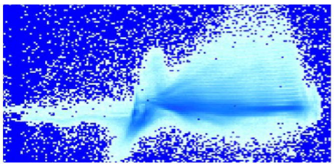

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Probing thermally activated dynamics in Artificial Spin Ices with coherent X-rays

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Arrays of nanoscaled magnetic elements, each acting as a single mesospin, are the building blocks of artificial systems of varying complexity in which the mesospin and lattice geometry can be used to design emergent mesoscale magnetic order. The geometry of the mesospin lattice determines the magnetic dimensionality and the interactions between the elements affect the global ordering and thermally driven dynamics [1]. Here, we focus on two types mesospin arrays arranged as Ising chains and square artificial spin ice (SASI) structures [2,3]. Different mesospin gaps generate varying interaction energies which compete with the thermally active Fe/Pd base material to drive the collective behaviour . As a function of increasing temperature, individual mesospins start to reverse, introducing defects into the arrays and reducing the correlations over characteristic timescales. Direct imaging using PEEM is limited for fluctuating systems due to long acquisition times and a limited field of view, so here we use a different approach and combine coherent magnetic scattering with x-ray photon correlation spectroscopy (XPCS). We measure one-time and two-time correlation functions as a function of applied field and temperature. We particularly concentrate on the temperature window between the mesospin blocking temperature TB (fixed by the Zeeman and shape anisotropy) and the Curie temperature of the Fe/Pd base material. This study yields new insights into the dynamics of magnetic excitations in these arrays, with both high spatial and temporal resolution.

[1] H. Stopfel et al., Phys. Rev. Materials 5, 114410 (2021).
[2] M. S. Andersson et al., Scientific Reports 6, 37097 (2016).
[3] V. Kapaklis et al., Nature Nanotech 9, 514–519 (2014).

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