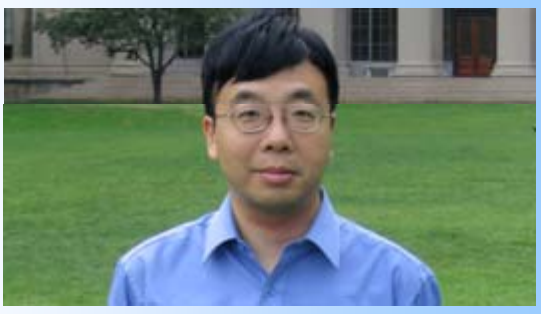
中国科学院物理研究所
INSTITUTE OF PHYSICS CHINESE ACADEMY OF SCIENCES

软物质物理实验室
学术报告

Coherent energy transfer in light-harvesting symmetry, disorder, and aggregation



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Ph.D. Department of Physics, Columbia University, New York, 1993
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2011 Visiting Lecturer of the Chemistry Research Promotion Center, Taiwan
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2005 Overseas Chinese Scholarship Award
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2001 NSF Early Career Award
1999 Young Researcher Award, International Conference on Luminescence
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1998- Assistant, Associate, and Full Professor of Chemistry, MIT
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ABSTRACT

Quantum coherence plays a central role in natural and artificial light-harvesting complexes and is explored by my group in terms of symmetry, static disorder, and the size and alignment of these complexes.

(1) An interesting observation of photosynthetic light-harvesting systems is the N-fold Symmetry of light-harvesting complex 2 (LH2) of purple bacteria. We have calculated the optical rotational configuration of N fold rings on hexagonal lattice, and established the symmetry principles for the promotion of maximum excitation energy transfer (EET). For certain fold numbers, there exist optimal basis cells with rotational symmetry, expendable to the entire hexagonal lattice for the global optimization of the EET network. Remarkable, one consecutive group of such symmetry numbers consists of the naturally occurring 8-,9-&10-fold rings, suggesting the design principle of matching the internal symmetry with the lattice order.

(2) We have studied coherent quantum transport in disordered 1-D and 2-D systems and clearly showed an optimal diffusion constant at an intermediate level of noise. Scaling Analysis similar to the mean first passage time analysis indicates the crucial role of localization length. Further detailed studies reveal that optical diffusion depends critically on dimensionality and range of interactions, and may not be observed in certain systems due to different scaling laws. We are also developing methods to calculate transport in a thermal environment and predict its temperature dependence.

(3) We have developed a novel numerical method to predict the quantum dynamics of extended systems. Based on the concept of dynamical maps, our method extracts all available information encapsulated in short-time non-Markovian quantum trajectories and compressed it into tensors of reduced size. Efficient propagation of these tensors generates dissipative quantum dynamics of large systems with arbitrary spectral densities, e.g., molecular chains of hundreds of sites strong quantum dissipation. Further, it can be applied to experimental setting s in the same spirit as processing tomography and permits direct reconstruction of dynamical operators, i.e., the Hamiltonian and memory kernel.

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