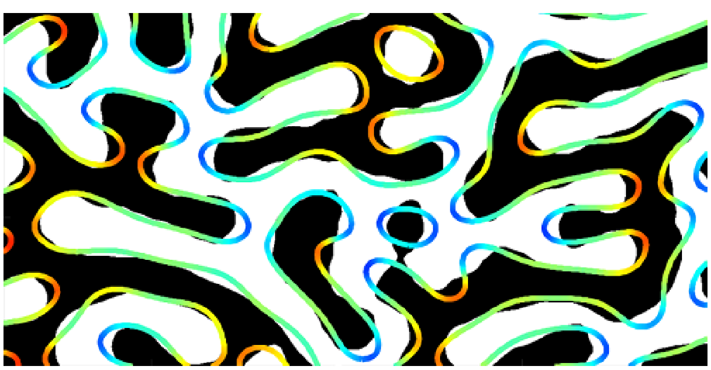
Domain Walls Break the Sound Barrier

Experiments reveal that the boundaries between magnetic domains in a multilayered magnetic metal can move faster than sound, confirming a previous prediction.

By **Ryan Wilkinson**

Ferromagnets, such as iron and nickel, contain regions of uniform magnetic polarization called domains. If the walls between these regions move too quickly, they can destabilize, causing existing domains to merge and new domains to appear. Conventional wisdom suggests that this destabilization occurs for domain-wall speeds exceeding about 0.5 kilometers per second (km/s). But in 2020, scientists predicted that domain walls in certain multilayered ferromagnets could remain stable at speeds above 10 km/s. This theory has now been experimentally verified by Rahul Jangid at the University of California, Davis, and his colleagues [**1**]. The team says that being able to move domain walls at such high speeds could be useful for making energy-efficient memory and data-storage devices.

Jangid and his colleagues investigated a multilayered ferromagnetic metal containing striped and labyrinth-like domains—two domain types with useful properties, such as high stability. The researchers fired an ultrashort infrared pulse at this metal, inducing domain-wall motion. A few femtoseconds later, they hit the metal with an ultrashort ultraviolet pulse that conveyed information about the material's domain-wall dynamics to a detector.



Credit: R. Jangid *et al.* [**1**]

By comparing the detected signal to simulations, the researchers inferred the dynamics of the two domain types. They found that the walls of striped domains stayed roughly stationary, while those of labyrinth-like ones moved at speeds of up to 66 km/s, without destabilizing. This peak speed is 10 times the speed of sound in the material and 5 times higher than the peak predicted by theory, indicating that much more of the infrared pulse's energy was converted to domain-wall motion than expected. The team says that understanding this discrepancy could be important for explaining and controlling ultrafast phenomena in the emerging field of quantum materials science.

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REFERENCES

1. R. Jangid *et al.*, "Extreme domain wall speeds under ultrafast optical excitation," **Phys. Rev. Lett. 131, 256702 (2023).**