Friday: Lorenzo Piroli

Title: Integrable Digital Quantum Simulation: Generalized Gibbs Ensembles and Trotter Transitions

Abstract: The Trotter-Suzuki decomposition is a promising avenue for digital quantum simulation (DQS), approximating continuous-time dynamics by discrete Trotter steps of duration T. Recent work suggested that DQS is typically characterized by a sharp Trotter transition: when T is increased beyond a threshold value, approximation errors become uncontrolled at large times due to the onset of quantum chaos. In this talk, we contrast this picture with the case of integrable DQS. We focus on a simple quench from a spin-wave state in the prototypical XXZ Heisenberg spin chain, and study its integrable Trotterized evolution as a function of T. Because of its exact local conservation laws, the system does not heat up to infinite temperature and the late-time properties of the dynamics are captured by a discrete generalized Gibbs ensemble (dGGE). By means of exact calculations we find that, for small T, the dGGE depends analytically on the Trotter step, implying that discretization errors remain bounded even at infinite times. Conversely, the dGGE changes abruptly at a threshold value T*, signaling a novel type of Trotter transition. We show that the latter can be detected locally, as it is associated with the appearance of a nonzero staggered magnetization with a subtle dependence on T. We highlight the differences between continuous and discrete GGEs, suggesting the latter as novel interesting nonequilibrium states exclusive to digital platforms