At 0°K, the electron velocity distribution is uniform within a sphere of radius $(2\mu_0/m)^{\frac{1}{2}}$ in velocity space, where $\mu_0$ = maximum energy of unexcited electrons, and $m$ = electron mass. Assume that the energy of the photon adds to the electron energy in such a way that it increases only the component of electron velocity normal to the surface element. And assume further an excitation probability $\alpha$ proportional to the normal component of the electron velocity. Considering the transformations of the sphere by the excitation energy $h\nu$, the surface potential barrier $W_a$, and the retarding potential $V_e$ applied at an angle $\delta$ to a surface element, one obtains an equation that is readily soluble when $V_e \geq (\mu_0+h\nu-W_a)\sin^2\delta$. The current from an element is

$$i=(2\pi em\alpha/h^3)\cos\delta\cdot[\mu_0+h\nu-W_a-V_e]^2,$$

which is just DuBridge's expression multiplied by $\cos\delta$.

The photoelectric current from a rough surface at 0°K thus shows the same dependence on retarding potential and on energy as that from a smooth surface, providing the surface is not too rough, and the retarding potentials are not too low. Assuming a maximum angle of 45° between surface element normals and the normal to the cathode, the formula is valid for $i \leq (2^{\frac{1}{2}}\pi em\alpha/h^3)(V_e)^2$.

The equation for $V_e < (\mu_0+h\nu-W_a)\sin^2\delta$ does not reduce to a simple form. From the equations it does follow, though, that the current will be less than DuBridge's expression, indicating that photoelectric saturation current curves for rough surfaces will be rounded even at 0°K.

The writer has examined the data of Overhage[2] on normal energy distribution to see whether the above arguments could explain any of the discrepancy between theory and his curves. They do not.

The writer wishes to express his indebtedness to Dr. W. V. Houston who suggested looking into this problem, and also suggested the mathematical treatment used.

* This work was done at the California Institute of Technology n 1941.

[1] L. A. DuBridge, Phys. Rev. **43**, 727 (1933).
[2] C. F. J. Overhage, Phys. Rev. **52**, 1039 (1937).

## Neutron Induced Activities in Lutecium, Ytterbium, and Dysprosium

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NITRIC acid solutions of $Lu_2O_3$, $Yb_2O_3$, and $Dy_2O_3$ were irradiated with neutrons in the Argonne heavy water pile. Decay curves of the irradiated lutecium sample showed 3.4-hour and 6.6-day activities as reported by Flammersfeld and Mattauch.[1] Decay curves of the ytterbium sample showed a 2.7-hour activity (probably the same activity reported by Marsh and Sugden[2] as 3.5 hours) and also a 102-hour activity not previously reported. No evidence of the 41-hour activity reported by Pool and Quill[3] was found. Decay curves of the dysprosium sample showed the 2.5-hour activity reported by Marsh and Sugden.[2]

Assignment of mass to three of these active isotopes was made as follows. A portion of the sample containing the activity in question was placed on the filament source of a mass spectrograph. Operation of the spectrograph separated the isotopes and deposited them on a photographic plate. The position of the active isotope on this plate was determined by placing a second photographic plate face to face with the original. The disintegration of the active isotopes on the first plate produced developable images on both plates. Comparison of the position of this active deposit with the normal mass spectrum on the original plate determined the mass of the active isotope. This method of mass assignment gives results without the necessity of assuming the nuclear reaction by which the isotope is formed and is therefore frequently valuable in establishing the nuclear reaction. Using these techniques the following masses were assigned: 6.6-day lutecium, 177; 102-hour ytterbium, 175; and 2.5-hour dysprosium, 165.

[1] Flammersfeld and Mattauch, Naturwiss. **31**, 66 (1943).
[2] Marsh and Sugden, Nature **136**, 102 (1935).
[3] M. L. Pool and L. L. Quill, Phys. Rev. **53**, 437 (1938).

## Interpretation of Anomalous Larmor Frequencies in Ferromagnetic Resonance Experiment

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RECENTLY J. H. E. Griffiths[1] reported an important new ferromagnetic resonance experiment at microwave frequency. The experiment is essentially the ferromagnetic analog of the Purcell-Torrey-Pound nuclear resonance experiment. Griffiths found however the unusual result that the resonance frequencies he observed were greater than the calculated Larmor frequencies for electron spin by factors of about two to six. He attempted unsuccessfully to explain the anomaly by the introduction of the Lorentz cavity force, a step which is definitely not justified.

A theory of the resonance effect is given below which leads to values of the resonance frequency in close agreement with the experimental determination. It is shown that it is important to consider the dynamic coupling caused by the demagnetization field normal to the surface of the specimen. The result is that the appropriate Larmor frequency should be calculated as for a field strength $(BH)^{\frac{1}{2}}$ rather than for $H$.

A ferromagnetic specimen whose surface is the plane $y=0$ is subjected to a strong d.c. field $H_z$ and a weak microwave field $H_x$. The magnetization $\mathbf{M}$ and the angular momentum density $\mathbf{J}$ are related by $\mathbf{M}=\gamma\mathbf{J}$, where $\gamma$ is the gyromagnetic ratio. The equation of motion $\partial\mathbf{J}/\partial t=[\mathbf{M}\times\mathbf{H}]$ may be written

$$\partial\mathbf{M}/\partial t=\gamma[\mathbf{M}\times\mathbf{H}], \quad (1)$$

where the components of $\mathbf{H}$ are $(H_x, -4\pi M_y, H_z)$. Here $-4\pi M_y$ is written for $H_y$ on the basis of the divergence relation $B_y=H_y+4\pi M_y=0$. The Lorentz and Weiss fields are omitted as they are always parallel to $\mathbf{M}$, and hence their vector product with $\mathbf{M}$ is identically zero. It is assumed that saturation obtains, and in fact that the d.c. field is sufficiently strong to outweigh the magnetic