SFB 767

Colloquium

Universität Konstanz

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Apr 26, 2018
Coffee and tea 15:15
Talk 15:30
P 603

Magnetic metamaterials

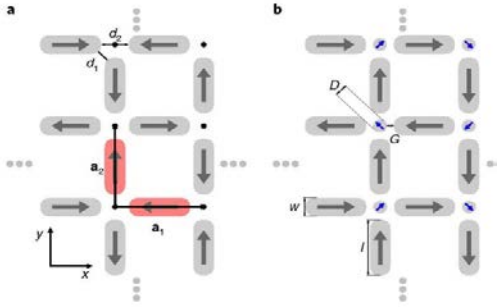

Figure 1. Illustration of mesospin design

Patterning is a mean of engineering additional energy scales into magnetic materials. The obtained properties can be unique and strongly deviating form the parent material, as e.g. exemplified by the formation of permalloy based artificial spin ice structures[1]. The magnetic interactions of the material is characterised by two energy scales: Atomic interaction within and between the islands. Consequently, the islands can be viewed as mesospins, interacting via their stray field, a close analogue to atomic spins.
When the inter-island interaction is sufficiently weak, the mesospins exhibit paramagnetic like behaviour [2]. By bringing the mesospins close enough, their mutual interactions results in ordering [3]. Furthermore, the shape of the islands can be used to tailor their spin dimensionality. For example, mesospins fabricated as elongated islands can be made Ising like[2] while circular islands can result in a XY behaviour [3].
When large arrays of interacting mesospins are formed, an order disorder transition can be obtained, resembling an ordinary phase transition [4,5]. However, the magnetic metamaterials are not restricted to the same rules/restrictions as their atomic counterparts: It is possible to combine and design the properties of mesospins in almost arbitrary fashion. For example, XY mesospins can be used as an interaction modifier, allowing the design of interactions between the Ising mesospins [6].
The results clearly demonstrate the possibility to design new energy and length-scales in magnetic metamaterials. The nature of the emergent order in these structures is only rudimentarily explored. A brief outlook is given, emphasising the possibilities using the interplay between the energy and length scales involved.

[1] R. F. Wang et al., Nature 439, 303 (2006). [2] U. B. Arnalds et al., Appl. Phys. Lett. 105, 042409 (2014); DOI: 10.1063/1.4891479 [3] U. B. Arnalds et al., Applied Physics Letters 101 (11) , 112404 [4]V. Kapaklis et al., N. J. of Physics 14 (2012) 035009 [5] V. Kapaklis et al., Nature Nano, DOI: 10.1038/NNANO.2014.104 [6] E. Östman et al., Nature Physics (2018), DOI: 10.1038/s41567-017-0027-2

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