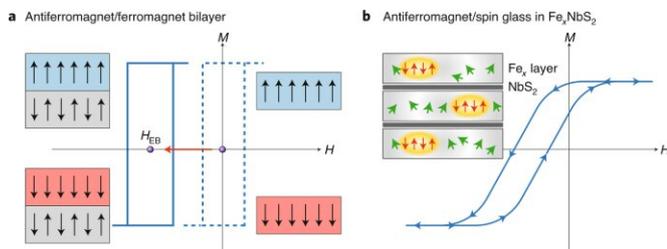


# Exchange bias set in a spin-glass phase could arise in a disordered antiferromagnet

25 January 2021, by Bob Yirka



a, In a regular ferromagnet, the magnetization ( $M$ ) switches at different magnetic fields depending on whether the field is ramped up or down (dashed lines). Pairing a ferromagnet with an antiferromagnet shifts the hysteresis loop, and the offset in the centre  $H_{EB}$  is the exchange-bias field. b, Schematic plot of the hysteresis loop in  $Fe_xNbS_2$ . The large exchange bias is attributed to the coexistence of two phases in the  $Fe_x$  layers that are separated by  $NbS_2$ , as schematically illustrated in the inset. A spin glass (green arrows) — a disordered phase that can have an overall net magnetization under an external field — coexists with antiferromagnetic order (red arrows). Credit: *Nature Physics* (2021). DOI: 10.1038/s41567-020-01127-6

A team of researchers from the University of California, Lawrence Berkeley National Laboratory, the Nuclear Research Center—Negev and the National High Magnetic Field Laboratory has developed a way to isolate antiferromagnet (AFM) heterostructures in the absence of a ferromagnet (FM) to study the coupling that occurs between AFM order parameters and spin-glass parameters. In their paper published in the journal *Nature Physics*, the group describes an exchange bias set in a spin-glass phase that could arise in a disordered antiferromagnet. Minhyea Lee, with the University of Colorado has published a *News & Views* piece in the same journal outlining the work done by the team.

Exchange [bias](#) occurs when behavior associated with hard magnetization in a thin film forces a shift

in the soft magnetization curve associated with a ferromagnetic film. The property has proved to be useful in a large number of technologies—most particularly, magnetic recording in hard disk drives. Despite its widespread use, the underlying basics of how [exchange bias](#) works is not very well understood. In this new effort, the researchers carried out experiments with magnetic materials in an attempt to better understand it.

As Lee notes hysteresis as it relates to ferromagnets refers to the record of what happens to the magnetization associated with a ferromagnet as it is swept through a [magnetic field](#). Exchange bias occurs when a hysteresis loop moves away from zero field due to an [antiferromagnetic](#) thin film coming into contact with a ferromagnetic film. In this case, the size of the shift is called the exchange-bias field.

In their work, the researchers found that the exchange bias in this situation is enhanced by increasing or decreasing Fe ions by approximately 10%. And in so doing, they found that the decrease or excess resulted in the formation of a spin-glass phase (where the atomic spins are not aligned), even as the underlying antiferromagnetic order persisted. The researchers suggest the large exchange bias could be ascribed to the coupling that occurred in the antiferromagnetic phase that played a role in the pinning layer. They further note that tuning the strengths of the antiferromagnetic and spin-glass parameters could be used to tailor exchange biases in a variety of spintronic applications.

**More information:** Eran Maniv et al. Exchange bias due to coupling between coexisting antiferromagnetic and spin-glass orders, *Nature Physics* (2021). DOI: [10.1038/s41567-020-01123-w](https://doi.org/10.1038/s41567-020-01123-w)

Minhyea Lee. Disordered exchange is biased, *Nature Physics* (2021). DOI: [10.1038/s41567-020-01127-6](https://doi.org/10.1038/s41567-020-01127-6)

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