32nd TcSUH STUDENT/POSTDOC SEMINAR

Tuesday, February 11, 2025|4:30-5:30 PM|HSC 102

Meet & Greet: Food and soft drinks will be served at **4:15 PM!!**

Eigenstate thermalization in the presence of symmetries

Siddharth Jindal

Department of Physics

Abstract: The eigenstate thermalization hypothesis (ETH) is the main phenomenological description of chaos and thermalization in quantum many-body systems. In general, additional symmetries result in conserved quantities that cannot thermalize in the same way as non-conserved quantities. Furthermore, in quantum mechanics, it is possible for distinct conserves quantities not to commute with one another. For example, a spin chain with global SU (2) symmetry can conserve total spin along all 3 axes simultaneously. Whereas the traditional ETH is formulated for systems that at most conserve energy, we discuss how it can be adapted to systems that contain Abelian and non-Abelian symmetries. We also discuss a related hypothesis known as Ergodic Bipartition (EB) and its analogous extension to systems with symmetries.

Bio: Mr. Siddharth is a Ph.D. candidate in the Department of Physics working under the supervision of Dr. Pavan Hosur. His current research focuses on studying the quantum many-body chaos, particularly the mathematical and conceptual underpinnings of the eigenstate thermalization hypothesis.

Fluorine-Free Ion-Selective Membrane with Enhanced Mg^{2+} Transport for Mg-Organic Batteries

Wen Ren

Department of Chemical and Biomolecular Engineering

Abstract: Magnesium (Mg) batteries offer a safer alternative for next-generation battery technology due to their insusceptibility to dendrite deposition. Selective membranes tailored for magnesium-ion conduction will unlock further technological advancement. Herein, we demonstrate fluorine-free magnesiated sulfonated poly (ether ketone) (Mg-SPEEK) selective membranes capable of facilitating magnesium-ion conduction while effectively rejecting soluble organic species. These membranes demonstrate a reversible Mg plating and stripping Coulombic efficiency (CE) of 85.4% and an ionic conductivity of 3.3×10^{-4} S cm^{-1} at room temperature, surpassing those for a Mg-Nafion selective membrane. Theoretical density functional theory (DFT) calculations reveal that SPEEK possesses more localized charge centers along its backbone compared with Nafion, potentially facilitating enhanced ion conduction. Full cells assembled with Mg-SPEEK coupled with the organic cathode pyrene-4,5,9,10-tetraone (PTO) and Mg metal demonstrated significantly improved capacity retention as compared to those assembled with conventional nonselective separators.

Bio: Mr. Wen Ren is a Ph.D. candidate in the Department of Chemical and Biomolecular Engineering at the University of Houston, working under the supervision of Prof. Yan Yao and serving as the lab manager. He obtained his master's degree from Shanghai Jiao Tong University, China, in 2022. His current research focuses on designing and developing advanced electrolytes for rechargeable magnesium and sodium batteries.

Rapid Identification Community Detection in Bipartite Networks with Generalized Bipartite Modularity Density

Tania Gosh

Department of Physics

Abstract: A bipartite network is a type of graph which consists of nodes of two different natures with links joining only between unlike nodes. This structure is prevalent in many real-world applications, such as relationships between authors and papers in citation networks, or patients and diseases in biomedical networks. Partitioning bipartite networks into communities is important for uncovering the underlying structure of these complex systems. Grouping nodes into dense communities reveals network interactions and dependencies. Among various approaches, modularity-based detection is widely used but faces challenges like the resolution limit, which restricts small community detection, and the NP-complete complexity of finding optimal partitions in large networks. To address the Resolution limit problem in the bipartite network, we introduced a novel metric, bipartite generalized modularity density Q_{bg}. This function has a tunable parameter that sets the scale for the typical community found. By varying this parameter hierarchical structure can be found in bipartite networks. Also, to tackle the NP-Complete nature, we explored the use of a recently introduced algorithmic scheme - RenEEL, to find the structure of a set of benchmark networks. These approaches increase the efficiency and accuracy of the partition found by combining information from multiple partitions obtained using different methods. RenEEL is a highly accurate ensemble learning algorithmic paradigm that can find partitions that maximize Generalized Bipartite Modularity Density. RenEEL uses extremal criteria to update the partition ensemble and bring it to consensus. RenEEL is particularly efficient because it uses consensus information within the ensemble to form a smaller, reduced network, a partition of which is then used to update the ensemble. We have shown that the combination of Generalized Modularity Density and RenEEL is effective in artificial networks, successfully identifying sub-communities and detecting hierarchical communities as a function of the control parameter.

Bio: Ms. Tania Ghosh is a Ph.D. candidate in the Department of Physics at University of Houston working under the supervision of Dr. Kevin Bassler. Her current research is based on finding different methods to calculate the modular structure in different systems and to relate that with nonlinear dynamics of complex network systems.

Persons with disabilities who require accommodations to attend this seminar should call 713-498-9703