

MAR16-2015-020446

Abstract for an Invited Paper
for the MAR16 Meeting of
the American Physical Society

A Fresh Twist on The Electron Microscope: Probing Broken Symmetries at a New Level

JUAN CARLOS IDROBO, Center for Nanophase Materials Sciences, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA

The introduction of aberration-correction in scanning transmission electron microscopy (STEM) has allowed the realization of Richard Feynmans long sought dream, atom-by-atom structural and elemental identification of materials by simply looking at the thing. Until now, the goal of aberration-correction in STEM has been to produce the smallest possible electron probes, which essentially corresponds to a near constant phase across the probe. Phases increase the size of electron probes and result in images and spectra with a lower spatial resolution. In this talk, calculations will be presented showing that aberrations in lenses are intrinsic generators of angular momentum, and that phases introduced in atomic-size electron probes can actually be beneficial when studying the symmetry of materials. In particular, examples of mapping magnetic ordering of materials with atomic size electron probes will be shown. Magnetic dichroism is one of the new frontiers where aberration-correction STEM can have a significant impact, and reveal information that is physically out of reach in X-ray and neutron synchrotrons. Current and future limitations in the experiments and requirements to reveal the magnetic moment (orbital and spin), charge ordering, crystal field splitting, spin-orbit-coupling, optical dichroism, and other physical phenomena associated with broken symmetries will be discussed. This research was supported by the Center for Nanophase Materials Sciences (CNMS), which is sponsored at Oak Ridge National Laboratory by the Scientific User Facilities Division, Office of Basic Energy Sciences, U.S. Department of Energy. Collaborators: J. Ruzs, J. Spiegelberg, M.A. McGuire, C.T. Symons, R.R. Vatsavai, C. Cantoni and A.R. Lupini.