On-line SPICE-SPIN+X Seminars

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The seminar will be via Zoom (Meeting ID: 871 5688 6829**) and live streamed in the SPICE YouTube Channel.**

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Modeling of magneto-thermodynamics phenomena

Magnetisation dynamics usually takes place at non-zero temperatures, i.e. in a thermodynamical environment. Many recent applications (e.g. heat-assisted magnetic recording) make use of temperature to influence the spin dynamics. On the contrary, others application (e.g. magnetocaloric) use magnetization changes to produce heat. In the present talk I will discuss our multi-scale framework to model both situations. I will review some recent results concerning the influence of temperature on domain wall width [1] or skyrmion size [2] and illustrate their motion under thermal gradient via the spin-Seebeck effect. Typically, domain walls or skyrmion are moving to the hot region, abeit for skyrmions with a skyrmion Hall angle. For the domain wall motion, especially in the perpendicular materials, we observed their oscillations as a function of time, particularly in the presence of pinning centers. For skyrmions, we also report a motion to the cold region in multilayered systems contrary to what happens in the ultrathin single layer case.

Since temperature can change magnetisation, there is a well-known reciprocal effect: magnetisation changes produce heat, used for example in magnetic hyperthermia for cancer treatment. These effects are typically considered through the area of hysteresis cycle, while I will underline the important role of local heating and magnetization dynamics [3]. Similarly, since the domain wall can be moved under thermal gradient, one can expect the reciprocal effect - the domain wall motion could be accompanied by a temperature release (the spin-Peltier effect for domain wall [4]). In this case the released temperature is proportional to the ratio of domain wall velocity/width. Here we consider the antiferromagnetic MnAu material, where ultra-high velocities are predicted when the domain wall is moved under current by spin-orbit torque. Importantly, when the domain wall velocities are high, its width decreases due to relativistic effects. We estimate that the domain wall motion in this material can be accompanied by a localized ultrafast heat pulse as strong as 0.1K, much higher than for coherent magnetization switching. The energy release is especially efficient under elastic collision of domain walls with the same topological charge [5].

[1] R.Moreno et al Phys. Rev. B 94, 104433 (2016)
[2] R.Tomasello et al Phys. Rev. B 97, 060402(R) (2018)
[3] C.Muñoz-Mendez, Phys. Rev.B 102, 214412 (2020)
[4] R.M.Otxoa et al Comm. Phys 3, 31 (2020)
[5] R.M.Otxoa et al Phys.Rev.Res. 3, 043069 (2021)