Referee report

on the doctoral thesis:

Denis Gorbunov

"Magnetic and magnetoelastic properties of *f-d* intermetallics with high content of 3*d*-metal"

Denis Gorbunov summarizes in the presented thesis the creditable sets of experimental data concerning structural and magnetic properties of the $R(Fe,Al)_{12}$ intermetallics that were received by extended study of their single crystals. In spite of results of the numerous studies of the polycrystalline $R(Fe,Al)_{12}$ intermetallics, the presented new and very valuable experimental data provide a credible background for a more obvious description and deeper understanding of a field and temperature evolution of complex magnetic structures and magnetic anisotropy in the $R(Fe,Al)_{12}$ intermetallics. The received results unambiguously verify that Denis Gorbunov is very skilled and precise experimentalist that is able to perform experimental research in the physics of condensed matter.

The thesis (five chapters, 142 references and 179 pages all together) is well organized. The systematic study was targeted on two important and dominant phenomena. Firstly, the effect of mutual Fe- and Al-content in the $LuFe_xAl_{12-x}$ intermetallics (with non-magnetic R-element) was studied within the homogeneity region $4 \leq x \leq 6$ with steps in composition $\Delta x = 0.5$ (Chapter 4). The huge effect of the increasing Fe-content on exchange interactions and magnetic anisotropy of $LuFe_xAl_{12-x}$ was verified and ascribed to the increasing occupation of the 8*j* sites in tetragonal crystal lattice by Fe atoms. Using the data, the magnetic phase diagram of the $LuFe_xAl_{12-x}$ intermetallics was constructed. In the following Chapter 5, the effect of R-Fe exchange interaction and single-ion magneto-crystalline anisotropy on fundamental magnetic properties of the RFe_5Al_7 intermetallics was systematically studied in intermetallics with R = Gd, Tb, Dy, Ho, Er and Tm. The conclusions are divided into two parts that collect a description of the observed phenomena in each chapter separately. A total absence of summarized tables does not make simple to follow the extended experimental results. However, they are described more clearly and in detail in the published papers of the candidate [108 – 114, 136] that also illustrate an ability of the candidate to participate in effective collaboration with several coauthors. I should like also to notice here the successful collaboration with team of the European Magnetic Field Laboratory in Dresden. The results of both, the magnetization and the magneto-elastic measurements at high magnetic fields up to

60T were fundamental for an understanding of the observed magnetic transitions within the presented model.

The phenomenological Kuzmin's model [127] (T = 0K, M_R and M_{Fe} saturated) was used to describe the magnetization isotherms of RFe_5Al_7 at 2 K and to determine the R-Fe exchange interaction. The crystal electric field (CEF) effect was taken in the model by single anisotropy constant K_R (p. 87) only. In the case of R_2Fe_{17} intermetallics, the CEF effect was successfully described in more detail (e.g. B.García-Landa et al., PRB 55 (1997) 8313). Were some theoretical works published that describe CEF effect in $R(Fe,X)_{12}$ in more detail?

Temperature dependence of spontaneous magnetization along easy axis is described by eqs. 5.1 – 5.4 (p. 81). The equation 5.2 seems to be nonsens0e, due to a misprint probably. The variable in the Brillouin function (eq. 5.3) depends on magnetization $M_{Fe}(T)$ and n_{RFe} only. Does it means that magnetization of the R-sublattice is governed by the Fe-sublattice only even in the case of $ErFe_5Al_7$, where molecular field is relatively low and comparable with external field? Spontaneous magnetization M_{Er} is zero (Fig. 5.81) at T_C = 200K (Fig. 5.98), however, the rapidly increasing magnetization with field in the case of the isotherms M(H,200K) or M(H,220K) of $ErFe_5Al_7$ (Figs. 5.69, 5.70) does not exhibit a paramagnetic behavior. A meaning of the used terms "spontaneous magnetization" and the Curie temperature T_C should be explained in more details.

The terms "paraprocess" and "high field susceptibility" are usually used for a slight increase of magnetization above its saturation (as in the case of the Pauli paramagnets). A use of these terms in the thesis (e.g. p. 82, 170) for the field induced changes in mutual orientation of R- and Fe-moments can be misleading.

A total list of all publications of the candidate was not enclosed.

Remarks and comments mentioned in this report do not reduce the very good quality of the thesis that demonstrates high level of both, the mastering of the used methods and the presentation of the received results. I can state that the candidate proved the ability to work independently in research. I recommend an acceptance of the thesis.

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