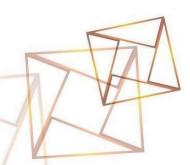
TATA INSTITUTE OF FUNDAMENTAL RESEARCH



## **ICTS Mathematics Seminar**

Title : Data-Driven Identification and Output Regulation Using Partially Observed Actuated

Trajectories: A Koopman Bilinear Approach

**Speaker**: Debdipta Goswami (Ohio State University, USA)

Date: Thursday, 17 July 2025

**Time** : 4:00 PM (IST)

**Abstract**: Data-driven Koopman-theoretic approaches have proven effective in output prediction, state

estimation, and control of nonlinear dynamical systems. For control-affine systems, the Koopman generator's affine dependence on inputs enables finite-dimensional bilinear approximations. However, selecting appropriate basis functions remains a challenge in noisy, partially observed settings. Although time-delayed observables help under partial observations, their efficacy diminishes in actuated systems. To overcome this, we model control-affine dynamics as a bilinear Hidden Markov Model defined by Koopman generators with a nonlinear observation map parameterized by a multilayer perceptron. We learn the HMM and decoder parameters via expectation-maximization, using an extended Kalman filter and smoother in the E-step and least-squares and gradient-based optimization in the M-step. We apply model-predictive control using the learned HMM for regulation. We demonstrate our method's effectiveness on: (1) an actuated polynomial system with a slow manifold, (2) a forced Duffing oscillator, and (3) the Kuramoto–Sivashinsky equation with

noisy observations.

**Venue**: Chern Lecture Hall

Zoom Link: https://icts-res-in.zoom.us/j/98545112148?pwd=JtAqov6DOXsbIKSvs0CKqyYXxzTfba.1

Meeting ID: 985 4511 2148

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