Probing Ferromagnetic Resonance in Square Artificial Spin Ice with Dzyaloshinskii–Moriya interaction

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Artificial spin ice (ASI) consist of lithographically fabricated array of interacting single-domain nanomagnets arranged in specific geometries that lead to magnetic frustration [1]. The spin wave dynamics of ASI can be tuned by modifying these geometrical patterns through the dipolar interactions between the nanomagnets [2]. Furthermore, inducing interfacial Dzyaloshinskii-Moriya interaction (DMI) introduces modification to the spin wave propagation by introducing chiral asymmetry in the ASI [3]. The spin wave dynamics of ASI can be studied by using broadband ferromagnetic resonance (FMR) spectroscopy, providing information on the effects of geometric frustration and interfacial DMI on spin wave propagation [4]. Understanding these effects holds promise for next-generation magnonic devices [5].

In the present work, we experimentally study square-lattice artificial spin ice composed of permalloy nanomagnets ($Ni_{80}Fe_{20}$), with interfacial DMI introduced by depositing a heavy metal layer above the array. Magnetic force microscopy is used to image the magnetic moments of individual nanomagnets, allowing direct observation of local magnetic configurations. The FMR result of ASI shows that the DMI modifies the FMR signals by introducing chiral asymmetry that shifts the resonance frequencies and broadens the linewidths. These results demonstrate that DMI has a significant effect on spin wave propagation in ASI.

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