Letters to the Editor

THE ELECTRICAL RESISTANCE ANOMALY OF EUROPIUM BELOW THE NÉEL TEMPERATURE

ŠTEFAN JÁNOŠ*, ALEXANDER FEHER*, JAN DUDÁŠ**, Košice

The electrical resistivity of a metallic antiferromagnet exhibits an anomalous behaviour in the vicinity of the Néel temperature. This behaviour is usually described in the immediate vicinity of the magnetic critical temperature by the temperature coefficient of resistivity dR/dT.

The main purpose of our measurements was determine the character of the electrical resistance anomaly of europium below the Néel temperature. The electrical resistivity measurements of the rare earth metals above their magnetic critical points were presented in [1].

Europium shows very large magnetic critical scattering effects in the electrical resistivity. In this metal the critical resistance at the Néel temperature is about 18.10^{-8} Ωm, which is comparable with the total electrical resistance 82.10^{-8} Ωm at this temperature [2]. Europium is body-centered cubic, antiferromagnetic at below about 89 K with a helical magnetic structure [3]. For measurements we used a europium sample with the following impurity content: Nd (0.01 %), Gd(0.01 %), Sm(0.01 %), Fe(0.01 %), N(0.005 %), Si(0.04 %), H(0.002 %), C(0.02 %). The electrical resistivity was measured with a potentiometer with a sensitivity of 10^{-8} V. The currents of the order of 100 mA stable to within a few parts in 10^5 per hour were used. Temperatures were measured with a calibrated platinum thermometer from Scientific Instruments. In order to obtain dR/dT, we used a quasistatic method with very small rates of heating, usually from 10 to 20 mK per minute. A set of about 5—8 adjacent experimental points was taken within temperature intervals ranging from 10 to 15 mK. From a fit of each set of experimental points a value of dR/dT could be obtained. The sample was handled in a special paraffin oil to avoid appreciable oxidation. Fig. 1 shows the log-log dependence of the temperature coefficient dR/dT on the parameter $\varepsilon = |T_N - T|/T_N$ in the neighbourhood of the Néel temperature. In the region $0.004 \leq \varepsilon \leq 0.02$ and $T < T_N$ (≈ 88.92 K) we have $dR/dT \sim \varepsilon^{\lambda} = \varepsilon^{-0.25 \pm 0.02}$, where λ is the critical resistive exponent. If we suppose that the exponent λ satisfies the relation $\lambda = 2\beta - 1$ [4], where β is associated with the magnetic contribution to the specific heat, we get $\beta = 0.37$, which is in disagreement with [5], where $\beta = 0.21$ was obtained. Meaden et al. [1] observed a logarithmic divergence for dR/dT above T_N in the region $0.09 \leq \varepsilon \leq 0.4$. Our results below T_N do not show a logarithmic divergence in the temperature range studied. For smaller values of $\varepsilon (< 0.003)$ the behaviour of the divergence changes significantly. Kraftmacher et al. [6] and Nagy and Pál [7] in

* Katedra experimentálnej fyziky, Prírodovedecká fakulta UPJŠ, nám. Február. víťazstva 9, 041 54 KOŠICE, Czechoslovakia.

** Katedra teoretickej a experimentálnej elektrotechniky, Elektrotechnická fakulta VŠT, 040 01 KOŠICE, Czechoslovakia.

their measurements on iron and nickel observed a logaritmic divergence for dR/dT on both sides of the Curie temperature.

The data of the electrical resistivity in the neighbourhood of a magnetic critical point suggest that the dR/dT behaviour is quite system dependent and do not show any simple universality behaviour as it is seen in the equilibrium properties. Under the paper [8] the critical exponent is $\lambda = -0.33 \pm 0.08$. This value is in a good agreement with our result $\lambda = -0.25 \pm 0.02$.

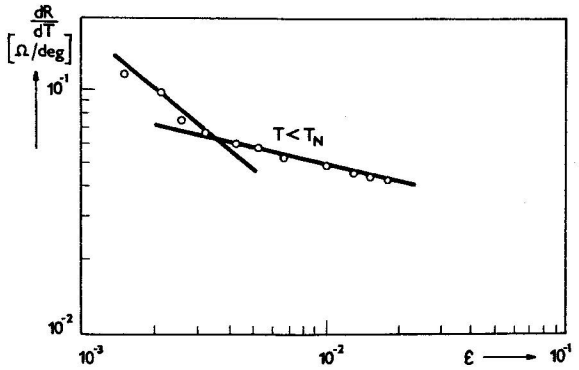

Fig. 1. The temperature coefficient of the electrical resistivity of europium below the Néel temperature.

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