Emergent symmetry assisted quantum Mpemba effect in a class of periodically driven systems

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Entanglement asymmetry is a probe of measuring the degree of a particular symmetry breaking, at the level of a subsystem through the entanglement entropy associated with it. In a non-equilibrium set up, such as quench, there are several works where one starts with an initial state that breaks a particular symmetry, and the system is then evolved via a symmetry preserving Hamiltonian. In such a set up, the symmetry is restored dynamically. There is also an observation of a counter intuitive effect, dubbed as the "quantum Mpemba effect", that demonstrates that for some initial states, more a symmetry is broken in the initial state, the faster it is restored under time evolution. From this viewpoint, the entanglement asymmetry, can also probe the proximity of the reduced density matrix of the subsystem to that of the equilibrium reduced density matrix (by imagining that the rest of the system is acting as a bath to the subsystem of interest). In this poster I will convey, how the dynamical restoration of emergent conservation laws that appear in a class of periodically driven closed quantum many-body systems, give rise to the "quantum Mpemba effect". In such systems, for some specific drive frequencies, the initial entanglement asymmetry decreases with time, and the symmetry is dynamically restored for a long metastable time scale, while, for other frequencies it saturates to a finite value. The presence of this long metastable timescale in these systems, can be understood from the presence of an approximate emergent symmetry in the corresponding Floquet Hamiltonian at these specific frequencies and in the high-drive-amplitude regime. The symmetry is exact in the first-order Floquet Hamiltonian at special frequencies whose quantitative values depend on the nature of the drive protocol. I will demonstrate this idea by considering two specific examples, one is the dynamical symmetry restoration in a driven integrable free-fermionic systems and the the other is the restoration of the emergent symmetry in a chain of periodically driven Rydberg atoms in the strong Rydberg blockaded regime.

[1] Tista Banerjee, Suchetan Das and K. Sengupta, **arXiv:2412.03654**