Condensed Matter Physics Seminar Series

Collective behavior of neural networks and complex systems in disordered superconducting loops

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Collective behavior of complex systems such as networks of neurons in our brain can be modeled by the dynamics of disordered systems. The time evolution of the system is described by the collective 'state' as it navigates the disordered energy landscape due to information from external stimuli. In this talk, I will describe our model of a disordered array of superconducting loops connected by Josephson junctions and their behavior in response to external excitations/stimuli such as currents, magnetic fields, etc. The loops exhibit discrete stable (long-range coherent) states in various quantized trapped flux configurations that dynamically evolve with time-varying excitations generating flux (information) flow between the loops. An n-dimensional space of excitations (i.e., the input information) can be mapped onto a configuration space comprising stable flux states and their flow patterns to generate associative memories. Our experimental and modeling results show that spatio-temporal information from excitations is translated to flux flow patterns with different temporal stabilities resulting in short-term and long-term memory. The flux flow maps the incoming and outgoing information as described using a network model to establish a novel architecture to perform complex computations that we think more represents the functioning of our brains.

Uday S. Goteti is a Distinguished von Neumann post-doctoral fellow at the Department of Physics in University of California, San Diego. He is currently working on developing theoretical understanding of and experimentally implementing disordered network architectures for brain-like computations. He received his Bachelor's degree (2012) in Electrical Engineering from JNTU, Hyderabad, India, and M.S. (2015) and Ph.D. (2019) in Electrical and Computer Engineering from Auburn University, Alabama. He has over 15 articles published in peer-reviewed journals and inventions registered in 4 patents.

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