# PHYSICAL MATH SEMINAR

## Neural Dynamics in the Visual Cortex: Understanding Responses to Chaotic Motion Patterns


**Tosif Ahamed**

*Janelia*



**ABSTRACT:**

The visual cortex plays a crucial role in processing dynamic visual stimuli. While its responses to predictable or naturalistic motion patterns have been extensively studied, the mechanisms underlying its processing of unpredictable motion remain less understood. This talk explores the neuronal activity within the visual cortex of mice when exposed to simple sinusoid gratings whose motion is driven by chaotic dynamics. Specifically, we record calcium activity from thousands of visual cortex neurons using 2-photon microscopy in mice, as animals watch whole-screen videos of chaotic gratings. Such visually simple but dynamically complex stimuli pose two computational challenges. First is state estimation: given that the visual scene only contains partial observations of the dynamics, are the visual neurons able to reconstruct the underlying state space? Using a new dynamical dimensionality reduction method called predictable mode decomposition, which extracts the longest predictable modes in recordings of high-dimensional dynamics, we find that indeed, it is possible to predict the future of chaotic stimuli from neural activity longer than would be expected from the visual input alone. This indicates that visual cortex neurons are able to extract information about unobserved dynamical variables. Given that animals have no incentive to predict or learn the structure of the underlying dynamics, how is the information about the unobserved variables represented? Interestingly, we found an activity mode that correlates with the uncertainty of the ongoing dynamics, suggesting that even in the absence of an explicit goal to predict the future, neurons in the visual cortex contain information about dynamical uncertainty. In summary, by analyzing neural responses of mice to chaotic visual stimuli, we found that the visual neurons possess sophisticated mechanisms for processing and understanding complex, unpredictable visual information.


**TUESDAY, NOVEMBER 5, 2024**

**2:30 PM – 3:30 PM**

**Building 2, Room 449**

MIT MATHEMATICS

https://math.mit.edu/pms/