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USING LANDAU THEORY IN FIRST-ORDER PHASE TRANSITIONS

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Landau theory can be applied to the transitions of the first or second order. For the case when the line of the first order phase transitions does not transform into the line of the second order phase transitions, i.e. not as ends with the tricritical point but not with a critical one: critical lines, limiting the region of metastable states, by using the Landau theory of phase transitions were determined.

Hamiltonian of uniaxial antiferromagnetic we write in the form:

$$\mathcal{H} = 2M_0\left[\frac{E}{2}\mathbf{m}^2 + \frac{b}{2}l_z^2 + \frac{a}{2}m_z^2 - \mathbf{mH}\right] \qquad (1)$$

where $\mathbf{m} = (M_1 + M_2)/2M_0$, M_1 and M_2 – sublattice magnetization, $2M_0$ – the value of dimension «G», E – exchange interaction parameter, a and b – parameters of uniaxial anisotropy, H – external magnetic field.

Believing in the formula (1) θ << 1, we obtain:

$$\mathcal{H} = \left[\frac{1}{2}\left(-H^2\frac{b}{E} - H^2 + H_{EA}^2\right)\theta^2 + \frac{1}{6}\left(4H^2\frac{b}{E} + 3H^2\frac{a}{E} + H^2 - H_{EA}^2\right)\theta^4\right], \qquad (2)$$

where H_{EA} – the field of the phase transition from a state where $1 \| OZ$ into a state where $l \perp OZ$, $H_{EA} = \sqrt{|b|E}$.

In eq. (2) the angle θ plays the role of the order parameter and we obtain the relation H2 = HEA(1 – (b/2E)) for the upper critical field.

To determine the angle θ from the equation $\partial\mathcal{H} / \partial\theta = 0$, using (2), it is impossible.

Believing θ = ?/2 − α, α << 1, we obtain the relation H1 = HEA(1 − (b+2a/E)) for the lower critical field.

Thus we can see that the Landau theory may be applied practically when dealing with the first-order phase transitions in the ferromagnetic materials but it needs further development.

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