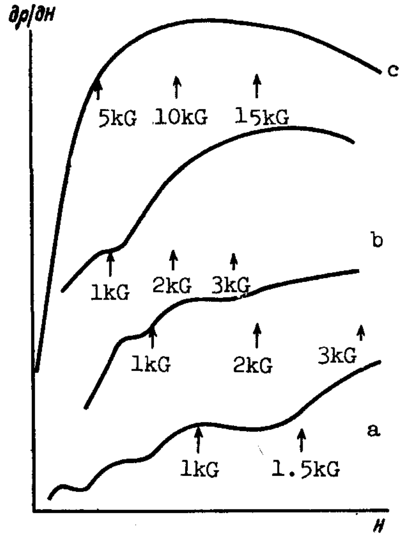
In [1] we proposed a method for investigating the topology of the Fermi surface of solids with the aid of the quantum size effect, by superimposing a quantizing magnetic field. It was shown that by using a film model in the form of an infinite potential well with a flat bottom, it is possible to obtain the nonmonotonic part of the thermodynamic potential, which contains oscillating terms whose period in the reciprocal magnetic field equals

$$\Delta(H^{-1}) = \frac{\pi H}{cS(n, \mathcal{E}_F)}, \quad (1)$$

where $S(n, \mathcal{E}_F)$ is the area of the section of the Fermi surface corresponding to the n-th dimension zone. Thus, when a quantizing magnetic field is superimposed in a direction perpendicular to the plane of the film, each of the cross sections allowed by the size quantization will play the role of an extremal section. This makes it possible to observe non-extremal sections in a film, unlike in a bulky sample, and to reconstruct in principle the form of the Fermi surface of the investigated material.



We present in this paper the results of the measurements of the differential magnetoresistance of bismuth films ~1000 - 3000 Å thick, in a magnetic field directed perpendicular to the plane of the film (along the trigonal axis of the crystal) at 4.2°K.

Three characteristic types of curves are observed: 1) an oscillating dependence of $\partial\rho/\partial H = f(H)$ (d = 1200 Å), Fig. 1a; 2) curves with one or two singularities (d = 1100 and 900 Å), Fig. 1b; 3) curves characterized by a monotonic variation of the magnetoresistance (d = 1700 Å), Fig. 1c (the scales of the curves differ).

The period of the observed oscillations of the differential magnetoresistance lies in the range 10^{-3} - 10^{-4} G^{-1}. No oscillations with such a large period were observed in bulky samples at the same field orientation.

The area of the electronic extremal cross section in bulky bismuth corresponds to a period 1.2×10^{-5} G^{-1} [2].

The presence of low-frequency oscillations in thin films and their absence in bulky material is in full agreement with the conclusions of [1].

Low-frequency oscillations are observed in relatively weak fields (500 - 5000 G), for which the criterion of the strong field $\mu H \gg 1$ is not satisfied ($\mu \sim 20\,000$ cm^2/V-sec at d ~ 2000 Å). This fact can be explained as follows.

The bismuth films constitute a mosaic single crystal with average crystallite dimension ~5 μ. It is natural to assume that the scattering of the carriers occurs predominantly on the boundaries of the crystallites. In this case, the conditions of quantization in the magnetic field will be determined by the ratio of the orbit diameter to the crystallite dimensions, i.e., they will be different for electrons belonging to different size zones. This circumstance explains the presence of low-frequency and the absence of high-frequency oscillations in "weak" fields.

The curves in Fig. 1b pertain to the case when there are one or two Landau levels under the Fermi level within the confines of one size zone (corresponding to the small section).

Finally, the curves of Fig. 1c are characterized by a film thickness such that the small section of the Fermi surface is missing, and the large-area section does not appear as a result of the inconvenient ratio of the orbit diameter to the crystallite dimensions.

We note that the results of measurements of the $\partial^2\rho/\partial H^2(H)$ dependence correlate fully with the presented data and, in addition, make it possible to observe in a number of cases simultaneously two non-extremal sections, the areas of which differ by ~4 - 10 times.

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[1] V. N. Lutskii and E. P. Fesenko, Fiz. Tverd. Tela 10, 12 (1968) [Sov. Phys.-Solid State 10, 8 (1968)] (see also Abstracts of Papers at 14th All-Union Conference on Low-temperature Physics, Khar'kov, June, 1967).
[2] L. S. Lerner, Phys. Rev. 127, 1480 (1962).

NUCLEAR DIFFRACTION OF RESONANT γ RADIATION BY AN ANTIFERROMAGNETIC CRYSTAL

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This is a continuation of our earlier investigations [1] of coherent effects predicted by Kaganov and Afanas'ev [2,3] and occurring in the diffraction of resonant γ radiation by nuclei. Obviously, these investigations can be performed most effectively under conditions when the Rayleigh scattering by the electrons is suppressed or completely excluded. The first attempt to suppress Rayleigh scattering was made in [4], where they succeeded in choosing the Bragg position upon reflection from a crystal of potassium ferrocyanide ($K_4Fe(CN)_6 \cdot 3H_2O$), such that the Rayleigh scattering from the nonresonant atoms extinguished almost completely the Rayleigh scattering from the iron atoms. The separation of nuclear diffraction in such a manner is possible only in rarely encountered particular cases.

There exists another more interesting and more promising possibility of separating nuclear diffraction, based on the spin dependence of the amplitude of nuclear scattering of resonant γ rays. As shown recently by Belyakov and Aivazyan [5], it follows from this dependence that the diffraction of resonant γ rays by magnetically ordered crystals should be sensitive to the magnetic structure. The situation is here analogous in many respects to that obtained in the case of diffraction of neutrons and used in magnetic neutron diffraction analysis [6]. If the periods of the magnetic and the crystal structures are different, then diffraction of the resonant γ rays should give rise to additional Bragg maxima, connected with the magnetic structure and produced as a result of resonant scattering by nuclei only.

If the magnetic and crystal structures coincide, then, generally speaking, both the nuclear resonance and the Rayleigh electron scattering of the γ rays contribute to the Bragg maximum, and interference between them should be observed.

However, as shown in the present paper with hematite as an example [1)], pure nuclear diffraction maxima can exist even in the case when the magnetic and crystal structures coincide.

Such a maximum was observed experimentally by us upon reflection of Mossbauer γ radiation of Fe^{57} from the system of (111) planes of hematite.

Figure 1 shows schematically the reflection case under consideration. The unit cell consists of four iron ions located on the [111] axis, and six oxygen ions (not shown). It is

[1)] Hematite is cited in [5] as an example of the case considered there, where the magnetic and crystal structures differ. In fact, according to [7], the magnetic and crystal cells of hematite are identical.