Referee report on the PhD thesis of Mgr. Jan Prokleška

"Cohesive and magnetoelastic properties of materials with strongly correlated electrons"

The thesis is devoted to a detailed investigation of the magnetism and magnetoelasticity in several metallic systems whose magnetic and other electronic properties are determined by the f electrons, 4f (NdRhSn, CePtSn, $PrCo_2Ge_2$) or 5f (UCoAl, UNiAl). In the cases of two compounds, the work combines measurements of bulk properties with microscopic studies by neutron diffraction (NdRhSn and $PrCo_2Ge_2$). Additionally, the magnetoelastic results on $GdRu_2Si_2$ and GdNi are briefly presented as well. The magnetic properties of numerous f-electron intermetallics have been studied in detail up to now, whereas the data collected on the magnetoelasticity (which includes several interesting effects, first of all the spontaneous and field-induced magnetostriction) are much poorer. The work of Mgr. Jan Prokleška contains many interesting results on magnetoelasticity of the rare-earth and uranium intermetallics and, therefore, contributes a new and important information to the understanding of this complicated fundamental phenomenon.

All samples used in the work are well-defined single crystals which is especially important because of the high anisotropy of both magnetic and elastic properties. One of the main (methodological) tasks of the study was to adjust a recently developed microdilatometric cell to a commercial cryomagnetic installation working in the wide field and temperature intervals. Taking into account this task, selection of the compounds for the study looks rather reasonable: their common features are the expected pronounced magnetoelastic anomalies which should accompany the spontaneous or field-induced magnetic phase transitions. Moreover, the compounds crystallize in several different structures with different symmetry. This helped Mgr. Jan Prokleška to test the microdilatometer under the different conditions and tasks. He modified the microdilatometer to fit it to the PPMS machine and created the corresponding software. The dilatometer is now successfully used for other studies carrying out in the Joint Laboratory of Magnetic Studies.

The thesis consists of 104 pages and is divided in 5 chapters. It contains 38 figures, 9 tables and list of 187 references. After a brief introduction (Chapter 1), the author gives a theoretical background (Chapter 2) of the phenomena considered in the original part of the thesis. The chapter provides an adequate introduction for further interpretation of the observed results. The experimental techniques and details of measurements are described in Chapter 3.

The main part of the thesis is formed by Chapter 4, containing the original results. General conclusions are summarized in the Chapter 5.

After critical reading of the thesis, I have several remarks and questions to the author.

1. Part 2.3.1, page 30. "For d_{U-U} above Hill limit the antiferromagnetism appears and above $d_{U-U} > 0.4$ nm no ferromagnetic compound is reported".

The general trend is right, but the particular number 0.4 nm is not correct. UGa_2 has $d_{U-U} = 0.402$ nm, i.e. > 0.4 nm, but it is one of the most strong uranium ferromagnets (I would say, the strongest one) with $T_C = 125$ K and $M_U = 2.7$ μ_B.

2. Also part 2.3.1, page 29. "Therefore, the magnetism in this type of compounds is typically observed with transition metals from the right part of a particular series", and previous sentences.

It would be good to add here that the situation is not so simple. In many isostructural solid solutions with clearly expected (on the base of the above picture) evolution of 5f-3d hybridization, a non-monotonous development of magnetism is observed. The best example is the onset of relatively strong ferromagnetism in the U(Fe,Co)Al system, i.e., between 2 paramagnets.

3. UCoAl and UNiAl. In the conclusion about these compounds (4.1.4, p. 72) the author, on my opinion, undersells somehow his results. He reduced their value to a confirmation of previous works with a minor new contribution. On my opinion, the observed deviation of "normal" phonon thermal expansion at high temperatures (80 K), far above the Néel temperature (UNiAl, 19 K) or characteristic temperatures connected with itinerant metamagnetism (UCoAl, 10-20 K), and its considerable suppression by high magnetic fields, are the very interesting and important results. They are needed to be discussed in more detail, taking into account different ground state of UCoAl and UNiAl as well as the fact that the electronic specific heat coefficient decreases at the metamagnetic transition in UCoAl and increases in UNiAl.

4. Part 4.2 on NdRhSn. In fact, the author limited the study to a detailed investigation of the intermediate antiferromagnetic phase. The ground-state phase should be described not so briefly, only by citation of references with contradictive results. Author's opinion about this phase is not clear. In conclusion to this part, he wrote "the same size of the magnetic and crystallographic unit cell below T_t". Does it mean that the ferromagnetic structure is confirmed? If so, is the structure collinear? This question arises because the magnetic moment

per the Nd atom was found in Ref. 144 to be smaller than for the single Nd^{3+} ion, and several versions to explain this difference appear.

5. NdRhSn, Fig. 4.9. Why, in difference with all other compounds studied, the data on volume changes with temperature as well as with field are not shown for this compound in a figure but only briefly mentioned in the text?

6. NdRhSn. For better understanding of the results, it would be useful to include the magnetization curves along the principle axes of a NdRhSn crystal in both the ground and intermediate phases, especially taking into account that they were obtained in Ref. 144 on the same single crystal, i.e., there is not doubt about possible "sample dependence".

I have found in the thesis some misprints and other minor errors (e.g., the caption to Fig. 4.2. Magnetovolume effect is not at "right top", as it is written, but at "left bottom") but their number does not exceed an acceptable level.

In conclusion, the work represents an extensive experimental study combining a serious methodological work with collection of interesting results and their proper interpretation. I think that the author, Mgr. Jan Prokleška, fully satisfies the requirements of the PhD degree.

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