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27 February 2015 - 2 pm

Room Remy Lemaire, K223 (1st floor, building K) - 25 rue des martyrs

[Access Map]

Alliance 2 “Spintronics & nanomagnetism”

MAGNETIC FIELD DRIVEN AND THERMALLY ACTIVE BEHAVIOUR OF ARTIFICIAL SPIN ICE

Summary :

Artificial spin ice are geometrically frustrated magnetic systems consisting of two-dimensional arrangements of dipolar-coupled monodomain nanomagnets arranged on the sites of the square or kagome lattice [1]. The nanomagnet moments mimic the spins in pyrochlore spin ice, with the anisotropy arising from the crystal field replaced by the shape anisotropy associated with each elongated nanomagnet. In order to investigate these systems, we mainly employ synchrotron x-ray photoemission electron microscopy (PEEM), which provides high contrast images of the magnetic configurations, but have also shown that x-ray resonant magnetic scattering can give important insights into the magnetic correlations [2].

Using PEEM, we have demonstrated the existence of emergent magnetic monopoles in the artificial kagome spin ice [3]. In an applied magnetic field, monopole-antimonopole pairs nucleate and separate in an avalanche-type manner forming one-dimensional Dirac strings consisting of reversed nanomagnet moments. With careful modification of the shape of particular islands it is possible to control string progression.

For the finite building blocks of the artificial kagome spin ice, consisting of one, two and three hexagonal rings [4, 5], when we attempt to apply an ‘effective thermal anneal’ via demagnetisation, we find that the percentage of low energy states decreases as the number of rings increases, indicating that it will be impossible to achieve the ground state in an extended array using such a partially deterministic demagnetisation protocol. We have therefore established a method to create thermally active artificial spin ice with fluctuating magnetic moments and to observe the evolution of the magnetic configurations with time in the PEEM. This allows us to study relaxation processes and provides a controlled route to the lowest-energy state [6, 7, 8].

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