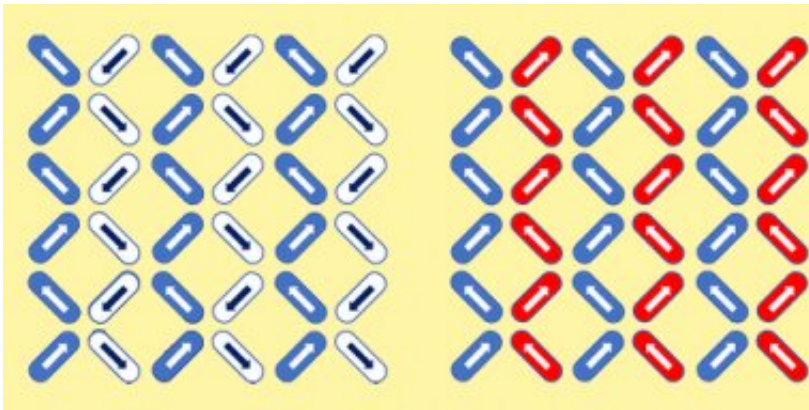


Nanomagnets offer clues to how avalanches work

November 12 2021



Credit: Yale School of Engineering and Applied Science

The behavior of avalanches has generated interest among physicists for the insights that they can provide about many other systems, not least of which is how snow falls down a mountainside. To that end, a team of researchers studied microscopic arrays of nanomagnets that provide the first experimental demonstration of a classic theoretical model, known as the "one-dimensional random field Ising model." The results were published today in *Physical Review Letters*.

For the study, researchers set up the arrays of nanomagnets in the lab of Peter Schiffer, the Frederick W. Beinecke Professor of Applied Physics, who led the experiment. The nanomagnets, which are a few millionths of an inch in dimension, interact with each other just like two refrigerator

magnets put close together. The array is first initialized so that, in alternating rows, half of the nanomagnets had the north pole pointing up and half had the north [pole](#) pointing down.

Using a large electromagnet, the team applied a [magnetic field](#) to the array, causing a fraction of the nanomagnets to flip their poles and magnetically align in the other direction. To detect the changes, they used a magnetic force microscope that has an extremely small magnetic needle that is either pulled down toward or pushed up away from the magnet, depending on whether it's going over the [north pole](#) or the south.

Among their findings is that the magnet poles flip in clusters along the rows of the arrays, with each microscopic flipping begetting another group of magnets to flip poles—the way that an avalanche works.

"That's a key point, because when one flips, that adds an extra impetus on the next one," Schiffer said. "What we measure is really the distribution of these clusters that have flipped. How many small ones? How many bigger ones? And then the distribution of those clusters is what we compare to the model, which makes a prediction about how those clusters should be distributed."

It is the first experiment to accurately reflect the random field Ising model in one dimension, which is one of the fundamental models for physicists to describe how things happen in large groups. Specifically, it involves things that can be in one of two states—in this case, things that are either pointing up or pointing down.

"What the [model](#) predicts is what that distribution of avalanche sizes should be," he said. "And that's what we see very cleanly—we measured the distribution of how the magnet poles flip, and it matches incredibly well what the expectations were."

One benefit of having a clean experimental demonstration is that carefully designed variations on this well-controlled [microscopic system](#) could help researchers understand and predict much more complicated phenomena in the [real world](#), such as how certain materials fall apart when pulled, or what causes electrical breakdowns in circuits.

More information: N. S. Bingham et al, Experimental Realization of the 1D Random Field Ising Model, *Physical Review Letters* (2021). [DOI: 10.1103/PhysRevLett.127.207203](#)

Provided by Yale University

Citation: Nanomagnets offer clues to how avalanches work (2021, November 12) retrieved 27 April 2024 from <https://phys.org/news/2021-11-nanomagnets-clues-avalanches.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.