[1] A. Gabor, Nature, 160, 89 (1947).
[2] A. B. Mikhailovskii and V. S. Tsypin, ZhETF Pis. Red. 3, 247 (1966) [JETP Lett. 3, 158 (1966)].
[3] I. M. Podgornyi, Lektsii po diagnostiki plazmy (Lectures on Plasma Diagnostics), Atomizdat, 1968.
[4] I. S. Ioffe, R. I. Sobolev, V. G. Tel'kovskii, and E. E. Yushmanov, Zh. Eksp. Teor. Fiz. 39, 1602 (1960) [Sov. Phys.-JETP 12, 1117 (1961)].
[5] I. G. Gorman and L. H. Th. Rietjens, Phys. Fluids, 9, 12 (1966).

REVERSAL OF THE SIGN OF THE LOW TEMPERATURE THERMAL EMF AND THE KONDO EFFECT

N. V. Volkenshtein, L. A. Ugodnikova, and Yu. N. Tsiovkin
Institute of Metal Physics, USSR Academy of Sciences
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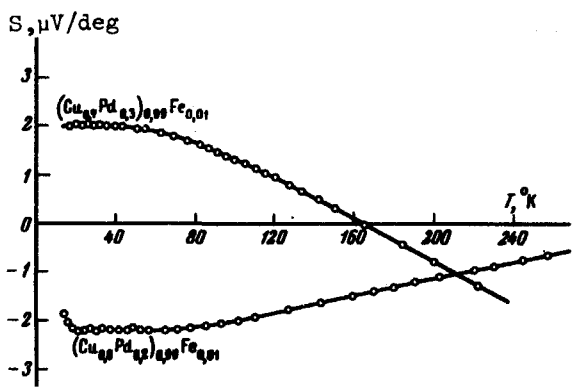
According to [1-5], the sign of the thermal emf due to a paramagnetic impurity is determined by the sign of the integral I of exchange interaction between the conduction electrons and the localized magnetic moments (under the condition $V \sim L^2 > 0$ [2], where L is the difference between the number of electrons of the impurity and host atoms and V is the amplitude of the scattering connected with the electrostatic potential of the impurity).

It is of interest to determine experimentally the sign of the thermal emf of the alloys $(Cu_{0.8}Pd_{0.2})_{0.99}Fe_{0.01}$ and $(Cu_{0.7}Pd_{0.3})_{0.99}Fe_{0.01}$, in which a negative and a positive sign of I is obtained when the results of the investigation of the temperature dependence of the electric resistance are reduced in accordance with the Kondo model [6].

We have investigated the temperature dependence of the thermal emf of the alloys $(Cu_{1-x}Pd_x)_{0.99}Fe_{0.01}$ (x = 0.05, 0.1, 0.2, 0.3, and 0.6) relative to the corresponding host matrices. The thermal emf S measured in this manner characterizes the interaction of the conduction electrons with the Fe ions. This interaction consists of the scattering of the conduction electrons, connected with the localized magnetic moment and with the static potential of the impurity ion.

It turned out that the S = f(T) plots of alloys containing 5, 10, and 20 at.% Pd were similar in form, differing only in the magnitude of the thermal emf (S = 4 μV/deg for the $(Cu_{0.95}Pd_{0.05})_{0.99}Fe_{0.01}$ alloy at T ~ 40°K). The temperature dependence of the thermal emf of the alloy $(Cu_{0.8}Pd_{0.2})_{0.99}Fe_{0.01}$ is shown in the figure.

At concentrations 30 and 60 at.% Pd, the character of the S = F(T) curves changes qualitatively, as can be seen from the plotted results for the alloy $(Cu_{0.7}Pd_{0.3})_{0.99}Fe_{0.01}$.



Temperature dependence of thermal emf, due to impurity iron atoms.

In the temperature interval 20 - 60°K, the thermal emf of the alloys in question is practically independent of the temperature. According to the Kondo model [1 - 4], this is due to the interference mechanism.

S < 0 at concentrations 5, 10, and 20 at.% Pd and S > 0 at higher concentrations. In the assumed model, this corresponds to a negative exchange interaction between the conduction elec-

trons and the localized magnetic moments for alloys containing 20 at.% Pd, and positive exchange at a higher palladium content, in full agreement with our investigations of the electric resistance of these alloys [6].

Similar results were obtained in investigations of alloys of Ag and Au with small additions of 4f-metals [7].

With increasing temperature, the relative role of the scattering of the conduction electrons, due to the exchange interaction, decreases against the background of a contribution, linearly increasing with the temperature, of the scattering connected with the electrostatic potential.

The reversal of the sign of the exchange interaction between the conduction electrons and the localized magnetic moments, and the difference in the behavior of the impurity thermal emf at higher temperature, are due to the appearance of d-carriers at palladium concentrations exceeding 30 at.%.

[1] J. Kondo, Progr. Theor. Phys. 32, 37 (1964).
[2] J. Kondo, ibid. 34, 372 (1965).
[3] J. Kondo, Proc. IX Low Temper. Conf. LT9, p. B, 1004 (1965).
[4] A. A. Abrikosov, Usp. Fiz. Nauk 97, 401 (1969) [Sov. Phys.-Usp. 12, No. 1 (1969)].
[5] S. V. Maleev, Zh. Eksp. Teor. Fiz. 51, 1940 (1966) [Sov. Phys.-JETP 24, 1300 (1967)].
[6] N. V. Volkenshtein, L. A. Ugodnikova, and Yu. N. Tsiovkin, ZhETF Pis. Red. 9, 189 (1969) [JETP Lett. 9, 110 (1969)].
[7] D. Gainon, P. Donze, and J. Siero, Solid State Comm. 5, 151 (1967).
[8] J. Friedel, Can. J. Phys. 34, 1190 (1956).

INVESTIGATION OF THE NORMAL AND ANOMALOUS NERNST-ETTINSHAUSEN EFFECTS IN FERROMAGNETIC METALS BELOW THE CURIE POINT

E. I. Kondorskii, R. P. Vasil'eva, Yu. N. Arkhipov, and A. V. Cheremushkina
Moscow State University

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Until recently, studies of the Nernst-Ettingshausen (NE) effect in ferromagnets were limited to themperatures below the Curie point. The purpose of the present investigation was to study the NE effect in ferromagnetic metals in the paramagnetic state, i.e., at temperatures above the Curie point.

The objects of the investigation were pure iron and nickel, and also iron-nickel invar alloys containing 36 and 40% Ni. The measurements were made in the temperature range from 200 to 900°C, using the method described in [1]. Unlike in [1], the magnetic field was produced in a wafer-type solenoid cooled with water and producing field intensities up to 10 kOe. We measured simultaneously the magnetic susceptibility. The experimental data were used to calculate the values of the "true" NE constant $Q = Q' - \Delta Q_h$, where $Q' = E/H\nabla T$ is the measured NE constant, $\Delta Q_h = \Delta E_h/H\nabla T$ is a correction representing that part of Q' which is connected with the Hall effect, ∇T is the temperature gradient along the thermal current q, and H and E are the intensities of the magnetic field transverse to q and of the transverse electric field (the NE field) respectively. The intensity ΔH_h appears in all cases when the absolute thermal emf is not equal to zero. The correction ΔQ_h can be determined from the experimentally known values of the electric resistivity, the Hall constant, and the absolute thermal emf. The