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Two-dimensional artificial skyrmion crystals stabilized by nano-patterning[1]

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The skyrmion crystal is a new material of current interest. It carries a topological charge and a Berry phase in real space and is anticipated to produce unconventional spin-electronic phenomena, such as the topological Hall effect and to exhibit spectacular dynamic properties. Technologically, skyrmion crystal may be exploited as a new class of spintronic material due to its unusual response to an electric charge current and spin current. A skyrmion crystal typically arises from helical spin structures induced by the Dzyaloshinskii–Moriya (DM) interaction. Experimentally, what has impeded its property exploration is that it is only to be found in few systems and within a narrow temperature and magnetic field range. In this talk, we present a practical design of a 2D skyrmion crystal, which completely by-passing the need for strong (or, indeed, any) DM interaction. The methodology is demonstrated with micromagnetic simulations and the computed skyrmion number per unit cell. The created skyrmion crystal has a robost working regime including room temperature, much broader than that for DM-driven skyrmion crystals. The method can dramatically widen the scope of the properties exploration and practical applications of the skyrmion crystal. In addition, from a more general point of view, previous experimental and theoretical studies of systems with DM interactions have already shown amply that the DM interaction is not sufficient for the spontaneous formation of a skyrmion crystal all by itself, since many systems with DM interaction do not display skyrmion-crystal self-assembly. Our method demonstrates that the DM interaction is not necessary either.

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