Seminar: Hard Condensed Matter Theory

JOHANNES GUTENBERG UNIVERSITÄT MAINZ

Room: Galilei Raum, 01-128 (Staudinger Weg 9)
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Topological transport in non-Abelian spin textures from first principles

The antiferromagnetic (AFM) chiral textures such as domain walls and skyrmions are rapidly entering the world of spinorbitronics and skyrmionics owing to the bright prospects associated with their utter robustness and operation speed. In my talk I will review our recent advances in theoretical understanding and modeling of spin transport properties of antiferromagnetic skyrmions [1]. In contrast to ferromagnetic skyrmions [2], the semiclassical "adiabatic" framework in antiferromagnets becomes rather intricate owing to the generally more complex gauge symmetry of these systems. To overcome this difficulty, we developed an advanced and powerful density functional theory (DFT) based methodology for computing the transport properties of AFM textures [3]. Within this approach, based on the DFT description of collinear AFM materials, we employ the Boltzmann formalism together with real-space real-time evolution of electrons in AFM textures to compute the currents arising in response to an electric field. By considering skyrmionic AFM textures in selected "synthetic" and "intrinsic" antiferromagnets we uncover the emergence of pronounced pure transversal spin currents, and we suggest that the corresponding topological spin Hall effect could be used not only to detect the AFM skyrmions, but also to possibly employ them as spin current generators in AFM-based devices [1]. We scrutinize the sensitivity of the topological spin Hall effect with respect to the details of the electronic structure and skyrmion shape, suggesting that the magnitude and sign of the novel phenomenon can be engineered by tuning such system's parameters as thickness, band filling, and magnetic exchange parameters. Furthermore, we consider an extension of the non-Abelian wave-packet dynamics to magnetic textures made of frustrated antiferromagnets, with particular focus on the impact of local non-collinearity on traversing electrons. Besides being an important step in our understanding of the topological properties of ever more complex skyrmionic systems, our results bear great potential in putting chiral antiferromagnets on the track of skyrmionics.

[1] P. M. Buhl, et al., Phys. Status Solidi RRL 11, 1700007 (2017).[2] C. Franz, et al., Phys. Rev. Lett. 112, 186601 (2014).[3] G.Bihlmayer, P. M. Buhl, et al., Psi-k Scientific Highlight, February (2018).

All interested are cordially welcome!

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