Coupled vortex-gyration modes in one-dimensional arrays of vortex-state disks

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Collective spin excitation in magnetic nanodots has attracted much attention owing to its various potential implementations in information processing devices. Although a lot of varieties of those excited modes are fundamentally understood, collective vortex-gyration modes in coupled vortex-state disks still remain elusive [1-6]. Here, we report on the first direct experimental demonstration, by means of a state-of-the-art time-resolved scanning transmission x-ray microscopy, of quantized (or discrete) wave modes of collective vortex gyrations excited in a one dimensional chain of physically separated but dipolar-coupled permalloy disks. Furthermore, we interpret the experimentally observed discrete modes and their dispersion relations with the help of numerical calculation, micromagnetic simulations, and analytical derivations. The results reveal that characteristic dispersions can be expressed simply in terms of the intrinsic angular eigenfrequency of isolated disks and their specific polarization (*p*) and chirality (*C*) ordering. The dynamic dipolar interaction determined by the specific *p* and *C* orderings governs the magnonic band structure of a given one dimensional array. Accordingly, and promisingly, the propagation property of collective vortex gyration and its dispersion can be manipulated by vortex-state ordering, the dimensions of each disk, and the nearest-neighbouring disks's interdistance [7]. This work constitutes a milestone towards the practical achievement of this new class of magnonic crystals.

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