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Novel dynamical phases of matter in an isolated quantum system

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In recent years, the dynamical behavior of a generic isolated quantum many-body system has attracted widespread attention. One of the most important questions is whether such a system can return to a thermalized state under its own dynamics after a sudden quench. While thermalization is the expected behavior in many cases, there can be situations where the opposite occurs. I will start by introducing a proper definition of quantum thermalization and then explain how to theoretically determine whether an isolated quantum many-body system is in a thermalized state. Afterward, I will present the most typical example of escaping thermalization in the past decade: the phenomenon of many-body localization. This phenomenon occurs when a strong disorder is present in the system. I will briefly review the research progress in this direction and highlight the work we have done recently [1-3]. Additionally, I will discuss the problem of quantum chaos in isolated quantum systems. Specifically, we have recently investigated how to capture signals of quantum chaos in quantum circuits through out-of-time-ordered correlators (OTOC) [4].

[1] D. Vu, K. Huang, X. Li, and S. Das Sarma, Phys. Rev. Lett. 128, 146601 (2022).
[2] K. Huang, D. Vu, X. Li, and S. Das Sarma, Phys. Rev. B 107, 035129 (2023).
[3] K. Huang, D. Vu, S. Das Sarma, and X. Li, arXiv:2305.20090 (2023).
[4] K. Huang, X. Li, D. Huse, and A. Chan, arXiv:2308.16179 (2023).