Emergence of chiral torques and the Magnetoelectric Effect from magnetic dipolar coupling

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Chiral magnetic insulators manifest novel phases of matter where the sense of rotation of the magnetization is associated with exotic transport phenomena. Effective control of such phases and their dynamical evolution points to the search and study of chiral fields like the Dzyaloshinskii-Moriya interaction [1]. Here we combine experiments, numerics, and theory to study a zig-zag dipolar lattice as a model of an interface between magnetic in-plane layers with perpendicular magnetization. The lattice comprises two parallel chains of dipoles with perpendicular easy plane rotation. The dipolar energy of the system is separable into a sum of symmetric and antisymmetric long-range exchange interactions between dipoles, where the antisymmetric coupling generates a nonlocal Dzyaloshinskii-Moriya field. Magnetization dynamics in the system are prompted by varying the interchain gap, which tunes the Dzyaloshinskii-Moriya torques between the chains and raises a spin current, an electric polarization, and stable winding textures [2]. The chiral torques emerging from such internal fields trigger hysteretic dynamics through the propagation of magnetic avalanches of chiral Bloch domain walls.

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