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Reviewer report
on the habilitation thesis "Magnetism in UTX compounds"
by Dr. Jan Prokleska

The thesis presents selected original results of a project aiming to study "ferromagnetic quantum criticality in clean systems" where Dr. Prokleska has been the main proposer and principal investigator. The thesis consists of nine articles resulting from that project and a summary of about 40 pages, which reviews the scientific context and highlights the most relevant scientific advances.

Studies of quantum critical phenomena are one of the key topics in the research on strongly correlated electron systems and large progress has been made e.g. with quantum critical states reached by substitution and also with quantum criticality in clean systems reached by the application of high pressure on e.g. antiferromagnetic Kondo lattice systems. The feasibility of investigations of itinerant ferromagnetic quantum criticality, however, revealed to be much more restricted because in many cases features of ferromagnetic quantum criticality are blurred by disorder and suitable clean systems, which can be pressure tuned to their itinerant ferromagnetic critical point, are rare and their experimental studies are constrained by the required extreme experimental conditions. In this context, Dr. Prokleska selected one isostructural family of uranium intermetallics, namely those with the hexagonal ZrNiAl structure-type, which provides a rich variety of magnetic ground states and thus offers suitable candidate materials for the studies targeted in his project.

The experimental work in the thesis divides basically into six major categories: (i) preparation of single crystals and a detailed analysis of related experimental conditions and the impact of thermal treatment history on relevant properties such as e.g. residual resistivity and coercive magnetic field of ferromagnetic crystals, in order to achieve optimum crystal quality for subsequent studies of physical properties, (ii) high pressure studies of the resistivity and magnetization of ferromagnetic UTX compounds, e.g. UCoGa and URhGa, (iii) extensive substitution studies for probing the vicinity of e.g. paramagnetic URhAl towards a ferromagnetic critical point, (iv) studies of the interchangeability of substitution and pressure, (v) systematic studies of the critical behaviors of ferromagnetic phase transitions in UTX compounds and their analysis with respect to universality classes, (vi) magnetic-force-microscopy studies of the evolution of surface ferromagnetic domains in the magnetization process.

The scientific progress presented in the thesis by Dr. Prokleska appears rather significant and spans a wide range of experimental as well as theoretical aspects ranging from the identification and characterization of an itinerant ferromagnetic tricritical point, an evaluation of the universality classes of ferromagnetic phase transitions and their discussion of their relation to the degree of uranium 5f localization, analysis of spin-fluctuation features reflecting the degree of 5f localization and their interrelation with opposite pressure responses of the Curie temperatures of UCoGa and URhGa, observation and discussion of extremely narrow ferromagnetic domain walls, and finally, significant progress on crystal preparation and insight on thermal history effects, which have, of course, been the basis for the above mentioned scientific advances. All together, these achievements manifest a rather substantial progress not only in the understanding of the magnetism of UTX compounds, but also important insight on general features of 5f magnetism with variable degree of delocalisation and insight on itinerant ferromagnetic quantum criticality in general.

The nine publications are summarized in the habilitation thesis, among which one is most prominently published in NPJ Quantum Materials, others well published in Physical Review, AIP, IOP and Elsevier journals, and all together they feature a high scientific level. The articles and the thesis summary are well and precisely written, and the research presented therein is in line with the current scientific state of the art, thus, demonstrating the broad knowledge of Dr. Prokleska in diverse fields of solid state physics and, of course, a wide range of experimental skills and solid theoretical insight. The originality check report via the *Turnitin* system reveals, of course, text matches of the summary with the nine publications summarized therein, but it does not provide any indication of true plagiarism. Considering that the substantial scientific progress presented in the thesis is essentially the result of one larger project conducted by Dr. Prokleska as the main proposer, it demonstrates his excellent qualification as an independent researcher. His Scopus record shows an overall output of 139 publications in a period of 18 years which received, till present, 1680 citations and resulted in a current h-index of 17, which I rank above-average of typical habilitation candidates.

In conclusion, I would appraise the results presented in the habilitation thesis as being of a high scientific level and manifesting a significant contribution to the research on 5f magnetism. Based on my review of the habilitation thesis and generally available information, I am convinced that the high quality and comprehensiveness of the research of Dr. Prokleska clearly meets the profile of requirements for a habilitation in the field of experimental solid state physics. I thus, recommend appointing Dr. Prokleska as associate professor.

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