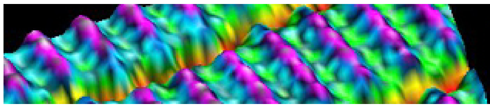

Department of Physics and Astronomy
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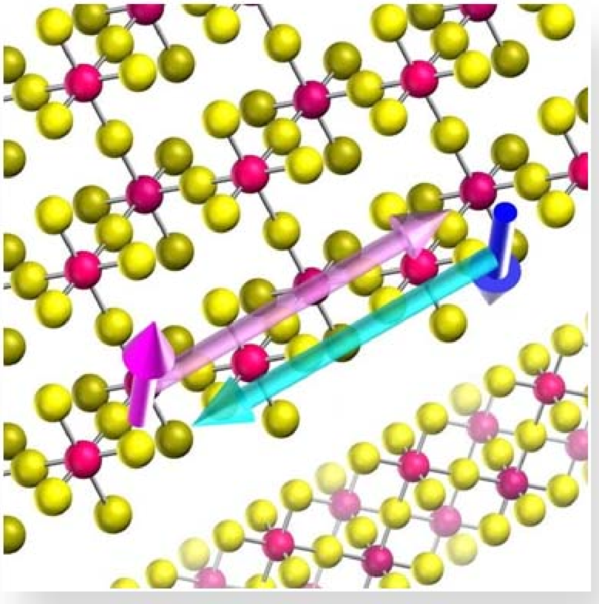
21st Century Alchemy:

Turning Trivial Oxides into Novel Topological Insulators

University of Tennessee Physicist Wenguang Zhu, along with Di Xiao and Satoshi Okamoto of Oak Ridge National Laboratory, Ying Ran of Boston College, and Naoto Nagaosa of the University of Tokyo and RIKEN, in their recent work published in *Nature Communications* on December 20, have predicted a new kind of exotic electronic state, and they've done so using a class of mineral unearthed nearly two centuries ago—adding a 21st Century chapter to an age-old discovery.



Network of oxygen (yellow spheres) and transition-metal (red spheres) ions realized in a (111) bilayer of transition-metal oxides. Upper left: top view, and lower right: side view. Along the edge of such a structure, electrons with up-spin and down-spin indicated by arrows flow in opposite directions without dissipations.

Using scientific modeling and calculations, Zhu and his colleagues have found that bilayers of perovskite-type transition-metal oxides grown along the [111] crystallographic axis have potential to become two-dimensional topological insulators at room temperature. Such a state was previously known to appear only at extremely low temperatures in semiconductors with heavy elements.

A perovskite is any compound that has the same type of crystal structure as the mineral of the same name, which simply describes what you might call the material's DNA. It was first discovered in the Ural Mountains of Russia in 1839. A transition metal oxide is made up of both oxygen and any metal from the "transition elements" portion of the periodic table—the section that bridges the two sides of the table comprising the main elements like hydrogen and helium. Topological insulators (TIs) are characterized by an unusual trait: they behave as an insulator in their interior but conduct electricity on their surfaces. Such materials provide nontrivial electronic states in which electrons with opposite magnetic moments, called spins, counter-propagate on the surface without dissipations. This is significant because low dissipation means less current loss, and finding materials that can provide more efficient delivery of electronic current at room temperature has become a necessity as demand for more and electronic power increases. The group's summary explained that "such structures are likely to be realized experimentally, as oxides of this type are already being synthesized for a variety of other applications by researchers world-wide. Among the various oxides investigated, $LaAuO_3$ is found to be the most promising. Providing guidance for the experimental realization of such two-dimensional topological insulator states is a key step toward understanding their fundamental properties and exploring practical applications, including in low-energy-consumption computation."

The paper, entitled "Interface Engineering of Quantum Hall Effects in Digital Transition Metal Oxide Heterostructures," is available at *Nature Communications* online, at http://www.nature.com/ncomms/journal/v2/n12/full/ncomms1602.html.

Nature Communications is an online-only, multidisciplinary journal dedicated to publishing high-quality research in all areas of the biological, physical and chemical sciences. Papers published by the journal represent important advances of significance to specialists within each field.