

Invalidity of Vonsovsky's Results on the Ferromagnetic Anomaly of the Work Function

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The theoretical result on the ferromagnetic anomaly of the work function by Vonsovsky and Sokolov is shown to be invalid. A consistent derivation within this model leads to no anomaly at the Curie point.

In 1951 Vonsovsky and Sokolov¹ derived a ferromagnetic anomaly in the electron workfunction (WF) Φ at the Curie point T_c . Their theoretical result was used in the interpretation of experimental data on the WF of Ni by Comsa et al.² and Hölzl and Porsch³. A change in the temperature dependence $\Delta\Phi/\Delta T$ at T_c was expected, but not found in³.

The theoretical derivation¹ of an anomaly in the WF is based on the s-d model of ferromagnetic metals by Vonsovsky⁴. Their result¹ can be written as

$$\Phi(y) = W - \varepsilon_\beta (1 - \delta_1 y^2) \quad (1)$$

with

$$\varepsilon_\beta = 4\pi^2 a^2 \beta \left(\frac{3n}{8\pi}\right)^{2/3} \quad \text{and} \quad \delta_1 = \frac{2}{3} k_1 \frac{\beta'}{\beta} - \frac{1}{9} k_1^2.$$

The constant parameters β , β' and k_1 are explained in the s-d model⁴, a is the lattice constant, n the density of the 4s-electrons, y represents the spon-

taneous magnetisation of the 3d-electrons, which is assumed to be the main part of the total magnetisation. y vanishes for $T > T_c$ thus giving rise to a change in the temperature dependance of WF at T_c . W is the depth of the 4s-electrons potential well for $T > T_c$.

In the ferromagnetic state the 4s-electron gas is represented by two components of polar spin orientations denoted $\pm$. The potential wells of the components then are defined by¹

$$W_\pm = \Phi + \xi_\pm. \quad (2)$$

Using the expressions given in Vonsovsky's paper⁴ we calculate the chemical potentials of the two components to be

$$\xi_\pm = \varepsilon_\beta \left(1 \pm \frac{\beta'}{\beta} y\right) (1 \pm k_1 y)^{2/3}.$$

Further reevaluation shows the following inconsistency in the mathematical treatment. The expansion of $\xi_\pm$ in (2) up to linear terms in y and making use of another form of (2)

$$\Phi = \frac{1}{2}(W_+ + W_-) - \frac{1}{2}(\xi_+ + \xi_-) \quad (3)$$

leads to the y^2 -dependence of Eq. (1) only if the chemical potentials in the second term of (3) are developed not equally far but up to quadratic terms in y . No physical argument can be seen for an approximation of $\xi_\pm$ in two different ways and recombining the results thereafter. So (1) cannot be helpful in discussing experimental data on the T -dependence of WF in ferromagnets.

This reevaluation shows that even within Vonsovsky's model no anomaly at $T = T_c$ can be expected. This result is in full agreement with the best experimental measurements by Hölzl and Porsch³.

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² C. Comsa, A. Gelberg, and B. Iosifescu, Phys. Rev. **122**, 1091 [1961].

³ J. Hölzl and G. Porsch, Thin Solid Films **28**, 93 [1975].

⁴ S. Vonsovsky, J. Phys. (Moscow) **10**, 468 [1946].

