凝縮系物理学ゼミナール
Condensed Matter Seminar

Date: 16:00-17:30, Wednesday, 4 October 2023

Title: Interaction-induced Liouvillian skin effect

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Abstract:

Recently, non-Hermitian physics has been extensively investigated both theoretically and experimentally [1]. One of the most remarkable phenomena resulting from non-Hermiticity is the non-Hermitian skin effect [2], which exhibits a strong dependence of eigenvalues and eigenstates on boundary conditions. In noninteracting systems, previous studies have shown that the nontrivial point-gap topology induces the non-Hermitian skin effect [3]. Moreover, the non-Hermitian skin effect has been generalized to the open quantum system described by the Lindblad Equation. It has been reported that the Liouvillian skin effect can be another mechanism which causes the slowing down of the relaxation process [4].

Despite the great importance of the skin effect above, the effect of the interaction has not been sufficiently explored. In ultracold atoms, it became possible to implement both correlations and particle losses [5]. This development urges us to analyze the interaction effect on the skin effect.

In this study, we propose interaction-induced Liouvillian skin effect in one-dimensional open quantum systems [6]. Specifically, we find that in the presence of interactions, the eigenmodes and eigenvalues of the Liouvillian are drastically different depending on the boundary conditions. Moreover, we construct the topological invariant using the Liouvillian superoperator and then numerically confirm that the topological invariant captures the Liouvillian skin effect. In my presentation, we also give a detailed analysis of the dynamics.

Reference :

[1] Y. Ashida, et al., Advances in Physics 69, 249 (2020); K. Kawabata et al., Phys. Rev. X 9, 041015 (2019).

[2] S. Yao and Z. Wang, Phys. Rev. Lett. 121, 086803 (2018).

[3] N. Okuma et al., Phys. Rev. Lett. 124, 086801 (2020); K. Zhang et al., Phys. Rev. Lett. 125, 126402 (2020).

[4] T. Haga et al., Phys. Rev. Lett. 127, 070402 (2021); T. Mori and T. Shirai, Phys. Rev. Lett. 125, 230604 (2020).

[5] T. Tomita et al., Science Advances 3, e1701513 (2017).

[6] SH, K. Yamamoto, and T. Yoshida, arXiv: 2305.19697, to appear in PRB.