Symmetry in non-equilibrium quantum processes

Jianshu Cao

MIT, 77 Mass. Ave. 6-237A, Cambridge, USA

The talk explores the role of symmetry in quantum transport and in driven systems.

Symmetry in molecular systems such as benzene rings, LH2 complexes, carbon nanotubes, and C60 can result in multiple steady state solutions in non-equilibrium transport measurements [1]. However, dynamic or static disorder in open systems will break the symmetry and thus the degeneracy of multiple steady-states, leading to a unique current. To reveal the symmetry hidden under disorder, we demonstrate the slow relaxation of dynamical currents and uncover hidden signatures of multiple steady states [1,2].

Another type of symmetry is the commutativity of coupling operators, exemplified by non-commutative quantum transport [3]. Further, to study the symmetry in driven systems, we have systematically developed Floquet response theory for open quantum systems driven by a strong but periodic driving field and perturbed by a weak but arbitrary probe field [4,5]. Dynamical symmetries of the Floquet states lead to spectroscopic signatures including symmetry-protected dark states and Floquet-band selection rules [4].

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[2] Magnetic field induced symmetry breaking in nonequilibrium quantum networks. J. Thingna, D. Manzano, and J. Cao, New J. Phys. 22, 083026 (2020)

[3] Unusual Transport Properties with Noncommutative System-Bath Coupling Operators. C. Duan, C.-Y. Hsieh, J. Liu, J. Wu, and Jianshu Cao, J. Phys. Chem. Lett. 11, 4080 (2020)

[4] Dynamical Symmetries and Symmetry-Protected Selection Rules in Periodically Driven Quantum Systems. G. Engelhardt and J. Cao, Phys. Rev. Lett. 126, 090601 (2021)

[5] Discontinuities in driven spin-boson systems due to coherent destruction of tunneling: breakdown of the Floquet-Gibbs distribution. G. Engelhardt, G. Platero and J. Cao, Phys. Rev. Lett. 123(12), 120602/1-7 (2019)