SEMINAR

by

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TITLE

Quantum coherence in Biology and Materials Science

ABSTRACT

The main question we address is the following: Can we harness quantum coherence in practical applications, like increasing efficiency in solar cells?

In a series of pioneering studies, Fleming and co-workers [Nature, 2007, 446 782-786; PNAS, 2009, 106, 17255-17260] reported existence of long lived quantum coherence in photosynthetic Fenna-Matthews-Olson (FMO) complex. It was surmised that such coherence can play important role in facilitating efficient energy transfer processes. The occurrence of quantum coherence in quantum transport is also implicated in the exciton transport processes in conjugated polymers (Science, 2009, Nat. Materials 2017). However, most studies invoke Markovian approximation where the temporal correlation of bath fluctuations is neglected. Here we use an elegant method based on Kubo's quantum stochastic Liouville equation (QSLE) to study the effects of correlated bath fluctuations for the first time and find the interesting result that fluctuations can not only destroy coherence but under appropriate conditions can also facilitate it. We find out the conditions of coherence and also effects of coherence on excitonic line shape. Under certain conditions efficiency of energy transfer increase with coherence. We explore the role of non-Markovian bath fluctuations in different limits through the study of population and coherence. We also consider temperature effect to quantify the difference between temperature independent as well as temperature dependent studies.

References :

1. R. Dutta and B. Bagchi, "Effects of dynamic disorder on exciton migration: Quantum diffusion, coherences, and energy transfer", J. Chem. Phys. 2016, 145, 164907 (1-14).
2. R. Dutta, K. Bagchi and B Bagchi, "Role of quantum coherence in shaping the line shape of an exciton interacting with a spatially and temporally correlated bath," J. Chem. Phys. 2017, 146, 194902 (1-17).
3. R. Dutta and B. Bagchi,) "Quantum coherence in photosynthetic system". JPC-Lett. (under revision)