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Spin - orbit coupling in ferro- and antiferromagnets

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The coupling of the mechanical lattice degree of freedom to the spin system by spin-orbit effects gives rise to a range of exciting mechanisms that can be key enablers for future low power GreenIT devices.
The three main challenges that need to be met concern the stability of spin structures, their efficient manipulation and finally the low loss transport of spin information [1].
So firstly to obtain ultimate stability, topological spin structures that emerge due to the Dzyaloshinskii-Moriya interaction (DMI) at structurally asymmetric interfaces, such as chiral domain walls and skyrmions with enhanced topological protection can be used [2-4]. We have investigated in detail their dynamics and find that it is governed by the topology of their spin structures [3]. By designing the materials, we can even obtain a skyrmion lattice phase as the ground state of the thin films [3].
Secondly, for ultimately efficient spin manipulation in ferromagnets and antiferromagnets, we use spin-orbit torques, that can transfer more than 1ħ per electron by transferring not only spin but also orbital angular momentum. We combine ultimately stable skyrmions with spin orbit torques into a skyrmion racetrack device [3], where the real time imaging of the trajectories allows us to quantify the novel skyrmion Hall effect [4].
Finally to obtain efficient spin transport, we study the coupling between phonons and magnons in ferro- and antiferromagnetic insulators that can be used as spin conduits for long distance spin transport [5]. We establish that both, bulk and interface effects play a key role and together govern the measured spin transport signals in ferro-, ferri- and antiferromagnetic compounds [5,6]

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