Spin-orbit induced topological magnetization dynamics for GreenIT

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In our information-everywhere society IT is a major player for energy consumption and novel spintronic devices can play a role in the quest for GreenIT. Reducing power consumption of mobile devices by replacing volatile memory by fast non-volatile spintronic memory could also improve speed and a one-memory-fits-all approach drastically simplifies the microelectronic architecture design. Novel low power storage-class memory devices have been proposed, where switching by alternative means, such as spin-polarized currents is used [1]. For this we develop new highly spin-polarized materials and characterize the spin transport using THz spectroscopy [2].

Topological spin structures that emerge due to the Dzyaloshinskii-Moriya interaction (DMI), such as chiral domain walls and skyrmions possess a high stability and are of key importance for magnetic memories and logic devices [1,2]. We have investigated in detail the dynamics of topological spin structures, such as chiral domain walls that we can move synchronously with field pulses [3].

For current-induced dynamics we find in addition to spin transfer torques [1] that spin-orbit torques dominate the dynamics. We determine these independently of the DMI [4,5] and we find that the sign of the DMI is opposite for stacks with CoFeB compared to stacks with a CoFe as the magnetic layer due to B diffusion at the interface [4].

For strong DMI novel topologically stabilized skyrmion spin structure emerge and we demonstrate for the first time that we can move a train of skyrmions in a "racetrack"-type device [1] due to spin-orbit torques reliably [6] and we find skyrmion lattices at room temperature in confined geometries [6].

Finally we study the field - induced dynamics of skyrmion [7] and find that the trajectory of the skyrmion's position is accurately described by our quasi particle equation of motion. From a fit we are able to deduce the inertial mass of the skyrmion and find it to be much larger than inertia found in any other magnetic system, which can be attributed to the non-trivial topology [7].

References:

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