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Enhanced exciton diffusion length via cooperative quantum transport MASOUD MOHSENI, MIT, DAMIAN ABASTO, USC, SETH LLOYD, MIT, PAOLO ZANARDI, USC — The energy transfer rate in biomolecular systems is typically calculated from the transition probability of an excitation hopping from one molecule to another using Förster energy transfer based on dipole-dipole interaction of individual molecules in the perturbative regime. However, due to strong interactions of among a group of molecules the excitation can become highly delocalized leading to an effective large dipole moment with an enhanced oscillator strength. Under certain symmetries, this could lead to an enhancement in exciton transfer rate via cooperative donation or acceptance of an excitation. Here, we explore this phenomenon in various multichromophoric geometries, under different symmetries, initial conditions, and dynamics. We study the behavior of the exciton diffusion length under the effects of disorders and environmental fluctuations and quantify the crossover from ballistic to diffusive regimes. Specifically, for a quasi-1 D array of rings containing N chromophores interacting with a bosonic bath, an interplay of time scales dictates the exciton dynamics. In the “far-field” regime, environmental interactions are dominating and the system properties are approaching those of the incoherent equilibrium Gibbs state. However, in the “near-field” the coherent interactions among dipole aggregates dominate other time scales and exciton diffusion length is enhanced by a factor of \sqrt{N} .

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