1.0 photoneutrons (Na — Be) in the center of a uranium sphere, measured the distribution of the $Np^{237}$ fissions, and were able to determine the transport parameters of $U^{238}$ for a group of neutrons with energies 0.5 — 1.0 Mev. The values obtained in this case were $\alpha = 0.22 \pm 0.01$ and $\beta = 0.187 \pm 0.008$.

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*This value is in excellent agreement with the results of measurements made by Leachman and Schmitt[1] (0.307 ± 0.005 barns).

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[1] R. B. Leachman and H. W. Schmitt, J. Nucl. Energy **4**, 38 (1957).

[2] Kuz'minov, Kutsaeva, and Bondarenko, Атомная энергия (Atomic Energy) (in press).

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# *CONCERNING THE SYNTHESIS OF THE SHAPE OF THE FERMI SURFACE IN METALS*

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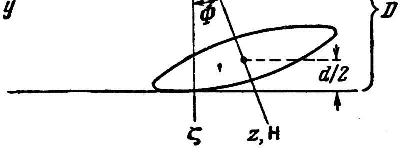
THE synthesis of the shape of the Fermi surface $\epsilon(\mathbf{p}) = \epsilon_0$ (where $\epsilon$ and $\mathbf{p}$ are the energy and quasi momentum of the conduction electron, and $\epsilon_0$ is the limiting Fermi energy) from the experimental results is a task of great importance to the theory. I. M. Lifshitz and A. V. Pogorelev proposed[1] a method of such a synthesis from the extremal areas $S_{ext}$ of the cross-sections of the Fermi surface. These areas can be determined from the periods of the oscillations of the magnetic susceptibility $\chi$ in the de Haas — van Alphen effect.



As a rule, however, harmonic analysis of the experimental curves of $\chi(H)$ is a rather difficult task, owing to the large number of harmonics. In this work we propose a method whereby $S_{ext}$ and the radius vector of the surface $\mathbf{p}$ can be determined directly as a function of the direction $\mathbf{p}/p$ for various harmonics.

Let us examine the de Haas — van Alphen effect in a film in a constant magnetic field oriented in an arbitrary manner.

For brevity we shall assume that the Fermi surface is a single closed convex surface. Then, if the orbit corresponding to the central cross-section "is not contained" in a film of thickness D, i.e.,

$$D < d = \left| \int_{t_0'}^{t_0''} v_\zeta \, dt_2 \right|_{p_z=0,\, \varepsilon=\varepsilon_0} = \left| \cos\Phi \int_{t_0'}^{t_0''} v_z \, dt_2 + \sin\Phi \frac{2cp_x^{\max}}{|eH|} \right|_{p_z=0,\, \varepsilon=\varepsilon_0},$$

$$v_\zeta(t_0') = v_\zeta(t_0'') = Q; \qquad v_\zeta'(t_0') < 0; \qquad v_\zeta'(t_0'') > 0$$

(t is the time of one electron revolution in the orbit, $\mathbf{v} = \nabla_p \epsilon$ is the electron velocity, and the other symbols are as indicated in the diagram), then all the electrons collide with the surface, and the amplitude of the quantum oscillations of $\chi$ is proportional to at least the second power of $\mu H/\epsilon_0$ (where $\mu$ is the Bohr magneton for the conduction electron. The second power is obtained under the case which is most favorable in this sense, namely of specular reflection of the electrons from the surface — see Ref. 2.)

If, however, the orbit corresponding to the central cross-section "is contained" in the film (D > d), with

$$(l / D) \cos\Phi \, (\mu H / \varepsilon_0)^{1/2} \ll 1$$

($\ell$ is the mean free path of the electrons), then the electrons corresponding to the central cross section and contributing to the quantum oscillations will not collide with the surface. They satisfy the relation

$$\bar{v}_z(p_z) \approx \bar{v}_z(0) + \bar{v}_z'(0)\, p_z \sim v\, (\mu H / \varepsilon_0)^{1/2}.$$

Their energy spectrum coincides in the quasi-classical case with the spectrum in the bulk metal, and the amplitude of the corresponding quantum oscillations is proportional, as can be readily seen, to $(\mu H/\epsilon_0)^{3/2}$. In this case the magnetic moment differs from the magnetic moment of the bulk metal[3] only in that instead of D the formulas contain D − d, corresponding to those electrons which do not collide with the surface. In a magnetic field parallel to the surface, the formula for the magnetic moment, for any kind of reflection from the surface, coincides with formula (14) of the work by Kosevich and Lifshitz.[4]

Consequently, if one investigates $\chi_q(H)$ in a film with $D < l$, then, by determining the successive values of the magnetic field H for which there are sharp increases in the quantum oscillations with a given period, for all possible directions of H, we determine d and $S_{ext}$ for each of the surfaces individually (we mean here the closed surfaces into which $\epsilon(p) = \epsilon_0$ is resolved), without resorting to harmonic analysis. (The applicability of the above arguments to this case is obvious.)

The values of $d = D$ in a parallel field make it possible to determine

$$p_x^{\max} = |eHD|/2c$$

for the central cross-section of the above surfaces, at all directions x in the plane of the film, i.e., to construct directly all the cross-sections $\epsilon(p) = \epsilon_0$ and $p_y = 0$. A set of monocrystallographic films with a varying orientations of the crystallographic axes relative to the surface would make it possible to plot $\epsilon(p) = \epsilon_0$.

The values of $S_{ext}$, as already indicated, also make it possible to synthesize the Fermi surface by the Lifshitz-Pogorelov method.

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[1] I. M. Lifshitz and A. V. Pogorelov, Dokl. Akad. Nauk SSSR **96**, 1143 (1954).

[2] I. M. Lifshitz and A. M. Kosevich, Izv. Akad. Nauk SSSR, ser. fiz. **19**, 395 (1955).

[3] I. M. Lifshitz and A. M. Kosevich, Dokl. Akad. Nauk. SSSR **96**, 963 (1954); J. Exptl. Theoret. Phys. (U.S.S.R.) **29**, 730 (1955), Soviet Phys. JETP **2**, 636 (1956).

[4] A. M. Kosevich and I. M. Lifshitz, I. M. Lifshitz, J. Exptl. Theoret. Phys. (U.S.S.R.) **29**, 743 (1955), Soviet Phys. JETP **2**, 646 (1956).

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# *CALORIMETRIC DETERMINATION OF THE HALF-LIFE OF* $Ra^{226}$

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IN the determination of the half-lives of long-lived isotopes by the calorimetric method, one measures the thermal effect Q of the radioactivity of a known weight p of a given isotope. The half-life T is determined from the relation $T = (\ln 2) \cdot pN_0\epsilon/AQ$, where $N_0$ is Avogadro's number, A the atomic weight of the isotope, and $\epsilon$ the energy liberated by the isotope in the calorimeter in a single decay event. The decay constants of $Pu^{239}$ (Ref. 1) and $Ac^{227}$ (Ref. 2) were measured relatively recently by such a calorimetric method.

Many investigators have used this method to determine T for $Ra^{226}$. They measured the thermal effect of radium, either free of its short-lived derivatives[3] or in equilibrium with these derivatives.[4,5] Unfortunately, the Ra contents in the measured compounds was determined in these investigations indirectly, usually on the basis of $\gamma$ measurements. In addition, for the most part, the accuracy of the calorimetric measurements themselves was insufficient (1—4%), as was the accuracy with which $\epsilon$ was calculated for the elements of the $Ra^{226}$ series.

We made precise calorimetric measurements of three equilibrium compounds of radium, subjected to 10 (Ra I, Ra II) and 15 (Ra III) additional crystallizations to eliminate possible contaminations. The purity of these compounds was controlled by means of a spectral method, which detected the presence of only insignificant impurities of certain elements of the second group of the periodic table.[6] The total contamination $\alpha$ did not exceed, in all three cases, 0.2% (by weight).

The results of direct weighing of radium bromide before sealing the compounds, and the $Ra^{226}$ content in these compounds, are given in the table. The table lists also the results of the calorimetric measurements performed with the aid of a double static calorimeter.[9] The last column of the table gives the determined values of $Q_{\alpha+\beta}/p$ — the thermal effect of $\alpha$- and $\beta$-radiation per gram of radium. In the calculation of these quantities, account is taken of the absorption of $\gamma$-rays in the compound itself (self absorption), in the protective container, in the glass of the ampoules, and in the walls of the calorimetric cylinder itself.