It must be emphasized that the angular distribution has a specific form of a series of Bragg maxima, and in the cases of experimental investigation of one maximum it is necessary that the scattering by the thermal lattice vibrations not bring the quantum outside of the region of the maximum. If the observation is in a relatively broad range of angles, including several maxima, then the interference pattern becomes averaged out and the ratio of the cross sections will be smaller than (2).

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CONTRIBUTION TO THE THEORY OF ELECTRON SPIN RESONANCE IN ANISOTROPIC METALS

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1. Spin waves were recently observed experimentally in nonferromagnetic metals placed in a magnetic field $\vec{B}$ [1]. The theoretical prediction of the possible existence of such waves was made by V.P. Silin [2] on the basis of the theory of a degenerate electron liquid [3]. The experiments of Dunifer and Schultz [1] are based on the use of the phenomenon, predicted in [4], of selective transparency of metallic films in the case of spin resonance of the conduction electrons. In these experiments, besides the usual transparency line at $\omega = \omega_s = 2\mu_0 B/h$ (μ_0 - magnetic moment of the electron, h - Planck's constant), there is observed a series of additional lines. The presence of the additional lines is a reflection of the fact that a possibility arises for the magnetization to propagate from the skin layer to the interior of the metal, in the form of spin waves. The experiments were performed in sodium and potassium, the Fermi surfaces of which are approximated with sufficient accuracy by a sphere. Therefore these experiments were analyzed by using the model of an isotropic electron liquid. For most other metals, a more detailed model is necessary, which takes into account the anisotropy of the Fermi surface. In [5 - 7] there were considered effects of the influence of the anisotropy of the Fermi surface on the distribution of the spin waves in the electron liquid. In these investigations [1, 2, 5 - 7], no account was taken of the difference between the magnetic moment of the electron in the crystal and the moment for the free electron, due to the weak spin-orbit interaction between the conduction-electron spin and the orbital-motion moments of the electrons of the ion lattice. On the other hand, the difference connected with the interaction between the conduction electrons was taken into account. It is known, however, that in many cases the correction to the g-factor due to the spin-orbit interaction can be appreciable and observed in experiments [8]. In particular, for metals with an anisotropic Fermi surface, this correction depends on the orientation of the magnetic field $\vec{B}$ relative to the crystal axes. In the present communication we consider alkali metals of two types: metals in which the Fermi surface lies completely within the first Brillouin zone and is sufficiently far from its faces (e.g., potassium and sodium), and metals in which the Fermi surface passes close (in particular, as tangent) to two opposite faces (e.g., cesium under slight compression [9]). In the calculation of the anisotropy of the g-factor of the conduction electrons, connected with the presence of a weak periodic pseudopotential $W(\vec{r})$, we follow the method developed in [10]. The starting point will be the previously obtained [11] expression for the shift of the g-factor of almost-free electrons in the Bloch state $\vec{k}$, which is true for alkali metals:

$$\Delta g = \langle \Delta g(k) \rangle_{av} = -\langle \mu k^2 \sin^2\theta \rangle_{av} . \qquad (1)$$

Here θ is the angle between the vectors $\vec{k}$ and $\vec{B}$, μ is a numerical coefficient, and the averaging is carried out over the Fermi surface. We shall not engage at present in the rather complicated problem of calculating μ, since we are interested only in the angular dependence of Δg.

2. We consider first metals such as sodium and potassium, in which the Fermi surface lies entirely in the first Brillouin zone and is sufficiently far from all its faces, so that for none of these is the following condition satisfied

$$\frac{\hbar^2 q^2}{8m} - \left(E_F + \frac{1}{2}|W_q|\right) \ll \frac{1}{2}|W_q|, \qquad (2)$$

where $\vec{q}$ is a vector defining the position of the given Bragg plane in momentum space, E_F is the Fermi energy, m is the electron mass, and $W_q = \langle k + q|W|k\rangle$ is the matrix element of the pseudopotential. The pseudopotential is assumed to be local, which is a good approximation [12]. We then obtain from formula (1) with allowance for the influence of only one Bragg plane $k_z = -q/2$,

$$\Delta g(\theta) - \Delta g(0) \approx -\mu q^2 \sin^2\theta \left\{\frac{b^2}{2(1-a)} + \frac{b^2}{4}\ln\frac{1+\sqrt{a}}{1-\sqrt{a}}\right\}. \qquad (3)$$

Here

$$a = \frac{8mE_F}{\hbar^2 q^2}; \qquad b = \frac{m|W_q|}{\hbar^2 q^2}; \qquad \Delta g(0) = -\frac{\mu q^2}{6}$$

θ is the angle between the vector $\vec{B}$ and the k_z axis. In deriving (3) we have assumed the pseudopotential to be small ($b \ll a$, $b \ll 1$) and confine ourselves to terms of order W_q^2. We now take into account the contribution made by all the Bragg planes forming the first Brillouin zone (in the case of alkali metals, there are only twelve such planes). The summation of expression (3) over all twelve Bragg planes yields

$$\frac{\Delta g(\alpha, \beta) - \Delta g(0)}{\Delta g(0)} \approx 12b^2\left\{\frac{2}{1-a} + \ln\frac{1+\sqrt{a}}{1-\sqrt{a}}\right\}, \qquad (4)$$

where α and β are the angles determining the orientation of the magnetic field $\vec{B}$ relative to the crystal axes. From (4) we see that if the Fermi surface of the alkali metal is sufficiently remote from all the nearest Bragg planes, then the presence of a weak periodic pseudopotential leads to a correction of the order of W_q^2 to Δg. Under the assumptions made by us, this correction is isotropic, i.e., it does not depend on the orientation of the vector $\vec{B}$ relative to the crystallographic axes (the angles α and β do not enter in the right side of (4)).

3. We now proceed to the case of cesium, in which the Fermi surface, following relatively slight compression of the metal, comes close to two opposite Bragg planes, so that (2) is satisfied for these planes. Calculation shows that the correction to Δg due to these planes is of the order of W_q. The contribution introduced by all the remaining Bragg planes can be neglected here, since it will be of higher order in terms of the small pseudopotential W_q. In

particular, when the Fermi surface is tangent to two opposite Brillouin faces, i.e., when

$$E_F = \frac{\hbar^2 q^2}{8m} - \frac{1}{2}|W_q|$$

we get from (1)

$$\frac{\Delta g(\theta) - \Delta g(0)}{\Delta g(0)} \approx \frac{3}{8}\frac{|W_q|}{E_F}\sin^2\theta \ . \qquad (5)$$

Here θ is the angle between the direction of the vector $\vec{B}$ and the straight line perpendicular to the Bragg planes to which the Fermi surface is tangent. We see that the correction $\Delta g(\theta)$ is sharply anisotropic in this case. Therefore effects of the influence of the band structure on the g-factor should appear in experiments similar to [1] on spin resonance of the conduction electrons of a metal such as cesium. It is precisely the dependence of the g-factor on the angle θ, in accordance with formula (5), which leads to a shift of the line ω_s of the main spin resonance and of the lines corresponding to the spin waves when the magnetic field $\vec{B}$ rotates about the preferred direction in the crystal.

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LINE SHAPE OF TWO-PHOTON ABSORPTION IN A STANDING-WAVE FIELD IN A GAS

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The analysis of various nonlinear phenomena occurring when a strong field interacts with matter has been the subject of a number of investigations [1, 2]. The purpose of the present paper is to call attention to new important and physically interesting features that arise in resonant two-photon absorption in a gas in a strong standing-wave field.

1. As is well known [3], two-photon absorption is an effect of second