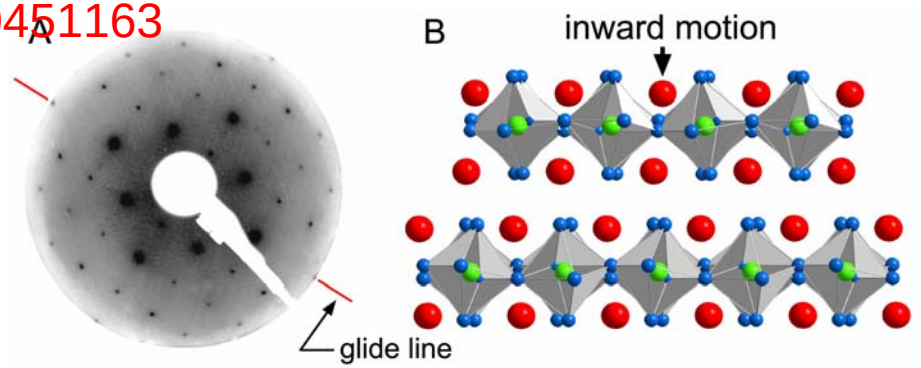
An Inherent Mott Transition at a Surface: $Ca_{1.9}Sr_{0.1}RuO_4$

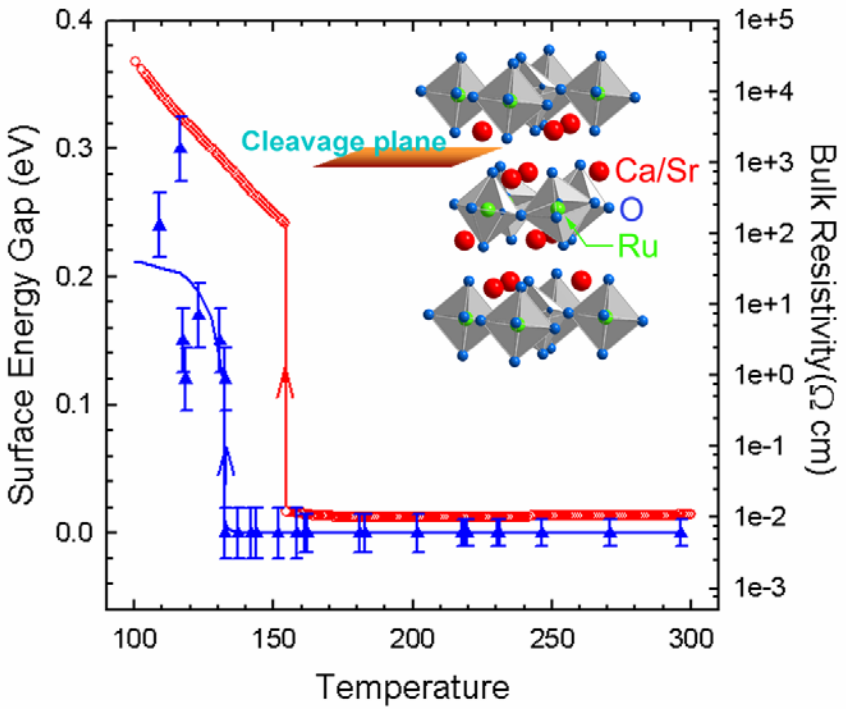
E.W. Plummer, University of Tennessee, Funded jointly by NSF and DOE(DMS&E)

DMR-0451163

Mott Transitions—metal-insulator transitions (MIT) driven by electron-electron interactions—are of fundamental importance in the physics of strongly correlated electron systems. In the layered perovskite $Ca_{1.9}Sr_{0.1}RuO_4$, a first-order Mott MIT accompanied by an abrupt lattice distortion occurs in the bulk at a temperature of T_C = 154 K. In contrast, at the surface, an unusual Mott MIT is observed at $T_{C,S}$ = 130 K, and remarkably without a simultaneous lattice distortion. The broken symmetry at the surface causes a 150% increase in the buckling of the Ca/Sr-O surface plane stabilizing a phase more amenable to a Mott-Insulator ground state than the bulk structure. Consequently, the surface Mott MIT not coupled to any structural transition thus offering a unique opportunity to gain insight into the precise nature of an *inherent Mott transition*.



(Above) A) LEED pattern from $Ca_{1.9}Sr_{0.1}RuO_4$ surface. B) Increased buckling of top most Ca/Sr-O plane by inward motion of Ca/Sr ions



(Right) Signatures of the metal-to-insulator transition in the bulk (T_C = 154 K) and at the [001] surface ($T_{C,S}$ = 130 K) of $Ca_{1.9}Sr_{0.1}RuO_4$ single crystal: *T* dependence of the bulk resistivity (o) measured using a physical property measurement system and surface energy gap (▲) measured by a scanning tunneling spectroscopy on cooling.

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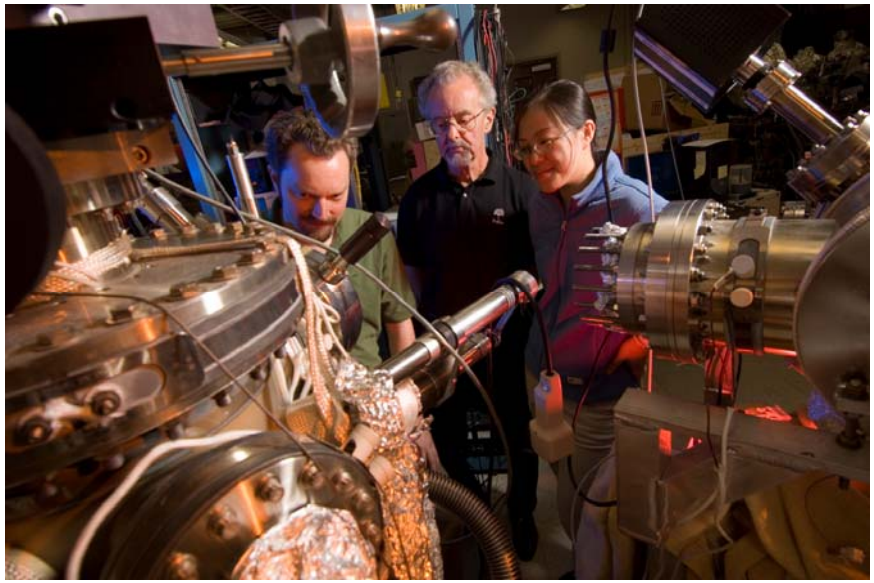
Outreach

Continuing cutting edge research is only possible through continuing scientific education at all levels. Not only is the training of graduate students and post-docs essential but motivating high school students is imperative to the advancement of science. In addition to the graduate students and post-docs involved in various aspects of this work, high school students through sponsored summer internships have learned different aspects of surface science through hands on experience and interaction with the group.



(Above) High school students from Farragut High School (TN): Kyle Peterson (left), Emma Stockdale (center), and Michael McCormick (right). Students are learning aspects of surface science and vacuum technology through direct contact with the group and active involvement in the research.

(Left) E. W. Plummer (center) with graduate student Rob Moore (left) and post-doc Hong Lu (right) interpreting LEED patterns from a $Ca_{1.9}Sr_{0.1}RuO_4$ surface.