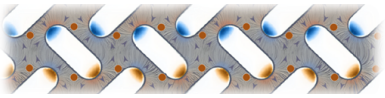
Workshop on



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Reducing the superparamagnetic blocking temperature of Permalloy nanomagnets in artificial square spin ice using a heavy-metal interface

Geometrical frustration arises when not all interactions are simultaneously satisfied, and artificial spin systems offer an ideal platform to study this with the use of microscopy techniques [1, 2]. Using spatially resolved x-ray photoemission electron microscopy (X-PEEM), we compare the thermal relaxation in artificial square spin ice fabricated out of Permalloy films, which were grown on a heavy-metal layer or directly on a silicon substrate. Interfacial Dzyaloshinskii-Moriya interaction (iDMI) [3], arising at the interface between the Permalloy film and heavy metal, lowers the magnetization switching barrier. Thus, the superparamagnetic blocking temperature of such nanomagnets is reduced, while the strength of their magnetostatic coupling remains unaffected. Initial hysteresis loops measured with MOKE show a significant decrease of the coercivity as a function of decreasing Permalloy thickness, and micromagnetic simulations qualitatively show the same trend when including iDMI. However, a direct measurement of iDMI strength is necessary to confirm the hypothesis. Our next aim is to characterize the coupling strength of the nanomagnets and extend the concept to other geometries such as the artificial kagome spin ice.

References:
[1] Heyderman, L. J., & Stamps, R. L. Artificial ferroic systems: novel functionality from structure, interactions and dynamics. J. Phys.: Condens. Matter 25, 363201 (2013)
[2] Nisoli, C., Moessner, R., & Schiffer, P. Colloquium: Artificial spin ice: Designing and imaging magnetic frustration. Reviews of Modern Physics, 85(4), 1473 (2013)
[3] Nembach, H.T., et al. Linear relation between Heisenberg exchange and interfacial Dzyaloshinskii-Moriya interaction in metal films. Nat. Phys. 11, 825 (2015)

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