MA 8: INNOMAG e.V. Dissertationspreis / Ph.D. Thesis Prize (2020)

The Working Group Magnetism (Arbeitsgemeinschaft Magnetismus der DPG) awards a dissertation prize whose aim is to recognise outstanding research done within the framework of a doctorate and communication of this research in an excellent way, both verbally and in writing. The prize is kindly supported by INNOMAG e.V. In this finalists session, pre-selected nominees will present and defend their dissertation. Afterwards, the prize committee decides on the winner of the INNOMAG e.V. Dissertation Prize 2020 and the award of 1000 EURO.

Time: Wednesday 10:00–12:10 Location: H2

MA 8.1 Wed 10:00 H2

Spin-orbit driven transport: Edelstein effect in Rashba systems and topological materials — •Annika Johansson — Martin Luther University Halle-Wittenberg, Halle, Germany

A charge current driven through a system with broken inversion symmetry can generate a spatially homogeneous spin polarization. This phenomenon is known as Edelstein effect [1,2]. Using semiclassical Boltzmann transport theory, I investigate the Edelstein effect in two- and three-dimensional Rashba systems and topological materials. Whereas the current-induced spin density in conventional isotropic Rashba systems is in-plane and perpendicular to the charge current, I show that the direction as well as the magnitude of the induced spin density can be strongly modified in systems with reduced symmetry, which provides new opportunities to control and manipulate the electrically induced magnetization [3].

Further, I predict a highly efficient Edelstein effect in three-dimensional Weyl semimetals, mainly originating from their topological surface states due to their favorable Fermi surface geometry, their strong spin polarization and the enhanced momentum relaxation time [4]. In comparison to Rashba systems, the Edelstein effect in Weyl semimetals is enhanced by at least one order of magnitude.

[1] A. Aronov and Y. Lyanda-Geller, JETP Lett. **50**, 431 (1989).
[2] V. Edelstein, Solid State Commun. **73**, 233 (1990).
[3] A. Johansson et al., Phys. Rev. B **93**, 195440 (2016).
[4] A. Johansson et al., Phys. Rev. B **97**, 085417 (2018).

MA 8.2 Wed 10:25 H2

Highly Efficient Domain Wall Motion in Ferrimagnetic Bilayer Systems at the Angular Momentum Compensation Temperature — •Robin Bläsing — RWTH Aachen University, Aachen, Germany

Within the last decade, the efficiency of current-induced motion of magnetic domain walls (DWs) has been enhanced tremendously by utilizing the exchange coupling torque (ECT) in synthetic antiferromagnetic structures. The focus of the present study is on exploring this mechanism in ferrimagnetic layers consisting of a transition metal layer and a rare earth metal layer which couple antiferromagnetically. The DWs are moved by nanosecond-long current pulses and their velocity is determined by using Kerr microscopy at various temperatures. It is shown here that the motion is most efficient at a certain temperature T_{A} at which the angular momenta of both layers compensate each other and the ECT is maximized. Since the device temperature is significantly increased by the current pulses, taking into account Joule heating is of major importance when determining T_{A}. The results of current-induced domain wall motion in the present thesis can be used for the development of novel storage devices and improving their efficiency.

MA 8.3 Wed 10:50 H2

Spintronics with Terahertz Radiation: Probing and driving spins at highest frequencies — •Tom Sebastian Seifert — Freie Universität Berlin, Berlin, Germany

Spin-orbit interaction (SOI) will be of central importance for future spin-based electronics (spintronics) as it permits, for example, the conversion of charge into spin currents and vice versa via the spin Hall effect. It is highly interesting to study spin dynamics at terahertz (THz) frequencies because spintronic devices should eventually operate at THz rates. In our experiments, we employ femtosecond optical and THz pulses to trigger ultrafast spin and charge dynamics in magnetic thin-film stacks featuring a strong SOI. In particular, we study THz emission from multilayers consisting of magnetic and a nonmagnetic materials [1,2,3]. By varying the magnetic layer material, we aim at identifying the different mechanisms that can lead to the ultrafast generation of spin currents. Such mechanisms include spin-voltage-driven transport [4] by conduction-band electrons in metal-metal stacks and magnon-mediated transfer of spin angular momentum in insulator-metal stacks [5]. Finally, we turn from probing to driving spins at highest speeds by demonstrating the picosecond writing speed of an antiferromagnetic memory element based on CuMnAs employing strong THz pulses[6]. References: [1] T. Seifert et al., Nat. Phot. 10 (2016). [2] T. Kampfrath et al., Nat. Nanotech. 8 (2013). [3] T. Seifert et al., APL, 110, 252402 (2017). [4] R. Rouzegar et al., ArXiv 2103.11710 (2021) [5] T. Seifert et al., Nat. Commun. 9 (2018). [6] K. Olejnik et al., Science Adv. 4 (2018).

MA 8.4 Wed 11:15 H2

Linear and nonlinear spin waves in nanoscale magnonic structures for data processing — •Qi Wang — Fachbereich Physik and Landesforschungszentrum OPTIMAS, Technische Universität Kaiserslautern, D-67663 Kaiserslautern, Germany

Spin waves, and their quanta magnons, attract attention as novel data carriers instead of electrons in future low-energy data processing units due to their short wavelength, low losses, and abundant nonlinear phenomena. Although separated spin-wave logic gates have already been demonstrated, the smallest sizes of these elements are in the ranges of a few micrometers and are not competitive with the current state-of-the-art CMOS technology. Moreover, the realization of an integrated magnonic circuit is still an unresolved challenge.

The objective of this talk is to present a nanoscale magnon directional coupler as a universal data processing unit for performing different logic operations and suitable for the integration into a magnonic circuit. First, the spin-wave characteristics in the nanoscale waveguides were studied theoretically and experimentally. Based on this knowledge, a nanoscale directional coupler was designed and its linear and nonlinear functionalities were studied using Brillouin Light Scattering spectroscopy. Following, the first integrated magnonic circuit consisting of two couplers and performing half-adder functionality was studied numerically. Finally, we introduced the inverse-design method into the field of magnonics and demonstrated its high performance, flexibility, and potential. These studies were supported by ERC StG MagnonCircuits.

Short break followed by bestowal of INNOMAG e.V. Dissertationspreis / Ph.D. Thesis Prize (2020)