INVESTIGATION OF QUADRUPOLE EFFECTS OF SECOND ORDER IN THE INTERMETALLIDE V_3Si

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A correlation between the quadrupole splitting of first order of the nuclear resonance on V^{51} and the temperature of the superconducting transition was observed in [1] for intermetallides of the V_3Si type. An investigation of the character of the tensor of the electric field gradient (TEFG), for the purpose of clarifying the cause of the high temperature of the superconducting transition, is of definite interest.

We investigated the nuclear magnetic resonance of V^{51} in V_3Si, in the range of magnetic fields from 2 to 9 kOe at three values of the temperature (78, 200, and 300°K). The samples were prepared by sintering in vacuum at 1400°C a compressed mixture of vanadium and silicon powders, corresponding to the stoichiometric composition.

It was observed that in a field of 9 kOe the form of the resonant absorption corresponds to a case typical of quadrupole splitting of first order, i.e., additional maxima (satellites), determined by the quadrupole interaction, are present besides the central component of the absorption at the resonant frequency of V^{51} nuclei. The distances between the satellites agree with the theory [2].

Within the limits of measurement accuracy, the dependence of the quadrupole splitting of the first order on the temperature and magnetic field intensity was not observed. The magnitude of this splitting is 210 ± 2 kHz, which is in good agreement with the results of [1].

When the magnetic field is decreased, the central component of the resonant absorption first broadens, and then splits into two unequal peaks. The form of resonant absorption in a magnetic field of approximately 2 kOe is shown in Fig. 1. The splitting of the central component becomes sufficient for resolution in a field of 5.5 kOe, and therefore the parameter characterizing the splitting can be chosen to be the distance between the maximum and minimum of the derivative of the resonant absorption. A plot of this quantity against the magnetic field intensity is shown in Fig. 2 (upper curve). The same figure shows the dependence of the distance between the peaks of the doublet

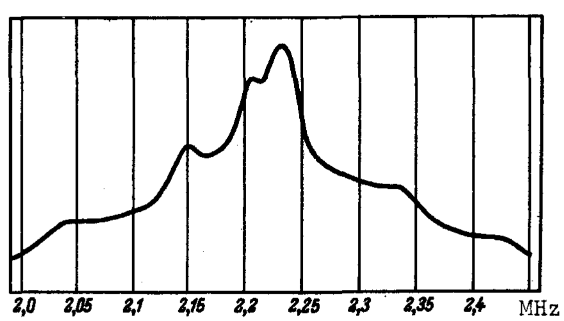

Fig. 1

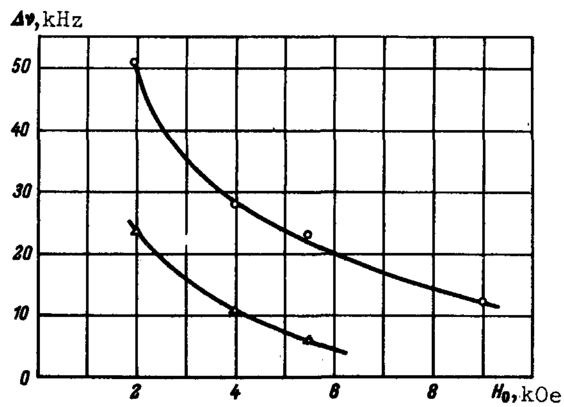

Fig. 2

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].

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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

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

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