SEMINAR SERIES

PHOTONICS INITIATIVE

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There's Plenty of Interaction at the Bottom

Abstract – The formulation of quantum mechanics in the late 1920s forever changed physics. More recently, quantum materials have emerged, presenting fascinating opportunities in condensed matter physics. Elementary interactions among elements such as photons, electrons, phonons, and other quasiparticles in quantum materials give rise to the emergence of intriguing phases and offer enormous opportunities for the development of quantum technologies. However, investigating these interactions at the relevant length scale requires high-resolution methods beyond traditional far-field optical imaging and spectroscopy techniques, which are constrained by the diffraction limit of light. Interestingly, during the same period in the late 1920s, a visionary scientist named Synge introduced a groundbreaking concept that could circumvent the diffraction limit. Synge shared his idea with Einstein, who encouraged him to publish it. After years of pioneering work by various groups, a powerful modern nano-optical technique, a variant of Synge's original idea has emerged that enables high-resolution exploration of plenty of nanoscale interactions, some of which I will highlight in this talk. I will present examples from two classes of quantum materials, correlated oxides and van der Waals (vdW) crystals, that we studied across the visible to terahertz spectrum. Correlated oxides offer exciting opportunities to reconfigure nano-optoelectronic phenomena, owing to their highly tunable local optical and electronic properties. Our recent results reveal how external perturbations, such as applied strain, fields, or thermal input, alter dopant distribution at the nanoscale in correlated oxides, leading to ordered, reconfigurable phases. This reconfigurability enables the design of robust artificial synapses and opens new frontiers for fundamental understanding of memory, learning, and information retention for brain-inspired information processing. In-plane vdW heterostructures composed of atomically thin monolayers with lateral interfaces, distinct from vertical heterostructures, can lead to intriguing physical phenomena arising from various interactions, including intralayer coupling, lateral strain, interface defects, spin-orbit interaction, correlated electronic fluctuations, and 2D alloys at interfaces. I will present recent results that provide quantitative insights into the role of these interactions in altering the complex dielectric function of 2D materials at the nanoscale.

Bio – Dr. Yohannes Abate is the Susan Dasher and Charles Dasher MD Professor of Physics at the University of Georgia and Founding Director of the Quantum Science & Engineering Program (https://quantum.uga.edu/). Abate's condensed matter physics research interests include investigation of nanoscale and quantum phenomena and interactions in two-dimensional materials, oxide materials, and quantum emitters. Particularly his group is fascinated by how non-equilibrium or collective quantum phenomena that occur at the atomic/molecular scale result in nanoscale emergent behavior in quantum materials. His group implements various terahertz, infrared, optical spectroscopy and scanning probe techniques with diffraction unlimited spatial resolution. Professor Abate joined the University of Georgia (UGA) as an associate professor of physics in August 2017. He received his PhD in Physics at the University of Iowa in 2006. From 2006-2009 he was a postdoctoral research fellow at the University of California, Berkeley and Lawrence Berkeley National Laboratory. In September of 2009 he has spent time as a Visiting Scientist at the Nano-Photonics Laboratory, Max-Planck-Institut für Biochemie, Martinsried, Germany. He has received the NSF Career Award (2016) and in 2023 he has been selected by the Gordon and Betty Moore Foundation as one of its 2023 Experimental Physics Investigators. He received the BS degree in physics from Addis Ababa University, Ethiopia. He is a member of the American Physical Society and Materials Research Society.

YOHANNES ABATE
The University of Georgia

Date:
Thursday August 28, 2025

Time:
11:00am – 12:00pm

Location:
ASRC Auditorium
85 Saint Nicholas Terrace
New York, NY 10031

Zoom Meeting ID:
873 8977 0653
Passcode: 133893

Host:
Andrea Alù, Director, Photonics Initiative, ASRC, CUNY GC

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