

Ordering artificial magnetic crystals.

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Artificial spin ice is a well-known term for fabricated magnetic structures ordered structurally but disordered in magnetization. Basic building blocks - most commonly stadium-like ovals - have high shape anisotropy, effectively limiting magnetization to have only two stable monodomain states. The configuration of such a state can be formally treated like a spin. The magnetic structure of such samples is usually not in thermodynamic equilibrium. It is due to the high shape anisotropy of the basic elements. This is the reason why these structures are often referred to as artificial spin ices, even though only a few of them are true spin ices in the strict sense. Many systems referred to as artificial spin ices has well defined periodically ordered magnetic ground state. The real-world problem is to find a method to bring these systems to the ground state if they are locked in some higher energy state. We recently suggested magnetizing samples in a direction perpendicular to the sample plane [1]. The magnetization perpendicular to the sample plane partially tilts the magnetization in the out-of-plane direction, effectively reducing in-plane shape anisotropy and intraelement interaction. The interaction reductions, in turn, allow individual elements to switch and order the samples. We demonstrate this idea on several structures, particularly in those that have been experimentally proven to be difficult to order.

References:

[1] J. Tóbič, P. Bokes, S. Lepadatu, I. Vetrova, T. Ščepka, J. Šoltýs, *Physical Review B* **112** (2025), 134429.

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