GP-Spin Seminar

Basic Tutorial:

Spin-Orbitronics and Orbitronics

4:30 pm, Thursday, **May 30**, 2024

Advanced Tutorial:

Combining the best of all worlds: Altermagnets – a new class of magnets

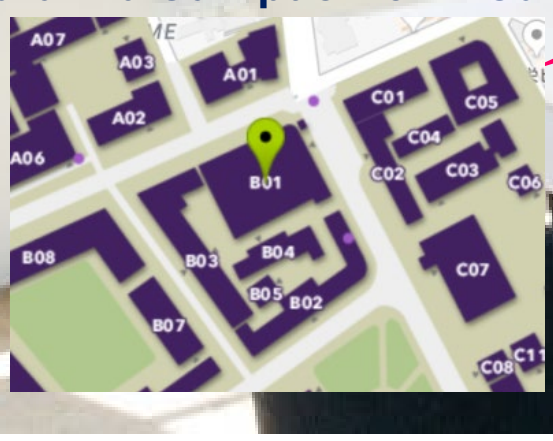
4:30 pm, Friday, **May 31**

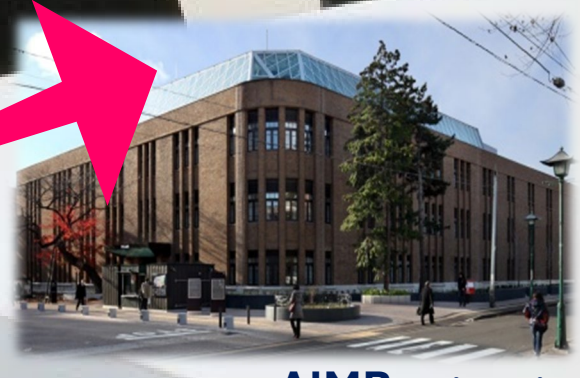
Professor Dr.
Mathias KLÄUI

Instutute of Physics & Materials Science in Mainz, Johannes Gutenberg Universiy

Venue: **Seminar Room**, 2nd floor, AIMR Main Building
Katahira Campus, Tohoku University

Katahira Campus North Gate





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Basic Tutorial

Spin-Orbitronics and Orbitronics

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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 enabling low power memory devices.

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].

References

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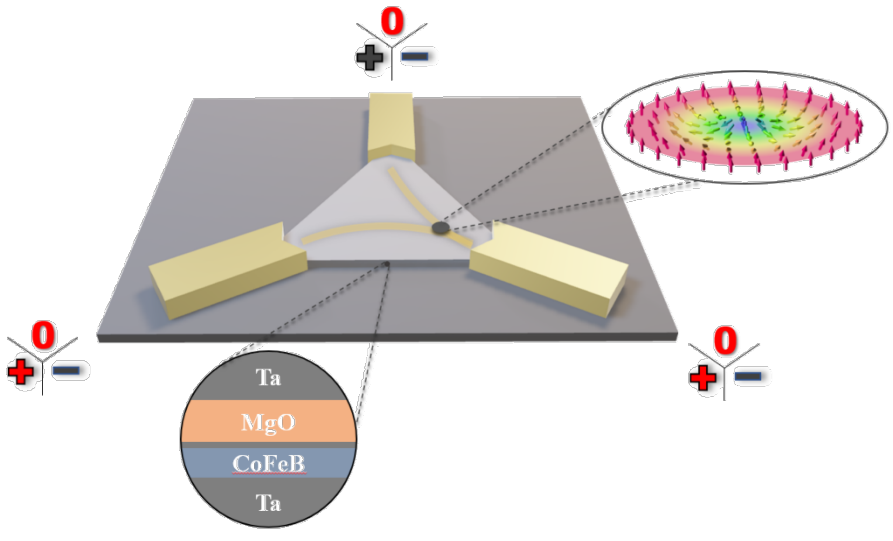
M. Brems et al., Appl. Phys. Lett. 119, 132405, 202



Advanced Tutorial

Combining the best of all worlds: Altermagnets – a new class of magnets

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So far, spintronics has relied on ferromagnetic materials with parallel alignment of spins. However, ferromagnets exhibit comparatively slow dynamics. Recently antiferromagnets have moved to the forefront of research. While known for a long time, antiferromagnetically ordered systems have previously been considered, as "interesting but useless". However, since antiferromagnets potentially promises faster operation, enhanced stability and higher integration densities, they could potentially become a game changer for new spintronic devices. Here we show how antiferromagnets can be used as active spintronics devices by demonstrating the key operations of "reading" [1], "writing" [2], and "transporting information" [3] in antiferromagnets. While possible, it has turned out to be difficult to read and write antiferromagnets because of the zero spin – polarization due to the antiparallel alignment of spins and thus zero net moment.

Here we combine the best of (i) ferromagnets: spin-polarized currents and (ii) antiferromagnets: zero net moment with ultra-fast dynamics in a new class of magnets: ALTERMAGNETS [4].

Going beyond ferromagnets and antiferromagnets, we develop altermagnetic materials [4,5]. This recently identified class magnets with collinear antiferromagnetic magnetic order can exhibit spin splitting and particular spin transport properties and torques [4]. Here we demonstrate the spin splitting in RuO_2 and CrSb [5] und analyze particular symmetries of the Hall signal in the altermagnet hematite [6].

References

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