Spin Dynamics, Loop Formation and Cooperative Reversal in Artificial Quasicrystals with Tailored Exchange Coupling

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Aperiodicity and un-conventional rotational symmetries allow quasicrystalline structures to exhibit unprecedented physical and functional properties [1,2]. In magnetism, artificial ferromagnetic quasicrystals exhibited knee anomalies suggesting reprogrammable magnetic properties via non-stochastic switching [3,4]. However, the decisive roles of short-range exchange and long-range dipolar interactions have not yet been clarified for optimized reconfigurable functionality. We report broadband spin-wave spectroscopy and X-ray photoemission electron microscopy on different quasicrystal lattices consisting of ferromagnetic Ni81Fe19 nanobars arranged on aperiodic Penrose and Ammann tilings with different exchange and dipolar interactions. We imaged the magnetic states of partially reversed quasicrystals and analyzed their configurations in terms of the charge model, geometrical frustration and the formation of flux-closure loops. Only the exchange-coupled lattices are found to show aperiodicity-specific collective phenomena and non-stochastic switching. Both, exchange and dipolarly coupled quasicrystals show magnonic excitations with narrow linewidths in minor loop measurements. Thereby reconfigurable functionalities in spintronics and magnonics become realistic.

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