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The growing field of spin electronics – spintronics – tells us that electrons spin like a top, carry angular momentum, and can be controlled as units of power, free of conventional electric current. Nonvolatile magnetic memory based on the "spin torques" of these spinning electrons has been recently commercialized as STT-MRAM (spin transfer torque-magnetic random access memory).

Colorado State University physicists, joining the fundamental pursuit of using electron spins to store and manipulate information, have demonstrated a new approach to doing so, which could prove useful in the application of low-power computer memory. Publishing Sept. 1 in *Nature Communications*, they've demonstrated a new way to switch magnetic moments – or direction of magnetization – of electrons in a thin film of a barium ferrite, which is a magnetic insulator. Until this point, scientists have only demonstrated this switching behavior – the key to writing information as memory – in metal thin films.

The work was led by Mingzhong Wu, professor in the Department of Physics, with first author Peng Li, a former postdoctoral researcher now at Seagate, and second author Tao Liu, a current postdoc at CSU. The work was performed in collaboration with researchers at University of Alabama, Argonne National Laboratory, University of Notre Dame, and University of Wyoming. Other CSU authors include faculty members Stuart Field and Mario Marconi, and graduate students Houchen Chang and Daniel Richardson.

Switching magnetic moments of electrons in an insulator instead of a metal could prove to be a major breakthrough in spintronics, by allowing a spin current-based memory storage device to be simpler, and also maintain more efficiency per electron. A property known as perpendicular magnetic anisotropy (PMA), key for information storage, in this case originates from the intrinsic magneto-crystalline anisotropy of the insulator, rather than interfacial anisotropy in other cases, Wu said.

"Higher efficiency and lower power than the standard are always the goal in memory applications," Wu said.

Beyond the application for computer memory, which captivates most spintronics researchers today, the CSU researchers' device does something bigger: It demonstrates the possibility of a new class of materials for spintronics. "What's exciting about this is that it's an enabling technology for exploring an entirely different class of configurations, some of which are theorized to be useful," said Jake Roberts, professor and chair of the Department of Physics.

In the CSU researchers' device, the spin current does the job of assisting magnetic switching. Next, they will attempt to further refine their device for more efficient switching, including using a topological insulator or the photo-spin-voltaic effect to produce spin currents. The photo-spin-voltaic effect was discovered by Wu and colleagues, and reported in *Nature Physics*.

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