ON THE EFFECT OF WEAK FIELDS ON THE MAGNETIC PROPERTIES OF U_3As_4[1]

О ВЛИЯНИИ СЛАБЫХ ПОЛЕЙ НА МАГНИТНЫЕ СВОЙСТВА U_3As_4

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Field and anglular dependences of transitions between states with defferent numbers of magnetic phases are studied in the case of a sample of a cubic ferromagnet with directions of easy magnetization ⟨111⟩.

Boundaries between states with different numbers of magnetic phases in a ferromagnet with easy directions ⟨100⟩ have already been studied in [1]. The present paper is devoted to the investigation of transitions which take place in a spherical sample U_3As_4 magnetized at 78 K in low fields oriented between the [001] and [111] directions in the (110) plane. The states with 1, 4 and 8 magnetic phases can exist in this case in dependence on the value and orientation of the field [2]. The formula $H_{t1} = NM_s \times (\sqrt{3} \cos \vartheta)^{-1}$ can be derived from the Néel geometric model [3] for the boundary between states with 8 and 4 phases. H_{t1} is the value of the magnetic field, ϑ is the angle between $\boldsymbol{H}$ and [001], N

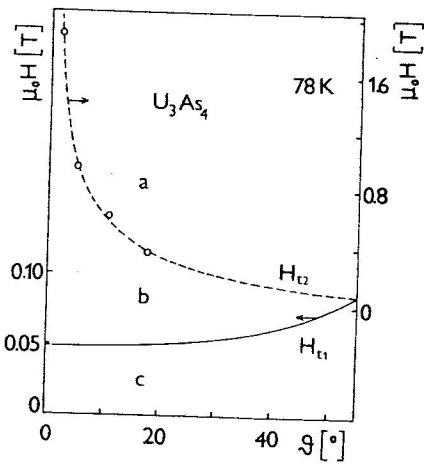

Fig. 1. Boundaries between states with different numbers of the magnetic phase in U_3As_4 in dependence on the value and orientation of the field. H lies between the [001] and [111] directions in the (110) plane. a, b and c — ranges of states with 1, 4 and 8 magnetic phases, respectively.

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is the demagnetizing factor of the sample and M_s is the spontaneous magnetization. The dependence $H_{t1}(\vartheta)$ calculated for U_3As_4 is in Fig. 1.

The points depict the boundary $H_{t2}(\vartheta)$ between states with 1 and 4 phases. The points were obtained from torque measurements on U_3As_4 in low fields [4]. The expressions $H_{t2}(0°) = NM_s + H_a$ and $H_{t2}(54.7°) = NM_s$ can only be calculated explicitly. The relation $H_a = -2K_1/M_s$ follows from the extreme condition of magnetic energy of a sample with 1 phase: $E = -HM_s \cos(\varphi - \vartheta) + E_a + \frac{1}{2} NM_s^2$ (anisotropy energy $E_a = K_1 (\sin^4 \varphi/4 + \sin^2 \varphi \times \cos^2 \varphi)$), φ is the angle between M_s and [001]. It can also be derived from the Néel geometric model that the relation $H_{t1} = H_{t2}$ must take place for the directions of easy magnetization. It provides the expression for H_{t2} (54.7) mentioned above. The only available results of suitable measurements in the ⟨111⟩ directions for US [5] show that this material (cubic ferromagnet with K_1 and M_s comparable with U_3As_4) exhibits at 78 K the considered transiton in the field 0.14 T which is near the theoretical value.

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