Contribution ID: **36** Type: **Poster**

Symmetry breaking in chaotic many-body quantum systems at finite temperature

Recent work [1] has shown that the entanglement of finite-temperature eigenstates in chaotic quantum many-body local Hamiltonians can be accurately described by an ensemble of random states with an internal U(1) symmetry. In this talk, I will discuss our recent work [2], where we develop this framework to investigate the universal symmetry-breaking properties of such eigenstates. As a probe of symmetry breaking, we employ the entanglement asymmetry, a quantum information observable that quantifies the extent to which symmetry is broken in a subsystem. This measure enables us to explore the finer structure of finite-temperature eigenstates in terms of the U(1)-symmetric random state ensemble. I will present the derivation of universal analytical predictions for the symmetric random states. These results show a remarkable agreement with exact numerical data across various locally interacting chaotic spin models.

[1] C. M. Langlett, C. Jonay, V. Khemani, and J. F. Rodriguez-Nieva, Quantum chaos at finite temperature in local spin Hamiltonians, arXiv:2501.13164.
[2] A. Russotto, F. Ares, and P. Calabrese, Symmetry breaking in chaotic many-body quantum systems at finite temperature, arXiv:2504.06146.

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Session Classification: Poster