Quantum Physics

# Highly efficient energy excitation transfer in light-harvesting complexes: The fundamental role of noise-assisted transport

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Excitation transfer through interacting systems plays an important role in many areas of physics, chemistry, and biology. The uncontrollable interaction of the transmission network with a noisy environment is usually assumed to deteriorate its transport capacity, especially so when the system is fundamentally quantum mechanical. Here we identify key mechanisms through which noise such as dephasing, perhaps counter intuitively, may actually aid transport through a dissipative network by opening up additional pathways for excitation transfer. We show that these are processes that lead to the inhibition of destructive interference and exploitation of line broadening effects. We illustrate how these mechanisms operate on a fully connected network by developing a powerful analytical technique that identifies the invariant (excitation trapping) subspaces of a given Hamiltonian. Finally, we show how these principles can explain the remarkable efficiency and robustness of excitation energy transfer from the light-harvesting chlorosomes to the bacterial reaction center in photosynthetic complexes and present a numerical analysis of excitation transport across the Fenna-Matthew-Olson (FMO) complex together with a brief analysis of its entanglement properties. Our results show that, in general, it is the careful interplay of quantum mechanical features and the unavoidable environmental noise that will lead to an optimal system performance.

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