Multiferroics could lead to low-power devices

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(PhysOrg.com) -- Magnetic materials in which the north and south poles can be reversed with an electric field may be ideal candidates for low-power electronic devices, such as those used for ultra-high data storage. But finding a material with the right combination of magnetoelectric properties has proven a difficult challenge. Using a theoretical approach, Cornell theorists might have found one.

Craig Fennie, assistant professor of applied and engineering physics, and research associate Nicole Benedek used theoretical calculations to understand exactly why and how a particular crystalline ceramic, a layered perovskite, is multiferroic. Multiferroic materials are simultaneously ferroelectric (electrically polarized) and ferromagnetic (they exhibit a permanent magnetic field). Their results were published online March 7 in *Physical Review Letters*, appearing later in print, and are also the subject of a "Viewpoint" in the journal *Physics* and a "News and Views" column in the journal Nature Materials.

A lot of materials respond to electric fields; others to magnetic fields -- but a small subset of materials called multiferroics respond to both. This discovery decades ago caused excitement due to the potential implications for, for example, magnetic storage devices that barely require power.

The Cornell researchers' density functional theory calculations revealed that octahedron rotations -- lattice distortions ubiquitous in complex crystalline materials such as perovskite -- simultaneously induce and thereby couple ferroelectricity, magnetoelectricity and ferromagnetism.

This prediction is remarkable because octahedral rotations usually cannot produce a polarization. It also lends new insight into the problem of how to introduce multiferroic order into different materials and the possibility of discovering the best materials to make low-power electronics at room temperature.

Their study demonstrates the possibility of robust, controllable coupling of magnetization and ferroelectric polarization, as well as suggesting electric field switching of the magnetization.

Provided by Cornell University

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