Figure 2 shows the energy spectrum of the α-particles of U^{238}. In this case, too, a fine structure was revealed. The fine structure line is separated from the fundamental by 45 kev. The ratio of intensity of the fundamental to the fine structure line is 4. The half-width of the lines is about 30 kev.

An analysis of the curves has shown that they cannot be represented by the sum of two gaussians, corresponding to a fundamental group and a fine structure group. The existence of a third group of α-particles had to be assumed with an energy lying between the fundamental and the fine structure group. This is reasonable since immediately after emitting a low-energy α-particle the nucleus emits a conversion electron. Half of the total number of emitted conversion electrons, falling in the working volume of the chamber, produce additional ionization. Consequently, half of the pulses v_α from the α-particles of the fine structure line are registered simultaneously with the pulses v_e from the conversion electrons, and what we get is the sum of the pulses, equal to $v_\alpha + v_e$, corresponding so to speak to a group of α-particles of intermediate energy $E = E_\alpha + E_e$. The other half of the pulses is registered as α-particle pulses of energy E_α. Our analysis of the curves shows the existence of such lines. The separation between the lines is about 30 kev, which corresponds to the kinetic energy of the electrons emitted from the L-shell of the atom.*

The intensities of the groups are identical which shows that the conversion is practically 100%.

It should be noted that number of authors[4–6] have studied the fine structure of the α-spectrum of U^{238} by an indirect method, viz., by studying the conversion electrons accompanying α-decay, using electron sensitive emulsions impregnated with a uranium salt. From the data of the above authors, the intensity of the transition to the first excited level amounts fo 23 ± 3%. After finishing our measurements it became known (private communication from J. Teillac) that the fine structure of the α-decay had been studied by Valladas using an ionization chamber with ion collection. He plotted the energy spectrum of the α-particles of U^{238} by means of the coincidences of the α-particles and the γ-radiation accompanying conversion, thereby avoiding registering the fundamental group of α-particles. His results agree with ours.

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*The mean energy going into the formation of one ion pair by electrons is the same as for α-particles.

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On the Theory of Skin Effect in Metals

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IN ANY THEORY of skin effect in metals one usually assumes $B = H$ since the magnetic susceptibility of metals is very slight ($\chi \sim 10^{-6}$). However, it is easy to see that neglect of the spin paramagnetism of the free electrons would lead to a substantial error in determining the coefficient of electromagnetic wave transmission through a sufficiently thick film. As was shown in Ref. 1, this is due to the damping of the magnetic moment due to spin paramagnetism at a depth

$$\delta_{\text{eff}} \sim v\,[t_0 T_{\text{sp}} / 3\,(1 + \omega T_{\text{sp}})]^{1/2}$$

(v is the limiting Fermi electron velocity, ω is the electromagnetic field frequency, T_0 and T_{sp} are the electron free path times without and with spin transfer). Since the usual skin layer depth is

$$\delta \sim \sqrt{c^2 / 2\pi\omega\sigma}, \quad \text{then}$$

$$\delta / \delta_{\text{eff}} \lesssim (c / v t_0) \sqrt{m / 2\pi n e^2} \sim 10^{-14}\,\text{sec} / t_0 \ll 1$$

(n, m, and e are the density, effective mass, and charge of the electron, while σ is the conductivity of the metal). Therefore, taking the spin magnetic moment into account leads to an albeit small but slowly-damped addition. In this paper, the coefficient of wave transmission through a sufficiently thick film $[d \gtrsim 2\delta \ln (\delta_{\text{eff}}/4\chi\delta)]$ is calculated taking this addition into account.

In this case, the complete system of equations is [see Eq. (14) of Ref. 1]

$$\operatorname{curl} \mathbf{E} = -i\omega\mathbf{B}/c; \quad \operatorname{curl}\mathbf{H} = 4\pi\mathbf{j}/c;$$

$$\mathbf{H} = \mathbf{B} - 4\pi\mathbf{M}; \quad \mathbf{M} = \chi(\mathbf{B} - \mathbf{w});$$

$$\frac{\partial \mathbf{w}}{\partial z} v\cos\theta + \frac{\mathbf{w}}{t_0^*} = \frac{\overline{\mathbf{w}}}{t_0} + i\omega\mathbf{B};$$

$$\frac{1}{t_0^*} = \frac{1}{t_0} + \frac{1}{T_{\text{sp}}} + i\omega; \quad \overline{f} = \frac{1}{2}\int_0^\pi f \sin\theta \, d\theta.$$

The solution of this system is completely analogous to the solution of the system (26) of Ref. 1 and leads to the following formula for the transmission coefficient:

$$K \sim \left| \frac{\chi c^3 Z^2}{2\pi d(\omega + 1/T_{\text{sp}})} \right|^2, \quad 2\delta \ln \frac{\delta_{\text{eff}}}{4\pi\chi\delta} \ll d \ll \delta_{\text{eff}}.$$

In particular, for normal skin effect and $\omega \gg 1/T_c$

$$K \sim \left(\frac{2\chi c}{\sigma d}\right)^2 \lesssim \frac{2\pi\chi^2\omega}{\sigma} \ln^{-2}\frac{c}{v\sqrt{2\pi\sigma t_0}} \sim 10^{-17}.$$

In conclusion, I would like to express my gratitude to I. M. Lifshitz and M. I. Kaganov for valuable discussions.

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Radiation From a Point Charge, Moving Uniformly Along the Surface of an Isotropic Medium

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THE MOTION OF CHARGED particles close to the surface of a dielectric material has been treated in a number of papers [1,2]. The case of a straight charge line moving close to a medium with arbitrary ε' and μ' was already treated by the author[3].

We shall now give some results of the corresponding case of a point charge. It is known[4] that in a uniform motion of a particle at a distance l from the surface the radiation into the surface is limited to wavelengths $\lambda\!\!\!^- \gtrsim l\sqrt{\mu'\varepsilon'}$ (more accurately $\lambda\!\!\!^- \gtrsim l\beta$). This allows to obtain a qualitative picture assuming a nondispersive medium. Then the energy emitted per unit time by Cerenkov radiation by a particle moving at a distance l from the medium with a a velocity $v = \beta c$ is given by

$$P = -\frac{e^2}{2\theta l^2}\frac{c}{\sqrt{\mu'\varepsilon' - 1}}\left\{\theta^2\mu'\left(1 - \frac{\mu'}{\sqrt{\mu'^2 + \Gamma^2}}\right) + \frac{\mu'\varepsilon - 1}{\varepsilon' - \mu'}\left(\frac{\mu'}{\sqrt{\mu'^2 + \Gamma^2}} - \frac{\varepsilon'}{\sqrt{\varepsilon'^2 + \Gamma^2}}\right)\right\}, \quad (1)$$

$$\theta^2 = 1 - \beta^2, \quad \Gamma = \gamma/\theta, \quad \gamma^2 = \mu'\varepsilon'\beta^2 - 1.$$

We note for comparison that the radiation per unit length from a charge filament of linear charge density ρ is[3]

$$P_l = (2v\rho^2/l)\,\varepsilon'\Gamma/(\varepsilon'^2 + \Gamma^2). \quad (2)$$

From these formulae we deduce that:

a) In the relativistic case $\theta \to 0$, independently of the characteristics of the medium, the radiated power approaches the limits

$$P \to e^2c/2l^2; \quad P_l \to 0. \quad (3)$$

b) In the nonrelativistic case but if $\beta\sqrt{\varepsilon'} \gg 1$

$$P \approx \frac{e^2}{2l^2}\frac{c}{\sqrt{\varepsilon'}}\beta^2; \quad P_l \approx 2\frac{\rho^2}{l}\frac{c}{\sqrt{\varepsilon'}}\beta^2. \quad (4)$$

This means physically that at low velocity the field enters the medium practically perpendicularly to the surface if $\varepsilon' \gg 1$.

c) For a magnetic material ($\varepsilon' = 1$) at $\beta^2\mu' \gg 1$ and nonrelativistic velocity the radiated power is given by

$$P \approx e^2c/2l^2\sqrt{\mu'}, \quad P_l \approx 2\rho^2 c/l\sqrt{\mu'}. \quad (5)$$

The form of these expressions is due to the fact that at particle velocities above the inversion velocity (see below) the field is being expelled from the magnetic medium.

d) Finally, for a medium of the type of a ferrite ($\mu' \gg \varepsilon' \gg 1$) we have for $\mu'\beta^2 \gg \varepsilon'$ and $\theta \approx 1$