Problemi Attuali di Fisica Teorica

Tredicesima Edizione

Meccanica Quantistica e Computazione Quantistica
(giornate a cura di G. Casati – Como, S. Pascazio – Bari)

1 Aprile 2007

Lloyd's Baia Hotel

Vietri sul Mare (Italy)

G. Benenti (Insubria)
with A. D'Arrigo and G. Falci

Quantum capacity of dephasing channels with memory

Quantum channels with memory are the natural theoretical framework for the study of any processing of quantum information in systems suffering from low frequency noise, that is, noise with correlation times longer that the time between consecutive uses of the channel.
A central quantity in both classical and quantum information theory is the capacity of a noisy channel, that is, the maximum number of bits or qubits that can be reliably transmitted per channel use. In particular, quantum capacity refers to the coherent transmission of quantum information (measured in number of qubits). We show that the amount of quantum information that can be reliably transmitted down a dephasing channel with memory is maximized by separable input states. In particular, we model the channel as a Markov chain or a multimode environment of oscillators. While in the first model the maximization is achieved for the maximally mixed input state, in the latter it is convenient to exploit the presence of a decoherence-protected subspace generated by memory effects. We explicitly compute the quantum capacity for the first model and provide a lower bound for the latter. In both cases memory effects enhance the quantum capacity.

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Domenico Giuliano (Calabria)

Boundary Field Theories for Josephson Devices

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Gianluca Panati (Roma I)

with F. Faure, H. Spohn and S. Teufel.

Adiabatic decoupling of Quantum Dynamics

Separation of time scales is a fundamental tool in understanding the dynamics of both classical and quantum systems. Following this leading idea, a general mathematical theory to deal with quantum systems has been developed (space-adiabatic perturbation theory). In the seminar I will first illustrate the main ideas of this theory in the simplest case, namely the Born-Oppenheimer approximation in molecular physics. Then I will show as similar methods can be applied to analyse the dynamics of non-interacting electrons in a perturbed periodic potential (relating the Schroedinger equation and the celebrated "colorful Hofstadter butterfly"), to the Dirac equation and to models in semi-relativistic QED.

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Fabrizio Piacentini (INRIM Torino)
with G. Brida, M. Genovese, M. Gramegna, L. Krivitsky, A. Meda,
M. Paris , A. Ranzoni, I. Ruo Berchera, P. Traina

Quantum metrology, quantum information and Bell inequality tests: recent works at INRIM

I will present the work performed at INRIM on the application of quantum optical states to quantum information and metrology and foundations of Quantum Mechanics investigation. After a general review of the activity of our lab, I will describe in details a series of experiments where we have reconstructed the statistics of various quantum optical states with an innovative method based on "variable" quantum effciency and on/off detectors. The success of the presented applications and the simplicity of the method suggest a possible widespread applicability of it. I will then describe our work on photo-detectors calibration by exploiting PDC light and in particular the extension to analog detectors, and mention studies concerning fiber effects on transmission of entangled states and their application to quantum communication. Finally, I will present some recently obtained results about Bell inequality violation tests performed in our lab.