S N BOSE NATIONAL CENTRE
FOR BASIC SCIENCES
Block JD, Sector III, Salt Lake, Kolkata 700 106

DEPARTMENTAL SEMINAR

Physics of Complex Systems

15th June,2026 **12.00 Noon** **FERMION**

SPEAKER

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TITLE OF THE TALK

Sparse Identification of Coarse-Grained Dynamics in Conserved and Non-Conserved Ising Systems

ABSTRACT

Understanding how macroscopic continuum dynamics emerge from microscopic interacting many-body systems remains a central challenge in statistical physics. In this work, we investigate the use of the Sparse Identification of Nonlinear Dynamics (SINDy) framework to infer coarse-grained dynamical equations directly from microscopic simulations of the two-dimensional Ising model with both non-conserved (Glauber) and conserved (Kawasaki) dynamics. Starting from Monte Carlo generated spin configurations, we construct coarse-grained magnetization fields through block averaging and employ PDE-SINDy to identify the dominant terms governing the mesoscopic evolution.

The candidate libraries are systematically constructed by incorporating the relevant physical symmetries and conservation laws associated with the two dynamics. Using sparse regression techniques such as Sequential Threshold Least Squares (STLSQ) and Sequential Threshold Ridge Regression (STRidge), we examine the role of sparsity and nonlinear contributions in the inferred equations. The recovered models are validated through train–test analysis and Fourier-space comparisons between the inferred and original temporal derivative fields.

For Glauber dynamics, the inferred equations successfully recover the dominant relaxational and gradient-driven terms characteristic of Model A dynamics, while for Kawasaki dynamics the inferred equations exhibit the conserved structure expected for Model B dynamics. The reduced models reproduce important qualitative features of phase-ordering kinetics, including domain coarsening, evolving correlation functions, and Porod-law behavior of the structure factor. Our results demonstrate that sparse equation discovery can recover compact and physically interpretable continuum descriptions directly from microscopic evolution data, while also highlighting the challenges associated with accurately reproducing long-time coarsening exponents and transient growth kinetics. The present study establishes Ising coarsening dynamics as a useful benchmark for testing data-driven coarse-graining approaches in non-equilibrium statistical physics.

HOST FACULTY

Prof. Sakuntala Chatterjee
DEPT. OF PHYSICS OF COMPLEX SYSTEMS

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