Seminar: Hard Condensed Matter Theory

JOHANNES GUTENBERG UNIVERSITÄT MAINZ

Room: Galilei Raum, 01-128 (Staudinger Weg 9)
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Spin-orbit effects from ab-initio theory: from electron scattering to chiral spin textures

The spin-orbit interaction (SOI) is at the heart of spin orbitronics and gives rise to unique physical effects. The vision is to exploit SOI for the generation, transport and detection of spin currents without magnetic fields, i.e., the all-electric control of the electron spin, or to stabilize new magnetic states with non-trivial topology and novel properties. Crucial from a materials perspective how much lattice defects, impurities and –in general– symmetry breaking alter such important spin-orbit effects like spin-relaxation, the Hall effects and Dzyaloshinskii-Moriya interaction (DMI).

I will introduce the Korringa-Kohn-Rostoker (KKR) method and focus on our new developments for the calculation of aforementioned spintronic effects with predictive power. I will show selected examples to highlight the capabilities of our approach, starting from our discovery of a colossal anisotropy of spin-relaxation in metals [1-3], which originates from a pure band-structure effect. By explicitly including scattering properties off impurities, we predict the electron skew-scattering contribution to the Hall effects in ferromagnets for the first time [4] and analyze complex disorder in the L10-ordered alloy FePt [5]. Finally, I will turn to magnetic interactions and highlight the importance of symmetry-breaking for an anisotropic DMI, which leads in a double-layer Fe on W(110) to the stabilization of anti-skyrmions rather than skyrmions [6]. To conclude, I will analyze the effect of intermixing on the DMI at the prominent Co/Pt interface employing the powerful Coherent Potential Approximation (CPA) for a disordered system [7].

[1] Zimmermann et al., Phys Rev. Lett. 109, 236603 (2012), [2] Zimmermann et al., Phys. Rev. B 93, 144403 (2016), [3] Long et al., Phys. Rev. B 90, 064406 (2014), [4] Zimmermann et al., Phys. Rev. B 90, 220403(R) (2014), [5] Zimmermann, et al., Phys. Rev. B 94, 060406(R) (2016), [6] Hoffmann et al., Nature Commun. 8, 308 (2017), [7] Zimmermann, et al., in preparation.

All interested are cordially welcome!

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