Direct Observation of Magnon Modes in Kagome Artificial Spin Ice with Topological Defects

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Kagome artificial spin ice (KASI) is a network of Ising type nanobars on a kagome lattice [1-3]. The magnetodynamic study of such disordered state has been confined to global magnetodynamics [4]. From fundamental physics side such dynamically controlled microstates may offer a way to create Dirac strings via microwave assisted switching in a controlled manner interior to the KASI lattice and study the disordered regime systematically. From magnonic application perspective mesoscopic experimental study of such micro-states of KASI is key towards their usage in as a new type of microwave filter [5] and reprogrammable magnonic crystals [6]. We investigate spin dynamics of KASI where topological defects confine magnon modes in Ni81Fe19 nanomagnets arranged on an interconnected kagome lattice using broadband spin wave spectroscopy, magnetic force microscopy, and micro-focus Brillouin light scattering (BLS) microscopy. Micro-focus BLS performed on magnetically disordered states exhibit a series of magnon resonances which depend on topological defect configurations detected by magnetic force microscopy. Nanomagnets on a Dirac string and between a monopole-antimonopole pair show pronounced modifications in magnon frequencies both in experiments and simulations. Our work is key for the creation and annihilation of Dirac strings via microwave assisted switching and reprogrammable magnonics based on ASIs.

References:

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