Strain Doping: A New Avenue for Understanding and Controlling Materials

Andreas Herklotz,
Institute for Physics,
Martin-Luther-University Halle-Wittenberg, Germany

The strong electronic correlations arising from overlapping spin-charge-orbital-lattice order parameters in complex oxides are of fundamental importance to many desirable characteristics such as metal-insulator transitions, ferroicity, colossal magnetoresistance, and high $T_c$superconductivity. Control over the orbital and lattice parameters in these systems is generally achieved through strain engineering imposed by heteroepitaxial film growth on non-lattice-matched substrates. This method involves perturbation in all three unit cell dimensions since the in-plane strain induced into a film's lattice is accommodated by an elastic reaction along the out-of-plane lattice direction driven by the Poisson effect.

This talk will give an overview of my recent work in developing low energy, low dose He ion implantation as a means to strain dope thin film materials. Unlike conventional epitaxy-based strain tuning methods, strain doping is an effective means of continuously controlling lattice expansion along the out-of-plane axis while leaving the in-plane axes locked to the substrate. Functionality is then controlled by modifying crystal symmetry and the tuning of orbital polarizations.

I will focus on recent results of several functional materials and demonstrate how this technique delivers never before possible control over structure, driving changes in magnetoresistance, multiferroicity, magnetic anisotropy, optical bandgaps, and magnetocaloric response.