explain the results of our experiment, i.e., the absence of a normal magnetization component and the reversal of the magnetization $\vec{m}$ along the x axis.

The transition layer from the surface state of magnetization to the volume state should have the character of a domain wall. Let us estimate the width of a 180° Neel wall. Taking into account the magnetostatic and exchange energies we obtain $t = [\pi^2 A/2a(0.86I_s^2)]^{1/2}$. For hematite we have $A = 4.5 \times 10^{-13}$ erg, $a = 3 \times 10^{-8}$ cm, $I_s = 2$ G/cm^3, and $t = 46$ μ. In the case of an external magnetic field normal to the surface, $I_s H >> 0.86I_s^2$, we obtain for the surface layer $t = [(\pi^2/4)(A/2a)(2/I_s H)^{-1}]^{1/2}$; $t = 4.3$ and 1.36 μ at $H = 100$ and 1000 Oe, respectively.

On the basis of an analysis similar to that given above, we can predict a new interesting effect, viz., the appearance of weak surface ferromagnetism on certain faces of antiferromagnetic crystals, for example on the face (111) of MnO and NiO as a result of the absence of inversion I, on the faces (100) and (110) of Cr_2O_3, MnO, and Ni (absence of I and C_3), on the (100) face of hematite below the Morin point (no C_3), etc.

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SUPERCONDUCTIVITY OF LUTECIUM

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Submitted 19 March 1973
ZhETF Pis. Red. 17, No. 9, 470 - 472 (5 May 1973)

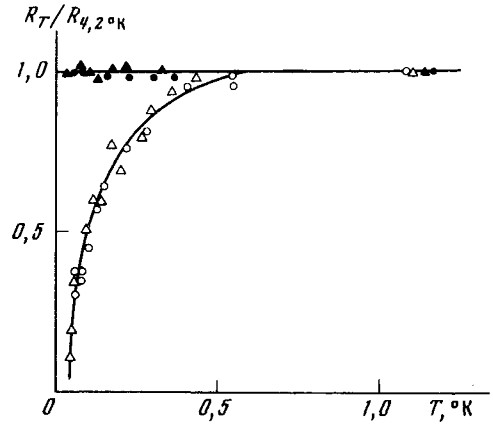
We measured the electric resistance of lutecium in the temperature range 0.03 - 4.2°K. A transition to the superconducting state was observed in the purest (99.9%) samples containing no ferromagnetic impurities. The transition temperature is $T_c = 0.10 \pm 0.03$°K and the critical magnetic field is $H_c < 400$ Oe.

The only previously known superconductor among the rare-earth metals (REM) is lanthanum, which is the first in the REM series. As to lutecium, the last of the REM series, no superconductivity was revealed by measurements of the electric resistance down to 1°K [1] and by measurements of the specific heat down to 0.4°K [4]. This rare-earth element has the same electron shell as lanthanum, $5d^1 6s^2$, and has in the metallic state a hexagonal lattice with parameters and electron structure close to those of lanthanum. It was unclear why lutecium is not superconducting. We have therefore measured the electric resistance of different lutecium samples in the temperature range 0.03 - 4.2°K.

The infralow temperature was obtained by adiabatic demagnetization of a paramagnetic salt that served simultaneously as a thermometer. Measurement of the susceptibility of the salt $\chi \sim 1/T$ determines the so-called "magnetic" temperature. The paramagnetic salt was chromium potassium alum or iron ammonium alum. The use of two different salts made it possible to convert more accurately from the measured temperature to the thermodynamic one [3].

The experimental procedure was described in detail in [3]. For greater reliability, two methods were used to produce thermal contact between the salt and the sample: the sample was placed either between the plates of a copper cold duct (the thermal contact between the sample and the copper was produced with "Apiezon-N"), or directly in a water-glycerine solution of the paramagnetic salt. The measurement current ranged from 0.1 to 0.5 mA.

The measured samples were prepared from lutecium 99.9% pure with no detectable ferromagnetic impurities, in the form of plates 30 × 3 × 0.25 mm having a resistance ratio R(300°K)/R(4.2°K) = 5 (Lu-1) and, after annearling, R(300°K)/R(4.2°K) = 15 (Lu-2).



Resistance of lutecium in the temperature interval 0.03 - 1.2°K: o) Lu-1, H = 0; o) Lu-1, H = 1000 Oe; Δ) Lu-2, H = 0, Δ) Lu-2, H = 400 Oe.

The results of measurements made on these samples are shown in the figure. The sharp drop in resistance below the residual value begins at T ≃ 0.5°K. If it is assumed, as usual, that T_c corresponds to half the change in the resistance, then the critical temperature for the measured samples is 0.10 ± 0.03°K. When the measurements were made in a transverse magnetic field, the superconductivity was destroyed. The results were fully reproducible in numerous measurements performed at different times. It should be noted that no transition to the superconducting state was observed in analogous measurements performed with lutecium samples 99.8% pure with 0.05% iron.

Thus, lutecium sufficiently purefied of ferromagnetic impurities is a superconductor with critical temperature 0.10 ± 0.03°K and critical field H_c < 400 Oe.

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