Spin-orbitronics and orbitronics for low power applications probed by x-rays

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Novel spintronic devices can play a role in the quest for GreenIT if they are stable and can transport and manipulate spin with low power. Devices have been proposed, where switching by energy-efficient approaches is used to manipulate topological spin structures [1,2].

We combine ultimate stability of topological states due to chiral interactions [3,4] with ultra-efficient manipulation using novel spin torques [3-5]. In particular orbital torques [6] increase the switching efficiency by more than a factor 10. By time-resolved magnetic STXM and PEEM imaging, we can reveal the details of the spin structure dynamics during excitation by these torques.

We use skyrmion dynamics for non-conventional stochastic computing applications, where we developed skyrmion reshuffler devices [7] based on skyrmion diffusion, which also reveals the origin of skyrmion pinning [7]. Such diffusion can furthermore be used for Token-based Brownian Computing and Reservoir Computing [8].

We go beyond simple ferromagnets and study multilayers with antiferromagnetic coupling termed synthetic antiferromagnets. We find that the diffusion dynamics is drastically enhanced due to the topology and efficient dynamics can be induced by spin torques [9]. Finally, we find novel topological spin structures, such as bi-merons that are stabilized in synthetic antiferromagnets [10] with exciting dynamics revealed by time-resolved x-ray microscopy.

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Bio

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He received his PhD at the University of Cambridge, after which he joined the IBM Research Labs in Zürich. He was a junior group leader at the University of Konstanz and then became associate professor in a joint appointment between the EPFL and the PSI in Switzerland before moving to Mainz. His research focuses on nanomagnetism and spin dynamics on the nanoscale in new materials. His research covers from blue sky fundamental science to applied projects with major industrial partners. He has published more than 450 articles and given more than 250 invited talks. He is a Fellow of the IEEE, IOP and APS, member of the German National Academy of Science and Engineering and has been awarded a number of prizes and scholarships. He has been one of the 2020/2021 IEEE Magnetics Society Distinguished Lecturers.
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