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Report on the doctoral thesis
"Investigation of spin structure and dynamics in magnetically ordered thin films"
presented by Tomáš Janda

I was appointed as referee for the doctoral thesis of Tomáš Janda, entitled 'Investigation of spin structure and dynamics in magnetically ordered thin films'. It was a pleasure to read this dissertation both due to its impressing scientific level as well as due to the quality of the text.

Tomáš Janda describes his experiments and results on the micromagnetic structure and the dynamics of the magnetic properties in a variety of samples. This includes magnetic semiconductors such as GaMnAsP with an out-of-plane magnetic anisotropy for the study of optically driven domain wall motion in a ferromagnetic system. Ultrafast phenomena were studied for Fe as a ferro-magnet and CuMnAs as an antiferromagnet, where a PIN photodiode was formed and used to generate very short current pulses. Optical writing and imaging of domains in antiferromagnets was investigated with a non-collinear antiferromagnet (Mn_3Sn), and a collinear system (CuMnAs).

For imaging, magneto-optical effects have been employed on a very high level of technical quality. In particular, the optically driven domain wall motion and the imaging of magnetic domains in are highly challenging tasks, and Mr. Tomáš Janda has proven his capabilities to successfully operate such systems, to evaluate the results on an excellent scientific level and to draw well-founded physical conclusions.

The topic of the thesis is original and of large interest for solid state physics. In particular, the coupling between spin and motion of charge carriers as well between the magnetization and charge- and spin-currents are at present major research topics that also promise many applications in, e.g., data storage and -processing. Consequently, the research community produces a large amount of results and corresponding publications. The work of Tomáš Janda is in the front line of this research and makes an original and important contribution to ferro- and antiferromagnetic spintronics.

The written thesis is clearly organized, gives a sound theoretical background, reports all necessary information on the scientific research work and the results obtained, and gives a very good overview on the publications in the field. The

research work has led to five publications in very well recommended journals, and Tomáš Janda is first author of four of them. Moreover, he has contributed to another eight publications. Thus, the quality of the written thesis as well as the quantity and quality of the publications is far above average.

Given that Tomáš Janda has done his work in one of the most successful groups worldwide, he of course was supervised by very active researchers with outstanding track records. He thus had a training and supervision of very high quality. The thesis, however, clearly documents, that he has major and independent contributions to all important topics of the research work. He, namely, constructed imaging systems used in the thesis, did all experiments, and evaluated the obtained results. It is clear, that he has demonstrated an impressing capability to perform creative scientific work. His results have advanced the field, and I look forward to his next experiments and results.

In the context of the work, I have only some specific questions to the candidate:

1: In the preface, one finds: 'This makes the magnetic order invisible on the outside….'. Could you comment what "invisible" means in this context?

2: Can you comment on the choice of the vector potential $\boldsymbol{A}$ in section 1.1 of your thesis?

3: In ferromagnets, there are often complicated magnetic domain wall structures that can include cross-tie walls and / or Bloch-points. Can you comment on the importance of such structures in antiferromagnets?

4: In many of your experiments, you have used a laser spot to locally heat a sample and detected a thermally induced global voltage. Can you comment about the family of effects that can arise when a magnetic material experiences a temperature gradient? Can you give an estimate of the temperature gradient around the laser spot (in- and out-of-plane)?

5: A more general question: What new applications of f- and af-spintronics do you expect in the short and long-term?

The presented thesis and the related publications show Mr. Tomáš Jandas capability of independent and creative scientific work. The quality of his thesis is far above average (I would rate it in the top ten percent). I thus can recommend that Mr. Janda is awarded the Ph.D. degree, and wish him all the best for the future.

Yours sincerely,

Prof. Dr. Günter Reiss