



TECHNISCHE UNIVERSITÄT
CHEMNITZ

Institut für Physik Physikalisches Kolloquium



Mittwoch, 16.01.2019, um 16:00 Uhr

Ort: Reichenhainer Str. 90;

Zentrales Hörsaal- und Seminargebäude,

Raum 2/N013

Dr. Jörg Wunderlich

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Spin-Orbit Coupling effects in Antiferromagnets: From the spin Hall effect to electrical writing and reading of *reversed* Néel vector states in a collinear antiferromagnet

Modern magnetic storage technologies are based on classical spin-transfer magneto resistance and spin transfer torque (STT) effects enabling the detection and manipulation of magnetisation in ferromagnets [1]. A promising new development in spintronics considers antiferromagnets (AFs) as active elements for robust magnetic storage and ultrafast information processing. AFs possess a microscopic staggered magnetic order with no net-magnetization, resulting in much faster dynamics (THz) than the one of ferromagnets (GHz) [2,3]. Although AFs have been known for about eighty years, their (spin) transport properties have only attracted interest lately. This is because it was believed to be difficult to manipulate and to detect the magnetic state of AFs [4,5]. Recently, large magnitude anisotropic magneto-transport effects in the tunnelling transport regime have indicated the possibility to detect AF order electrically [6-8]. Apart from STT, also relativistic current induced spin-orbit torque (SOT) effects due to the Spin Hall effect (SHE) [9,11] and the inverse spin Galvanic effect (iSGE) [9-11] can be used to manipulate magnetic moments [12-18]. SOT effects require inversion asymmetry (IA) and were first observed in a ferromagnetic semiconductor with IA crystal lattice [12] and systems with structural IA [13-18]. It has been shown that SOT effects can also act on the magnetic states of AFs [19]. They have been observed in AF thin films with structural IA [20] and SOT-driven switching of AF states has been recently realised in CuMnAs, a system with IA of the individual magnetic sublattices [21]. In my lecture, I will discuss potentially large magnitude anisotropic magneto-transport effects able to detect the antiferromagnetic Néel vector order parameter. Then, I will show that SHE, iSGE and the corresponding current induced SOTs can manipulate the Néel vector and can trigger switching between reversed Néel vector states by current pulses of opposite polarity. Finally, I will show that SOT enables also the detection of reversed AF states by detecting the nonlinear anisotropic magneto-transport response [22].

[1] C. Chappert, et al., Nat. Mater. 6, 81323 (2007). [2] L. Neel, http://www.nobelprize.org/nobel_prizes/physics/laureates/1970/lecture.pdf. [3] T. Jungwirth, X. Marti, P. Wadley, and J. Wunderlich, Nat. Nanotechnol. 11, 231 (2016). [4] A. H. MacDonald and M. Tsoi, Philos. Trans.A. Math. Phys. Eng. Sci. 369, 3098 (2011). [5] H. V. Gomonay, et al., Phys. Rev. B 85, 134446 (2012). [6] A. B. Shick, et al., Phys. Rev. B 81, 212409 (2010). [7] B. G. Park, et al., Nat. Mater. 10, 347 (2011). [8] I. Fina, et al., Nat. Commun. 5, 4671 (2014). [9] Y. K. Kato, et al., Science 306, 1910 (2004). [10] Y. K. Kato, et al., Phys. Rev. Lett. 93, 176601 (2004). [11] Garnichev, et al., arxiv (2004), JMMM 300, 127 (2006); Kato, et al., Phys. Rev. Lett. 93, 176601 (2004); Wunderlich, et al., arxiv/cond-mat/0410295v1 (2004); Phys. Rev. Lett. 94, 047204 (2005); Silov, et al. Appl. Phys. Lett. 85, 5929 (2004). [12] A. Chernyshov, et al., Nat. Phys. 5, 656 (2009). [13] I. M. Miron, et al., Nature 476, 189 (2011). [14] L. Liu, et al., Science 336 555 (2012). [15] A. Manchon, et al., Phys. Rev. B 78, 212405 (2008). [16] D. Fang, et al., Nat. Nanotechnol. 6, 413 (2011). [17] I. M. Miron, et al., Nat. Mat. 10, 419 (2011). [18] S.-H. Yang, et al., Nat. Nano. 10, 221(2015). [19] J. Zelezny, et al., Phys. Rev. Lett. 113, 157201 (2014). [20] H. Reichlova, et al., Phys. Rev. B 92, 165424 (2015). [21] P. Wadley, et al., Science 10.1126 (2016). [22] J. Godinho, H. Reichlova, D. Kriegner, V. Novak, K. Olejnik, Z. Kaspar, Z. Soban, P. Wadley, R. P. Campion, R. M. Otxoa, P. E. Roy, J. Zelezny, T. Jungwirth, J. Wunderlich., arXiv:1806.02795 [cond-mat] (2018).

Alle Zuhörer sind ab 15:45 zu Kaffee und Tee vor dem Hörsaal eingeladen.

Informationen zum Vortrag erteilt:
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