Webinar-39

Asian Consortium on Computational Materials Science (ACCMS) Global Centre

SRM University-*AP*, Amaravati, Andhra Pradesh, India

April 28, 2026 | 11:30 AM - 01:30 PM (IST)

Title: Emergent Phenomena Exploited at Oxide Heterointerfaces for Unconventional Computing

Panelist

Dr Darwin B Putungan

Institute of Physics, College of Arts and Sciences, University of the Philippines

Speaker

Prof. Tamalika Banerjee

Professor & Chair of Spintronics Functional Materials group, Zernike Institute for Advanced Materials, University of Groningen, Netherlands

Short Biography

Prof. Tamalika Banerjee is a Rosalind Franklin Fellow, Professor & Chair of Spintronics of Functional Materials group at the Zernike Institute for Advanced Materials, University of Groningen, and a member of CogniGron Centre. Her research group primarily works on Oxide Spintronics and their devices for brain-inspired computing. She is also the Founder (2024) of IMChip, whose patented technology is used for neuromorphic computing hardware for sustainable and responsible AI applications. She is also a Visiting Faculty at CeNSE, Indian Institute of Science, Bangalore, India (2026-).

She also held a Scientific Associate Investigator position at FLEET, ARC Centre of Excellence in Future Low-Energy Electronics Technologies, Australia (till 2024).

She obtained her PhD from the University of Madras, India, followed by a postdoctoral degree. She works at the Francis Bitter Magnet Laboratory, MIT, USA, Tata Institute of Fundamental Research, Mumbai, India, and MESA+ Institute for Nanotechnology at the University of Twente, the Netherlands. She is also a Senior member of IEEE.

Abstract

Classical computing based on von Neumann architecture is limited by a memory bottleneck, high power consumption, and heat dissipation. This is primarily due to the non-colocation of memory and processing units, making the hardware sequential and deterministic. These challenges can be efficiently tackled by processing the information on the signal, similar to what the human brain does. This has spurred the development of alternative, domain-specific computing paradigms beyond the conventional von-Neumann architecture using analogue devices with memristive materials that can collocate memory and processing in the same functional unit.

Several material systems from phase change memory, Mott memories, resistive random access memories, ferroelectrics, and ferromagnets have been actively researched, demonstrating their potential as memristors exhibiting diverse functionalities. In this webinar, I will discuss a popular choice of materials and devices, based on oxide materials, particularly those possessing competing and coexisting ground states. They offer a rich phase space and are ideal candidates, where emergent phenomena arising at their heterointerfaces can be tailored by strain and doping and tuned by external stimuli such as temperature, electric field, and magnetic field.

I will discuss two specific cases: In the first part, I will discuss the areal downscaling of interface memristive devices directly integrated on a semiconducting Nb-doped $SrTiO_3$ (Nb: STO) platform. We show a surprising enhancement in the memristive memory window, while maintaining analog behavior, contrary to expectations. The device designs on such semiconductors allow leveraging electric field effects at edges, increasing the dynamic range in smaller devices with high endurance and low device and cycle variation, down to the smallest devices with readout at low power. In the second part, I will show how we uniquely exploit the entire network of strained films of $La_{0.67}Sr_{0.33}MnO_3$ by engineering the octahedron tilt at the atomic scale, to demonstrate complex biologically plausible brain functionalities such as self-oscillation and integrate and fire neurons. The combination of an intrinsic coupled phase transition in $La_{0.67}Sr_{0.33}MnO_3$ and octahedral distortion due to the textured surface of the $LAlO_3$ substrate leads to multiple negative differential resistance (NDR) regimes in the network, when electrically driven out of thermodynamic equilibrium, at room temperature. By sweeping either voltage or current at room temperature, we find that thermal effects trigger the film toward non-linear transport regimes. By engineering the time dynamics of such metastable phases, we demonstrate voltage-tunable oscillators that dynamically oscillate at variable frequencies (kHz to MHz) and also show how orbital coupling effects, induced by local strain, enrich the phase space of operation of such oscillators. Finally, I will discuss how the time dynamics of the leaky, integrate, and fire neuron network lead to the development of probabilistic bits, useful for ultra-low power stochastic hardware.

Convener:

Prof. Yoshiyuki Kawazoe, Head, ACCMS-Centre

Prof. G P Das, TCG Crest

Prof. Ranjit Thapa, SRM University-*AP*

Local Organisers:

Dr Mahesh Kumar Ravva, SRM University-*AP*

Prof. Umesh Waghmare, JNCASR

Dr Surya VJ, ACCMS

Zoom Meeting Link:

https://srmap.zoom.us/j/99499377632?pwd=y49Cqboq0auG1z5yk2bPkG34TKzXi6.1

Meeting ID: 994 9937 7632

Passcode: 874501

Scan to Join