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Entanglement dynamics of Brownian models from universal low-lying modes

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Information-theoretic quantities such as Renyi entropies show a remarkable universality in their late-time behaviour across a variety of chaotic systems. Understanding how such common features emerge from very different microscopic dynamics remains an important challenge. In this talk, I will address this question in a general class of Brownian models with a variety of different microscopic couplings. In any such model, the Lorentzian time-evolution of the n-th Renyi entropy can be mapped to a transition amplitude with a Euclidean Hamiltonian on 2n copies of the system. Using the structure of the ground states of the Euclidean Hamiltonian, we derive an expression for the saturation value of the n-th Renyi entropy in terms of an equilibrium density matrix, consistent with a general proposal called the equilibrium approximation. In non-integrable models without conserved quantities in (1+1) dimensions, we find that the spectrum of the Euclidean Hamiltonian relevant for the second Renyi entropy and OTOCs has two degenerate ground states, and a well-defined one-particle band consisting of plane waves of domain walls between them. The one-particle band gives rise to the membrane formula for entanglement dynamics, with the velocity-dependent membrane tension determined by its dispersion relation. This structure provides an understanding of entanglement dynamics in terms of a universal set of gapped modes, analogous to the gapless modes which govern hydrodynamic behaviour of conserved charge densities.

Presenter: VARDHAN, Shreya (Stanford University, USA)