Consuntivo MI_{41}

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Open quantum systems. G.L. Celardo

Collaborators

F. M. Izrailev, Puebla, Mexico, L. Kaplan Tulane, USA, V. G. Zelevinsky MSU, USA

Abstract Superradiance in open quantum systems: nuclear physics, quantum transport, cold atoms, photosynthetic systems.
Using an effective non Hermitian Hamiltonian approach to open quantum systems, we recently demonstrated the occurrence of a Superradiance transition in a paradigmatic model for coherent quantum transport Coherent quantum regime is very important in nanoscale applications and it has important consequences in basic energy problems. As a short term goal I plan to investigate the interplay of opening and disorder in determining transport properties in the coherent quantum regime. In the long term I plan to investigate the consequences of the Superradiance transition in interacting many body systems. My aim is to focus on emergent properties of many body systems due to the interplay of openness and internal interaction.

Publications Phys. Rev. B 85, 052201 (2012), Phys. Rev. Lett. 106, 042501 (2011), Phys. Rev. B 82, 165437 (2010), Phys. Rev. B 79, 155108 (2009)

Superradiance Transition in Photosynthetic Light-Harvesting Complexes. G.L.C.

Collaborators

F. Borgonovi (Italy), M. Merkli(Canada), V. I. Tsifrinovich(USA), G. P. Berman(USA).

Abstract We investigate the role of long-lasting quantum coherence in the efficiency of energy transport at room temperature in Fenna-Matthews-Olson photosynthetic complexes. The dissipation due to the coupling of the complex to a reaction center is analyzed using an effective non-Hermitian Hamiltonian. We show that, as the coupling to the reaction center is varied, the maximum efficiency in energy transport is achieved at the superradiance transition, characterized by a segregation of the imaginary parts of the eigenvalues of the effective non-Hermitian Hamiltonian. We show that the optimal distance from the reaction center to the Fenna-Matthews-Olson system occurs at the superradiance transition, and is consistent with available experimental data.

Publications arXiv:1111.5443, submitted to The Journal of Physical Chemistry C.

Interplay of superradiance and disorder

Collaborators
R. Kaiser (FRANCE), N. Piovella (ITA), A. Biella (Master Student, Unicatt).

Abstract Using a non-Hermitian Hamiltonian approach to open systems, we study the interplay of disorder and superradiance in a one-dimensional Anderson model. Analyzing the complex eigenvalues of the non-Hermitian Hamiltonian, a transition to a superradiant regime is shown to occur. As an effect of openness the structure of eigenstates undergoes a strong change in the superradiant regime: we show that the sensitivity to disorder of the superradiant and the subradiant subspaces is very different; superradiant states remain delocalized as disorder increases, while subradiant states are sensitive to the degree of disorder.

Publications arXiv:1204.3325, accepted for publication in Fortschritte der Physik - Progress of Physics.

Collaborators

F. Borgonovi (ITA), S. Ruffo (ITA)

Abstract Magnetic materials are usually characterized by anisotropy energy barriers which dictate the time scale of the magnetization decay and consequently the magnetic stability of the sample. Here we present a unified description, which includes coherent rotation and nucleation, for the magnetization decay in generic anisotropic spin systems. In particular, we show that, in presence of long range exchange interaction, the anisotropy energy barrier grows as the volume of the particle for on site anisotropy, while it grows even faster than the volume for exchange anisotropy, with an anisotropy energy barrier proportional to $V^{2-\alpha/d}$, where V is the particle volume, $\alpha \leq d$ is the range of interaction and d is the embedding dimension. These results shows a relevant enhancement of the anisotropy energy barrier w.r.t. the short range case, where the anisotropy energy barrier grows as the particle cross sectional area for large particle size or large particle aspect ratio.

Publications arXiv:1106.0148, Enhancement of magnetic anisotropy barrier in long range interacting spin systems, submitted to PRB.

CONTROLLING ION CHANNEL DYNAMICS (BIOPHYSICS). G.L. Celardo

Collaborators
L. Ponzoni. Master Student, Unicatt
Dr. Armin Kargol Loyola University, Usa
Dr. L. Kaplan Tulane University, Usa

Abstract Ion channels are macromolecular “pores” in cell membranes, through which various ionic substances are allowed to pass. Transitions between metastable states are thermally activated, and are also influenced by the electrical potential difference between the internal and external parts of the cell. It is still unclear what conditions are needed to focus the ion channel on one state or another. The purpose of this project is to understand the form of the time dependent external potential needed to focus the ion channel on a desired metastable state, and to demonstrate this control experimentally.

Publications Focusing in Multiwell Potentials: Applications to Ion Channels, in preparation.

Thermalization in isolated systems. F. Borgonovi

Collaborators

F.M.Izrailev, Departamento de Fisica, BUAP, Puebla, Mexico

Lea F.Santos, Department of Physics, Yeshiva Univ. New York, USA

Abstract

Recent experimental progress in the study of various quantum systems of interacting particles has triggered interest in basic problems of many-body physics. One of the important issues is the onset of thermalization in isolated dynamical quantum systems due to interparticle interactions. We show that, although the fluctuations of the energy levels in integrable and nonintegrable systems are different, the global properties of the eigenstates are quite similar, provided the interaction between particles exceeds some critical value. In this case, the statistical relaxation of the systems is comparable, irrespective of whether or not they are integrable.

Publications

PRL 108, 094102 (2012) PRE 85, 036209 (2012)

Theory of Financial Risk: From Statistical Physics to Risk Management. F. Borgonovi

Collaborators

L.Spadafora Intesa SanPaolo

G.Berman LANL, USA

Abstract

Our derivation of the distribution function for future returns is based on the risk neutral approach which gives a functional dependence for the European call (put) option price C(K) given the strike price K and the distribution function of the returns. We derive this distribution function using for C(K) a Black-Scholes expression with volatility ? in the form of a volatility smile. We show that this approach based on a volatility smile leads to relative minima for the distribution function (ÒbadÓ probabilities) never observed in real data and, in the worst cases, negative probabilities. We show that these undesirable effects can be eliminated by requiring ÒadiabaticÓ conditions on the volatility smile.

Publications

Eur. Phys. J. B (2010), arXiv:1010.2184

Study of PM10 Resuspension phenomenon. F. Borgonovi

Collaborators
A.Agosti DMF Unicatt Brescia
A.Ballarin-Denti DMF Unicatt Brescia

Abstract
We consider the problem of non-exhaust fraction of traffic related PM10 emission, mainly associated with vehicle induced resuspension scenarios. In particular we show that resuspension factor dependency on the vehicle velocity can be expressed by a power law, and we show how resuspension factor is influenced by asphalt porosity and asphalt state of maintenance. Finally we apply our approach to the city of Milan, showing that the preventive strategy of asphalt maintenance and design is far way more effective than mitigative strategies of traffic control and street washing.

Collaborators

Laura Rebuzzini

S.Fishman, Technion, Haifa.

S.Wimberger, Heidelberg

J. Gong, Singapore

J.Wang, Xianmen

Irreversible behaviour and collapse of wave packets in a quantum system with point interactions. I. Guarneri

Abstract

A system of a particle and a harmonic oscillator, which have pure point spectra if uncoupled, is known to acquire an absolutely continuous spectrum when they are coupled by a sufficiently strong point interaction. Here, the dynamical mechanism underlying this spectral phenomenon is exposed. The energy of the oscillator is proven to exponentially diverge in time, while the spatial probability distribution of the particle collapses into δ function at the interaction point. On account of this result, a generalized model with many oscillators which interact with the particle at different points is argued to provide a formal model for the approximate measurement of position and collapse of wave packets.

Next (work in progress) : find classical analog, multi-dimensional generalization

Publications

I Guarneri, J.Phys. A Math. Theor. 44 485304 (2012)

Classical Dynamics of Quantum Entanglement. I. Guarneri

Collaborators

Giulio Casati

Jose Reslen

Abstract

We numerically analyze the dynamical generation of quantum entanglement in a system of 2 interacting particles, started in a coherent separable state, for decreasing values of $\hbar$. As $\hbar \to 0$ the entanglement entropy, computed at any finite time, converges to a finite nonzero value. The limit law that rules the time dependence of entropy is well reproduced by purely classical computations. Its general features may then be explained by simple classical arguments, which expose the different ways entanglement is generated in systems which are classically chaotic or regular.
In progress: prove that quantum correlations vanish in the $\hbar \to 0$ limit even though entanglement does not.

Publications

Phys Rev E 85 036208 (2012)

Long-Lasting Exponential Spreading in Periodically Driven Quantum Systems. I. Guarneri

Collaborators

Jiao Wang
Giulio Casati
Jiangbin Gong

Abstract

Using a dynamical model relevant to cold-atom experiments, we show that long-lasting exponential spreading of wave packets in momentum space is possible. Numerical results are explained via a pseudoclassical map, both qualitatively and quantitatively. Possible applications of our findings are also briefly discussed.

Publications

Phys. Rev. Lett. 107, 234104 (2011)