New Approaches for Probing Functional Nanosystems

Margaret Murnane, NSF STC on Real-Time Functional Imaging (STROBE)

All areas of nanoscale imaging and spectroscopy, from electron to visible to X-ray, are undergoing revolutionary advances. These are being driven by the development of large and small scale coherent X-ray sources, powerful electron microscopes that can image with near-atomic resolution, combined with advances in computational imaging. The NSF STC on Real-Time Functional Imaging (STROBE) is developing a new set of powerful, accessible, and broadly applicable real-time imaging modalities that can image disordered systems, implement dynamic imaging with a large field of view, with chemical and magnetic contrast, and with atomic/molecular/nanoscale resolution, that are applicable in situ under environmental conditions and that are minimally invasive. A host of applications in nanoscience and nanotechnology have already been demonstrated, including full-field microscopes with sub-wavelength spatial resolution in the soft X-ray region for the first time; quantifying how nanoscale energy flow differs from bulk; measuring how fast a material can change its electronic or magnetic state, probing how spin currents can control and enhance magnetization in ultra thin films; and visualizing the dynamic band structure of material in real time. In electron imaging, it is now possible to etermine the 3D coordinates of all individual atoms in a nanoparticle to correlate 3D atomic arrangements and chemical order/disorder with material properties at the single-atom level. Finally, for metrology in support of advanced nano-macturing that will use wavelengths in the extreme ultraviolet (EUV) region of the spectrum, new coherent imaging techniques surpass traditional approaches in terms of spatial resolution, speed and cost per image.

Bio: Dr. Margaret Murnane is Director of the US National Science Foundation STROBE Science and Technology Center on functional nanoimaging, a Fellow at JILA and a member of the Department of Physics and Electrical and Computer Engineering at the University of Colorado. She received her B.S and M.S. degrees from University College Cork, Ireland, and her Ph.D. degree in physics from the University of California at Berkeley in 1989, and joined the faculty of physics at Washington State University in 1990. In 1996, Margaret moved to the University of Michigan, and in 1999 to the University of Colorado. She runs a joint research group with her husband, Henry Kapteyn. Margaret's research interests have been in ultrafast optical and x-ray science. She is a Fellow of the American Physical Society, the Optical Society of America and the AAAS. Her honors include the Maria Goeppert-Mayer Award of the American Physical Society, the Ives Medal of the Optical Society, a John D. and Catherine T. MacArthur Fellowship, and election to the National Academy of Sciences, the American Phiosophical Society, and the Royal Irish Academy.