Review report

of the Karel Carva habilitation thesis

"Magnetization dynamics in solids studied by microscopic theory methods"

The papers that are reviewed in the habilitation thesis are focused belong to the new and fast growing field of antiferromagnetic spintronics. Using microscopic approaches, the applicant addresses such important problems as the dynamics of antiferromagnets in presence of current, the processes of ultrafast magnetization, induced by optical pulses, efficiency of spin transfer at the interfaces. Solving these problems deepens our understanding of underlying physics and is also important for experimental observations.

It should be noted that application of micromagnetic calculations to the magnetic systems is rather challenging, as the energy scale of many observables important for magnetic phenomena is at the edge of computational accuracy. Nevertheless, as seen from the thesis, these challenges can be overcome and micromagnetic calculations can predict such observables as critical temperature of magnetic ordering, magnetic anisotropy associated with the critical magnetic fields, spin torques etc.

The manuscript includes four chapters which introduce the basic concepts and the most spectacular results of the applicant. In the first chapter the author explains the principles of microscopic calculations in application to spin dynamics and magnetic anisotropy and illustrates them with an example of FeCo material. In the second chapter the author considers two not only interesting but very important cases of an antiferromagnet and topological insulator. The applicant illustrates the possibilities of microscopic approach by calculating temperature dependencies of sublattice magnetization which allow to determine the N\'eel temperature with high accuracy. In case of topological insulator Bi2Se3 the microscopic calculations give also the values of exchange interaction and allow to determine the Curie temperature as a function of doping. The third chapter focuses on spin-induced magnetization dynamics. Study of spin-mixing conductance and calculation of spin torques play a crucial role for spintronics. In many cases direct observation of these variables for multi-layered samples is difficult or even unaccessible and there are microscopic calculations which guide the experiments. The last, fourth chapter includes the results for which the applicant is recognisable in the community: modelling of ultrafast demagnetization dynamics in Gd-based ferrimagnets. Time-dependencies of the magnetization obtained from the three-temperatures model show good agreement with experimental data and give a clear picture of physical mechanisms behind this complicated phenomenon.

From my point of view, the papers of applicant have a great impact on the field of spintronics. He has high citational index which grows steadily. The habilitation thesis demonstrate abilities of applicant to provide the research in a highly competitive field, to collaborate effectively with the experimentalists, to generalise microscopic approach for

new systems (e.g. noncollinear antiferromagnets) and phenomena (e.g. spin torques). I believe that the applicant is a mature scientist and recommend to honour him with the applied degree.

Prof. Dr. Olena Gomonay

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