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Controlled Magnetic Reversal and Frustration in Artificial Quasicrystals[1]

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Recent studies of ferromagnetic (FM) antidot arrays have been restricted to simple periodic lattices (square, triangular, etc.). We have fabricated artificial FM quasicrystals (AFQ), which are ***aperiodic*** antidot lattices that are self-similar, retain definite rotational symmetry, and consist of a multiply-connected network of permalloy film segments. We focus on Penrose P2 tilings (P2T) constructed from film segments of two lengths ($d_1 = 810$ nm -1618 nm, $d_2 = 500$ nm-1 μ m), width W $\approx$ 100 nm, and thickness t = 25 nm [1]. Static and dynamic magnetizations were studied using DC magnetometry, broadband (BB) FMR, and micromagnetic simulations (MS). Reproducible "knee" anomalies observed in the hysteretic, low-field DC magnetization M(H,T) signal a series of abrupt transitions between ordered magnetization textures, concluding in a smooth evolution into a saturated state. Numerous FMR mode signatures quantitatively reproduce in opposite DC field sweeps in the near-saturated regime, which suggests pinning of the magnetization parallel to the AD edges and confinement of domain walls at P2T vertices control segment polarization and reversal. Novel "asymmetric" modes, defined by their presence on only one side of the field origin in a given sweep, are observed only in the reversal regime, and accompany knee anomalies in M(H,T). MS agree with experimental DC hysteresis loops and FMR spectra, and indicate that systematic control of magnetic reversal and domain wall motion can be achieved via tiling design, offering a new paradigm of **magnonic quasicrystals**. AFQ also behave as novel artificial spin ice systems that exhibit non-stochastic switching due to their aperiodicity and inequivalent pattern vertices. MS indicate pinned Dirac monopoles and confined magnetic avalanches exist in AFQ.

[1] V. S. Bhat *et al.*, Phys. Rev. Lett. **111**, 077201 (2013).

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