北京计算科学研究中心
BEIJING COMPUTATIONAL SCIENCE RESEARCH CENTER

Mini-Workshop on Quantum Information

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Crossover between Non-Markovian and Markov Dynamics Induced by a Structured Environment

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Prof. Ting Yu
Department of Physics and Engineering Physics
Stevens Institute of Technology, New Jersey, USA

Abstract: In this talk I will report our recent work on the crossover between non-Markovian and Markov dynamics induced by a hierarchical environment. It is known that non-Markovian evolution of an open quantum system can be induced by the memory effects of a reservoir. Although a reservoir with stronger memory effects may seem like it should cause stronger non-Markovian effects on the system of interest, this seemingly intuitive thinking may not always be correct. We illustrate this by investigating a qubit (a two-level atom) that is coupled to a hierarchical environment, which contains a single-mode cavity and a reservoir consisting of infinite numbers of modes. We show how the non-Markovian character of the system is influenced by the coupling strength between the qubit and cavity and the correlation time of the reservoir. In particular, we found a new phenomenon whereby the qubit Markovian and non-Markovian transition exhibits an anomalous pattern in a parameter space depicted by the coupling strength and the correlation time of the reservoir. In addition, I will report some recent work on the exact stochastic Schrödinger equation for the dynamics of an open quantum system coupled to a reservoir consisting of a finite or infinite number of bosons (or fermions). We use this stochastic approach to derive the exact master equation for an open system strongly coupled to its environment. The generality and applicability of our stochastic approach is justified and exemplified by four-level atomic systems and multiple qubit systems.

About the Speaker: Prof. Ting Yu established Quantum Information and Quantum Technology Group at Stevens Institute of Technology in 2008. His current research interests span many areas of quantum information science, quantum optics and quantum open systems, including quantum foundation, quantum trajectories, quantum entanglement dynamics, the theory of non-Markovian quantum dynamics, quantum control, as well as numerical simulations of many-body quantum open systems coupled to a noisy environment. He received his Ph.D. in Physics from Imperial College, London, UK in 1997. Since then he has worked as a postdoctoral researcher in University of Geneva and University of Rochester.

Date: May 21, 2014 (Wednesday)
Time: 13:30 – 14:20
Location: 606 Conference Room

海淀区荷清路 3 号写字楼 A 座六层 606 会议室

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Single-Particle Approach to Mesoscopic Transport

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Prof. Shmuel Gurvitz

Weizmann Institute of Science, Israel

Abstract: We develop a new approach to electron transport in mesoscopic systems by using a particular single-particle basis. Although this basis generates redundant many-particle amplitudes, it greatly simplifies the treatment. By using our method for transport of non-interacting electrons, we generalize the Landauer formula for transient currents and for time-dependent potentials. The result has a very simple form and clear physical interpretation. As an example, we apply it to resonant tunneling through a quantum dot where the tunneling barriers are oscillating in time. We obtain analytical expression for the time-dependent (ac) resonant current. However, in the adiabatic limit this expression displays the dc current for zero bias (electron pumping).The method allows us to derive the particle-resolve master equations for any bias voltages and temperatures. The result would be very useful for the counting-statistics analysis. We demonstrate that this approach can be applied for study of a qubit interacting with a single-electron transistor (representing the measurement device). We investigate the qubit's decoherence (decay of Rabi oscillations) as a function of the bias voltage and temperature.

About the Speaker: Prof. Shmuel Gurvitz obtained his Ph.D from Institute of Theoretical and Experimental Physics. Then he immigrated to Israel and conducted research in Weizmann Institute of Science in 1972. He is now a Professor of Department of Particle Physics and Astrophysics in Weizmann Institute of Science. His research interests include Open systems, Quantum Measurements, Mesoscopic Physics, Tunneling, Scattering theory.

Date: May 21, 2014 (Wednesday)

Time: 14:20 – 15:10

Location: 606 Conference Room

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Order, Memory, Equilibrium: The Search for a Quantum Hard Drive and New Laws of Quantum Statistical Mechanics

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Prof. Alioscia Hamma

Institute for Interdisciplinary Information Sciences

Tsinghua University

Abstract: The three concepts of the title are closely related in statistical mechanics and condensed matter. Order is what gives a material its macroscopic properties. A magnet is interesting because it is magnetic, not because it is made of iron or another substance. And magnetism is a form of organization, that we call Order. Equilibrium is the state in which materials are found, and equilibration is the most common phenomenon in Nature. There is no other law that is stronger than the one that imposes systems to reach equilibrium. And memory is the property of staying away from equilibrium. All these concepts are very well described by a device that we use every day: the Hard Drive. In this talk, I will tackle the following question: can one build a Quantum Hard Drive? Does Nature allow for it? If the answer is yes, then 1) we are in a good shape for amazing applications, and 2) we need new laws for quantum statistical mechanics.

About the Speaker: Alioscia Hamma obtained his PhD in University of Naples and ISI (also visiting student at MIT) in 2005. After graduation, he conducted his postdoctoral Research at University of Southern California and Perimeter Institute. He became a Distinguished Research Fellow at Perimeter Institute for Theoretical Physics (2009-2013); He is now an Assistant Professor at Tsinghua University, Center for Quantum Information, IIIS (2013). His research interests include quantum and classical statistical mechanics, quantum phase transitions, theory of entanglement, topological quantum computing, quantum information in open systems, theory of topological order, emergent quantum gravity.

Date: May 21, 2014 (Wednesday)

Time: 15:40 – 16:30

Location: 606 Conference Room

海淀区荷清路 3 号写字楼 A 座六层 606 会议室

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Feshbach P-Q Partitioning Technique for Quantum Control

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Prof. Lian-Ao Wu

Department of Theoretical Physics and History of Science

The Basque Country University, Spain

Abstract: We use a Feshbach P-Q partitioning technique to derive a closed one-component integro-differential equation. The resultant equation properly traces the footprint of the target state in quantum control theory. The physical significance of the derived dynamical equation is illustrated by both general analysis and concrete examples. We show that control can be realized by fast-changing external fields, even fast noises. We illustrate the results by quantum memory and controlled adiabatic paths.

About the Speaker: Prof. Lian-Ao Wu obtained his Ph. D. in Physics 1989 from the Jilin University in China. He has 25 years of research experience in centers in Canada, China, Japan, Europe, and the United States. He is now the Ikerbasque Research Professor in Department of Theoretical Physics and History of Science of The Basque Country University, Spain. His research fields include Quantum Control, Quantum Information Processing and devices.

Date: May 21, 2014 (Wednesday)
Time: 16:30 – 17:20
Location: 606 Conference Room
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