# The Relaxation and Recurrence Behaviors in Isolated Finite Many-Body Systems

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Isolated quantum systems follow the unitary evolution, which guarantees the full many body state always keeps a constant entropy as its initial one. In comparison, the local subsystems exhibit relaxation behavior and evolve towards certain steady states, which is called the local relaxation. Here we consider the local dynamics of some finite many body systems, and it turns out the local observables exhibits similar relaxation behavior as the macroscopic thermodynamics; due to the finite size effect, recurrence appears after a certain typical time. Especially, we find that the total correlation of this system, which sums up the entropy of all the local sites, approximately exhibit a monotonic increasing envelope. Moreover, the possible maximum of such total correlation calculated under proper constraints also coincides well with the exact result of time dependent evolution. For usual physical situations that an open system is weakly coupled with a thermal bath, this total correlation entropy increase could well return to the irreversible entropy production in the standard thermodynamics. In this sense, the increase of the total correlation entropy well corresponds to the irreversible entropy production in the standard macroscopic thermodynamics.

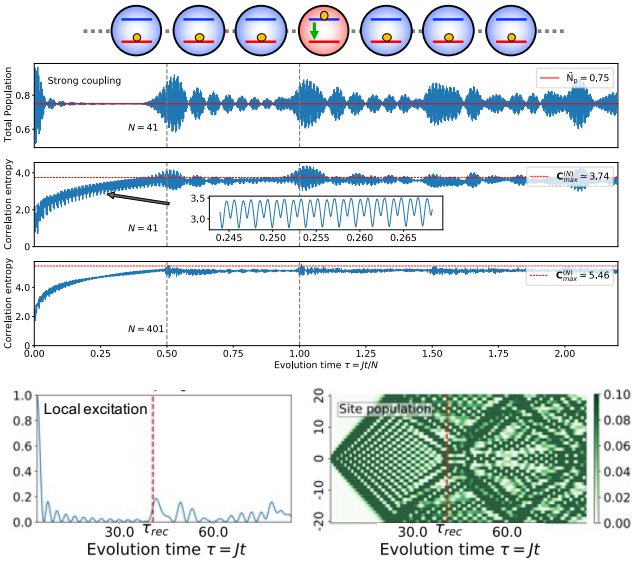


Figure 1: In a finite many body system, the local observables exhibit relaxation behaviors and approach towards certain steady state, which is similar as the macroscopic thermodynamics. The total correlation entropy of the many body system approximately exhibit a monotonic increasing envelope, which corresponds to the irreversible entropy production in the standard macroscopic thermodynamics

## References

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[2] T Kang and S-W Li, arXiv:2211.03050 (2022)