New Frontiers for Einstein's Electrons : Photoemission Studies of Novel Correlated Materials and Artificial Heterostructures

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Angle-resolved photoemission spectroscopy (ARPES) has played a pivotal role in shaping our understanding of the high-Tc cuprates and a handful of other systems. Unfortunately the vast majority of materials have traditionally remained beyond the reach of photoemission spectroscopy. I will describe a new approach where we have combined oxide molecular beam epitaxy with high-resolution photoemission (MBE-ARPES) which allows us to now synthesize and study the electronic structure of epitaxial thin films of novel correlated materials, interfaces, and heterostructures. As an example of this technique, I will describe our ARPES studies of MBE-grown epitaxial thin films which reveal numerous insights into a number of correlated materials which cannot be studied using conventional ARPES, including colossal magnetoresistive EuO and $La_{1-x}Sr_xMnO_3$, and the "infinite-layer" electron-doped cuprate $Sr_{1-x}La_xCuO_2$. I will also describe our work on oxide heterostructures and superlattices such as the ($[LaMnO_3]_{2n}$ / $[SrMnO_3]_n$) superlattice comprised of alternating $LaMnO_3$ and $SrMnO_3$ blocks where we find that the electronic states evolve from a three-dimensional ferromagnetic metal, to a two-dimensional spin-polarized 2D electron gas, and ultimately to a two-dimensional ferromagnetic insulator with increasing superlattice block thickness n. I will conclude with a brief outlook on how this technique may provide new insights into the field of correlated oxide electronics.