

NORTHWESTERN UNIVERSITY'S DEPARTMENT OF MATERIALS SCIENCE AND  
ENGINEERING PRESENTS:

## 2021 MSE SPRING SEMINAR SERIES

# Divine Kumah, PhD

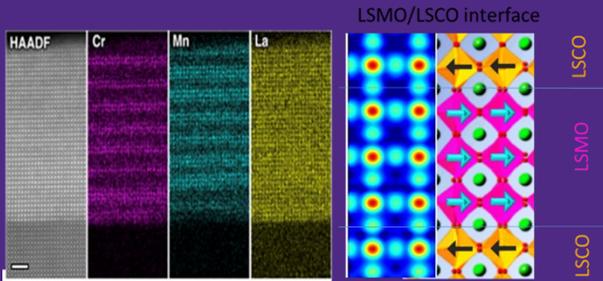
Assistant Professor, Physics  
North Carolina State University



Divine Kumah is an Assistant Professor in the department of Physics at North Carolina State University. He received his Ph.D in Applied Physics from the University of Michigan in 2009 and did postdoctoral research at the Center for Research in Interface and Surface Phenomena at Yale University. His research interests are in experimental condensed matter physics and are aimed at understanding the novel properties which emerge at the interfaces between crystalline materials. The Kumah Research Group at NC State uses state of the art atomic layer-by-layer deposition techniques including

molecular beam epitaxy to fabricate thin crystalline oxide films. The group is focused on understanding how atomic-scale structural distortions at interfaces can be manipulated to induce novel electronic and magnetic phenomena and the development of pathways for harnessing these unique functionalities for electronic and energy applications. Tools used by the group include atomic force microscopy, electron diffraction and synchrotron-based x-ray spectroscopy and diffraction.

## Emergent Phenomena at Complex Oxide Interfaces



The interplay between structural, electronic and spin degrees of freedom at complex oxide heterointerfaces provides an exciting route to explore quantum materials with novel functional properties. Atomic-scale interactions at the interfaces between polar and non-polar transition

metal oxides have led to the realization of exciting phenomena including two-dimensional electron gases, superconductivity and interfacial magnetism. However, these interactions may lead to the suppression of electronic and magnetic ordering at interfaces with strong structure-property relationships. By imaging the atomic structure of the interface between polar LaSrMnO<sub>3</sub>(LSMO) and non-polar SrTiO<sub>3</sub>, we identify interfacial structural distortions which are correlated with thickness-dependent metal-insulator and ferromagnetic-paramagnetic transitions in the rare-earth manganites. We show that these structural distortions can be tuned by inserting polarity-matched LaSrCrO<sub>3</sub>(LSCO) spacer layers at the LSMO interfaces leading to a stabilization of ferromagnetism in LSMO layers as thin as two unit cells. The stabilized magnetism is found to be independent of strain. We employ a combination of synchrotron X-ray diffraction, temperature-dependent magnetization measurements and X-ray magnetic circular dichroism to elucidate the interplay between structural and spin degrees of freedom in the rare-earth manganites.[1,2] Additionally, we find that by tuning growth and post-growth processing conditions, a two-dimensional electron gas (2DEG) forms at the interface between antiferromagnetic LaCrO<sub>3</sub> and SrTiO<sub>3</sub> providing a route to design all-oxide heterostructures which couple magnetic ordering with the mobile carriers within the 2DEG.[3] These results demonstrate the intimate role of picometer-scale structural distortions on the physical properties of transition metal oxides and have important implications for designing novel quantum materials with functional properties including multiferroicity, metal-insulator transitions and tunable topological phases.

**Tuesday, March 30 • 4 PM CST • Zoom**

Registration is required. RSVP link.

*Questions? Contact [Kristina.lugo@northwestern.edu](mailto:Kristina.lugo@northwestern.edu).*