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Probing the electronic structure of buried interfaces

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Abstract for a General Audience

In the electronics behind computer memory storage, the speed and size are dictated by the performance of permanent magnets inside devices called read heads. Complicated magnets made of stacked layers of thin films can be engineered to have properties that yield more energy storage and faster switching times compared to conventional iron or cobalt magnets. In these films, the interfaces between layers are responsible for the magnetic coupling that physicists hope to exploit to produce next-generation magnets. I studied a transition metal oxide material called LSCO, Lanthanum Cobaltite, which exhibits an exciting behavior: its sum is greater than the sum of its parts. When a similar material is grown on top of it, their interface behaves like a new layer with a different type of magnetism! I hope to explain this by demonstrating differently charged ions in the interface, which would be a promising result because charge is easy to control when making devices. The typical method for quantifying charge is x-ray absorption, but conventional techniques view every layer simultaneously, averaging the interfaces and the LSCO layers that I want to characterize separately. Instead, I used a new reflectivity technique, which tracks the intensity of reflected x-rays at different angles at energies near the absorption peaks of certain elements, to track changes in the electronic structure of the material. The samples were grown by collaborators at the Takamura group at U.C. Davis and probed with this "resonant reflectivity" technique on Beamline 2-1 at the Stanford Synchrotron Radiation Lightsource. This project was funded by the Department of Energy and supported by the SLAC National Accelerator Laboratory. This basic science effort ensures that, once scientists understand how to tune the magnetic properties of materials like LSCO, industries will be closer to designing the magnets that will revolutionize consumer electronics.

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