DEPARTMENT OF
PHYSICS & ASTRONOMY

Physics & Astronomy
Colloquium

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IISER-Berhampur

(Host: Yun Suk Eo)

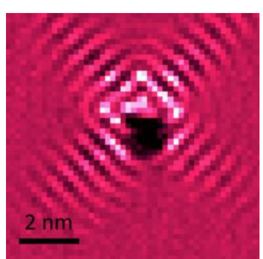
3:30 - 4:30 p.m. | Tuesday, Feb 3, 2026

Zoom Meeting: https://texastech.zoom.us/my/yunsukeo

(passcode: 621827)

Scanning Tunneling Microscopy/Spectroscopy: A Front-Seat Ticket to the Dance of Electrons

Condensed matter physics is, at its heart, the science of emergence: how simple microscopic ingredients give rise to rich collective behavior: a beautiful *dance* [1]. From astronomical observations to microscopy, visualization has played a central role in revealing new laws of nature. In condensed matter physics, however, the essential players: electrons and their collective behavior, are often inferred from indirect and averaged measurements. Scanning tunneling microscopy and spectroscopy (STM/STS) offers exciting opportunity to directly visualize electrons, enabling imaging in real-space, reciprocal-space and energy-space with atomic-scale resolution. As a direct probe of the electronic band structure, Fermi surface topology, and many-body interactions, it has provided deep insights into myriad of emergent phenomena such as unconventional superconductivity and topological states of matter. Thus, it provides a direct window into the intricate "dance" of electrons as they interact, pair, and organize into exotic phases. In this colloquium, I will discuss how STM/STS works and show some illustrative examples of uncovering the fundamental physics of correlated materials including imaging superconducting gap structures [2,3], charge density waves, pair-density waves [4], landau levels [5] and topological states of matter [6]. I will highlight the power of STM/STS to visualize quantum coherence, disentangle competing orders, and track emergent quasiparticles [7]. This front-row view of correlated electron systems not only deepens our understanding of quantum materials but also paves the way for novel applications in quantum computing and other exciting quantum technologies for the future.



[1] P.W. Anderson, "More is Different", Science 177, 393-396 (1972)
[2] R. Sharma, S. D. Edkins, Z. Wang et al., PNAS 117, 5222-5227 (2020).
[3] R. Sharma, A. Kreisel, M.A. Sulangi et al., npj Quantum Materials 6, 7 (2021).
[4] X. Liu, Y.X. Chong, R. Sharma et al., Science 372, 1447-1452 (2021)
[5] Y. X. Chong, X. Liu, R. Sharma et al., Nano Letters, 20, 8001-8007(2020).
[6] H. Inoue, A. Gyenis, Z. Wang et al., Science 351, 1184 (2016).
[7] S. Mukhopadhyay, R. Sharma, C.K. Kim et al., PNAS 116, 13249-13254 (2019).