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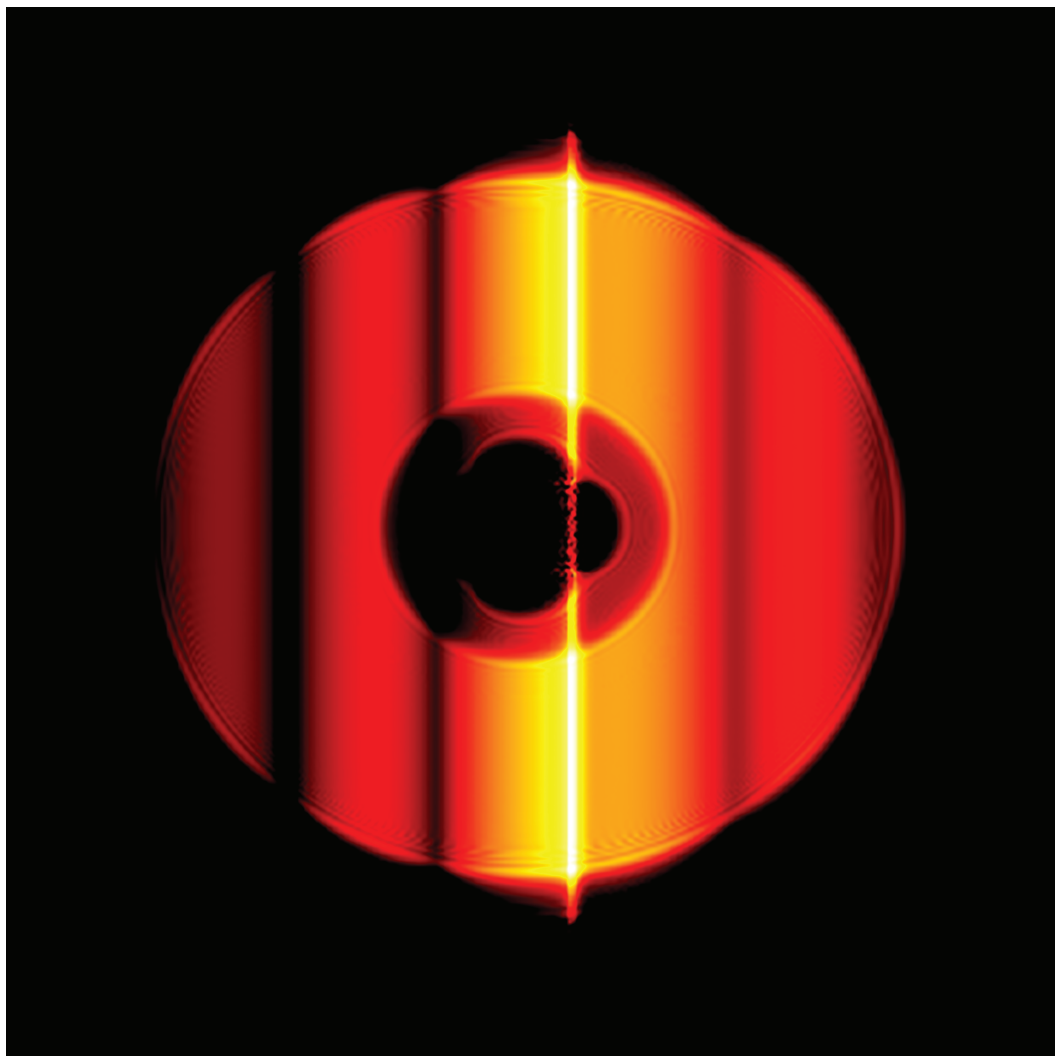
Paul G. Evans

Nanoscale Phase and Polarization Dynamics in Oxides: Successes and Hard Puzzles for X-ray Science

Emerging electronic materials including ferroelectric, multiferroic, and magnetic oxides are being designed and synthesized with a rapidly increasing level of sophistication and complexity. Oxide heterostructures, for example, are now created with a precise selection of their composition, crystallographic phase, and interface structure. An important consequence of this precision is that the electric polarization, magnetization, and structural phase can be controlled at the nano-to-mesoscopic scale yielding surprising effects on phase transformation behavior and functional properties. Even understanding the steady-state nanoscale distribution of these features poses a significant characterization challenge. An additional and even more imposing challenge applies to dynamic changes following optical or electronic perturbation, which are only beginning to be understood. The coherence, nanoscale spatial resolution, and ultrafast time resolution of x-ray techniques permit a new level of insight into these features. New phenomena revealed through the development of new x-ray methods include nanoscale fluctuations, electrically and optically induced transformations, and the coupling of nanoscale polarization to vibrational modes in ferroelectric and multiferroic materials. Diffraction-limited upgrades to the APS promise to allow this level of insight to be obtained for magnetic materials, at smaller length scales, and in sophisticated lithographic structures than is presently possible.



Paul Evans is a professor in the Department of Materials Science and Engineering at the University of Wisconsin-Madison. His research includes the development and application of x-ray nanobeam and time-resolved techniques to provide new insight into the structure and dynamics of emerging materials. The experiments his group conducts involve students and postdocs in extensive use of synchrotron and free-electron-laser light sources around the world.

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Bldg. 402 | APS Auditorium
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