Harnessing Complexity with Spatial Confinement

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Colossal magnetoresistance, the metal-insulator transition and high T_C superconductivity are a few of the fascinating emergent behaviors found in complex oxides. Electronic phase separation is thought to play an important role in giving these materials such unique characteristics. By spatially confining complex materials to length scales smaller than the electronic phase domains that reside within them, we have found that it is possible to access previously hidden electronic phases using simple transport measurements. This has led to observations of several new phenomena such as a reemergent metal-insulator transition, ultra-sharp jumps in resistivity at the metal-insulator transition, and the first high resolution observation of single domain dynamics at a first order transition. Not only will spatial confinement studies on correlated systems continue to give us new insights into fundamental physics, these studies are a vital step in the creation and implementation of future oxide electronic devices.

Phys. Rev. Lett. 100, 247204 (2008);
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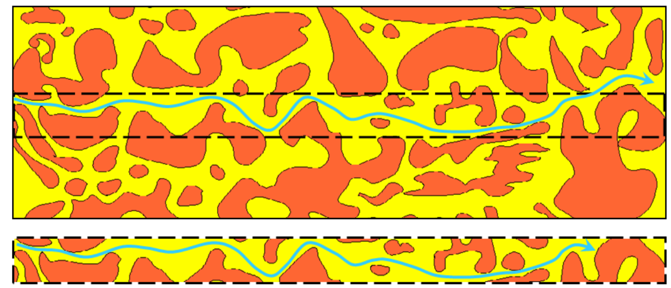
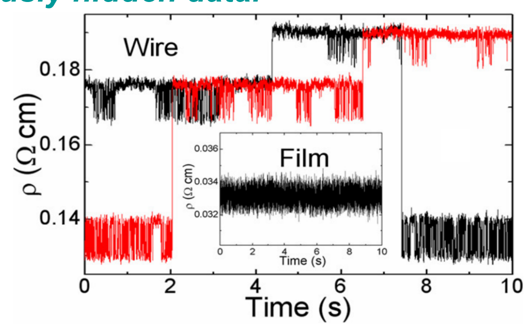


Probing current (blue arrow) in an unconfined structure (top) will follow the path of least resistance. Confining the conduction path (bottom) allows probing electrons to gather previously hidden data.



Discrete jumps in resistivity indicate that single electronic phase domains are actively fluctuating between electronic phases. Red and black plots were taken 5 hours apart and indicate the robust nature of the system. This behavior is never seen in the film geometry, as single domain fluctuations are drawn out by the larger system.

Fundamental Research: The Ultimate Adventure

Thomas Z. Ward, (funded by DOE)

Zac Ward took a very circuitous route to a career in research. His first undergraduate degree was in creative writing. He spent several years backpacking and hitchhiking around the world. Along the way, he tried many professions: a steel working in Colorado, a ski lift operator in Australia, a junior high school English teacher in Japan. However, none of the travel or various jobs was ever able hold his attention for very long.

This changed when he first entered a research laboratory where independence, creativity and curiosity were all expected and encouraged. The opportunity to work at Oak Ridge National Laboratory with some of the country's top scientist was the catalyst needed to turn an undirected dreamer into a contributing member of the scientific community.