Transport at Nano-scale: Coherence and Symmetry

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Transport in nano-scale systems often exhibits intriguing quantum coherent effects, which will be illustrated using two examples in this talk:

Exciton or charge transport in organic semiconductors shows an optimal diffusion constant at an intermediate level of noise/temperature. [1] Detailed calculations indicate the crucial role of Anderson localization and predict scaling laws that depends strongly on localization length. Further, we demonstrate 1D-2D transition in the diffusion along nanotubes and predict a universal scaling law for the radius-dependence of diffusion constant. [2]

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**.** [3] 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. [3] One application is the prediction of transport in lattices. [4]

If time allows, I will also introduce the polaron transformation and its application to non-equilibrium quantum transport.[5]

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(2) Quantum diffusion on molecular tubes: Universal scaling of the 1D to 2D transition. C. Chuang, C. K. Lee, J. Moix, J. Knoester, and J. Cao, Phys. Rev. Lett. 116, 196803 (2016)
(3) Dynamical signatures of molecular symmetries in nonequilibrium quantum transport. J. Thingna, D. Manzano, and J. Cao, Sci. Rep. 6, 28027 (2016)
(4) Quantum transport in d-dimensional lattices. D. Manzano, C. Chuang, and J. Cao, New J. Phys. 18, 043044 (2016)
(5) Non-canonical distribution and non-equilibrium transport beyond weak system-bath coupling regime: A polaron transformation approach. D. Xu and J. Cao, Front. Phys. 11, 1 (2016)