量子物理学・ナノサイエンス第 427 回セミナー

Nonnormality-induced spontaneous symmetry breaking in open quantum systems on infinite lattices

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日程　：　11 月 18 日（火）14:00－

場所　：　本館地下 B61 物理学系輪講室

概　要

For open quantum systems obeying a Lindblad equation, it is a challenging problem to clarify and classify what kind of non-equilibrium steady state (NESS) the system relaxes to after a sufficiently long time. In this talk, we consider open quantum spin systems on infinite lattices described by the Lindblad equation and present a definition of the NESS in such infinite systems. The NESS in infinite systems is not necessarily equivalent to the thermodynamic limit of the NESS in finite systems; the former may correspond in finite systems to a metastable state, not a NESS. We see this in a solvable model. We also find a sufficient condition for equivalence of them, which relates to both the Liouvillian gap and nonnormality, i.e., nonorthogonality among eigenmodes of the Liouvillian. The enhancement of nonnormality can cause spontaneous symmetry breaking (SSB) for the NESS in infinite systems, which we dub nonnormality-induced SSB. Since a Liouvillian is normal in unitary dynamics, such a type of SSB is unique to open quantum systems. Furthermore, the nonnormality-induced SSB can occur even when the Liouvillian is gapped. This work uncovers a novel phase of matter in open quantum systems and establishes a way to classify it by focusing on nonnormality. This talk is based on the preprint arXiv:2508.07448.

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