Titles and abstracts

1st meeting of the GDR "Quantum Dynamics"

Riccardo Adami

Mathematical models for the study of quantum decoherence.

The existence of quantum superposition states is well-known from the early days of quantum mechanics, as well as the fact that superpositions are revealed by interference. It happens that in the macroscopic world no interference is observed, and then the problem arises, how does superposition disappear. Nowadays it is believed that the suppression of superposition has a dynamical origin, and such a phenomenon is called decoherence. We introduce some models in which decoherence is put in evidence and computed.

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Wojciech De Roeck

Universal current fluctuations in disordered quantum wires: From the Anderson model to the DMPK(Dorokhov-Mello-Pereyra-Kumar)-equation.

The DMPK-theory is a random matrix model that describes how the distribution of the conductance of quasi one-dimensional quantum wires scales with the wire length. For long enough wires, one has localization whereas short wires exhibit a metallic regime with universal conductance fluctuations. We present rigorous work that justifies this theory in some cases.

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Clotilde Fermanian

A step toward a semi-classical analysis on the Heisenberg group.

In this talk, we present an algebra of pseudo-differential operators defined on the Heisenberg group in a work in collaboration with Hajer Bahouri and Isabelle Gallagher. To these operators is attached a notion of phase space which allows a semi-classical analysis on this group.

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Bertrand Georgeot

Quantum chaos, from quantum computers to the world wide web and rotating stars.

Quantum chaos is a field devoted to the study of quantum systems whose classical limit displays chaotic properties. Concepts and methods have been devised to understand such type of systems, which find applications in many different settings, including quantum mechanics of complex systems, quantum computation, and more surprisingly the properties of the world wide web and of rapidly rotating stars.

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Sylvain Golenia

Limiting absorption principle for some long range perturbations of Dirac systems at threshold energies.

We establish a limiting absorption principle for some long range perturbations of the Dirac systems at threshold energies. We cover multi-center interactions with small coupling constants. The analysis is reduced to study a family of non-self-adjoint operators. The technique is based on a positive commutator theory for non self-adjoint operators.

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Frank Hekking

Quantum dynamics of superconducting nanojunctions.

The dynamics of a Josephson junction is described by two canonically conjugate, macroscopic variables: the superconducting phase and the charge. For ultrasmall junctions, the behavior of these variables is governed by the laws of quantum mechanics. I will discuss the quantum dynamics of Josephson junction-based superconducting nanocircuits with the help of some specific examples. I will present calculations of the response of a SQUID to an externally applied time-dependent perturbation and compare the results with those of an equivalent classical calculation. I will use quantum optimal control theory in order to obtain external pulse shapes that induce certain desired transitions between the SQUID's quantum states with high fidelity. Finally, I will consider more complicated circuits containing several Josephson junctions that are coupled to each other.

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Hans-Rudolf Jauslin

Dynamics of mixed classical-quantum systems, geometric quantization and coherent states.

We describe quantum and classical Hamiltonian dynamics in a common Hilbert space framework, that allows the treatment of mixed quantum-classical systems. The analysis of some examples illustrates the possibility of entanglement between classical and quantum systems.

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Markus Klein

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Jean-Philippe Nicolas

Analytic applications of conformal methods in general relativity.

Roger Penrose developed conformal compactifications in the 1960's in order to replace asymptotic properties of fields on a given spacetime by trace properties of corresponding fields on the compactified spacetime. The method of the compactification focuses on characteristic directions and the applications a priori do not include pointwise decay estimates, except in some special cases where the compactification is more complete than usually.

This talk will give a general description of the method of conformal compactification and its direct use for obtaining asymptotic profiles for hyperbolic equations on globally hyperbolic spacetimes. Then we shall describe two more elaborate applications:

1. Scattering theory. On generically time dependent spacetimes, satisfying some adequate fall-off properties encoded in terms of the regularity of the boundary of the compactified spacetime, one can construct a scattering theory for conformally invariant field equations by solving a characteristic Cauchy problem at infinity for the rescaled field equation.

2. Peeling. A conformal compactification can be coupled with vector field techniques to analyze the optimal fall-off conditions on initial data which guarantee a given transverse regularity of the rescaled field at the characteristic part of the boundary of the compactified spacetime. Such results solve a long-standing uncertainty concerning Penrose's ideas as to the validity of flat spacetime as a model for asymptotic behaviour on asymptotically flat spacetimes.

Most of the work presented is in collaboration with Lionel Mason (Oxford).

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Tomáš Novotný

Full Counting Statistics of Electronic Transport in Nanoscopic Systems

I will present an overview of our recent works on the FCS of electronic transport through nanoscale devices. The talk will attempt to cover a broad range of topics pertinent to this theme, in particular a survey of the present experimental status as well as the theoretical approaches. I will discuss experiments using direct counting setups [1] as well as the threshold detection schemes [2] and issues related to them. On the theory side, the two main approaches based on generalized master equations [3] and non-equilibrium Green functions [4], respectively, will be illustrated on particular physical examples and their shortcomings and advantages will be explicitly exposed. Finally, I will report on the recently measured and understood universal features of high-order cumulants [1].

[1] C. Flindt, C. Fricke, F. Hohls, T. Novotný, K. Netočný, T. Brandes and R.J. Haug, *Universal oscillations in counting statistics*, Proc. Natl. Acad. Sci. USA 106, 10116 (2009).
[2] T. Novotný, *Josephson Junctions as Threshold Detectors of the Full Counting Statistics: Open issues*, J. Stat. Mech. P01050 (2009).
[3] C. Flindt, T. Novotný, A. Braggio, M. Sassetti and A.P. Jauho, *Counting Statistics of Non-Markovian Quantum Stochastic Processes*, Phys. Rev. Lett. 100, 150601 (2008).
[4] F. Haupt, T. Novotný and W. Belzig, *Phonon-assisted current noise in molecular junctions*, arXiv:0903.2268.

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Annalisa Panati

Spectral and scattering theory for abstract QFT Hamiltonians.

We introduce an abstract class of bosonic QFT Hamiltonians and study their spectral and scattering theories. An example belonging to this class is the space-cutoff $P(\varphi)_2$ *model with a variable metric of the form*

$$H = d\Gamma(\omega) + \int_{\mathbb{R}} g(x) :P(x, \varphi(x)): dx,$$

on the bosonic Fock space $L^2(\mathbb{R})$*, where the kinetic energy* $\omega = h^{\frac{1}{2}}$ *is the square root of a real second order differential operator* $h = D_x a(x) D_x + c(x)$*, where the coefficients* $a(x), c(x)$ *tend respectively to* 1 *and* m_∞^2 *at* ∞ *for some* $m_\infty > 0$*, (joint work with Christian Gérard).*

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Claude-Alain Pillet

Entropic fluctuations in classical and quantum statistical mechanics.

I will present results on a joint work with V. Jaksic and L. Rey-Bellet on general properties of entropy production in classical and quantum dynamical systems (Evans-Searles and Gallavotti-Cohen symmetries). In shall discuss in particular their relation to spectral properties of some tranfer operators (Liouvilians).

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Nicolas Roy

A microlocal approach to Ruelle resonances of Anosov diffeomorphisms"

In this talk, we explain how typical methods of quantum mechanical problems can be applied successfully to some problems of classical dynamical systems. We will describe the following : If f is an Anosov diffeomorphism on a compact manifold, the decay of the dynamical correlation functions is governed by the so-called Ruelle-Pollicott resonances. It follows from the works of Baladi & al and Liverani & al, that these resonances can be obtained by a suitable spectral analysis of the composition operator (or another one related to it) called the "Transfer operator".

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Eric Séré

Mean-field models of the relativistic atom.

I will describe several mean-field models describing the ground state of the electron-positron field in the neighborhood of a heavy nucleus. In the case of the reduced Bogoliubov-Dirac-Fock model, I will discuss the existence of a ground state and I will give a nonperturbative result on charge renormalisation (joint work with Philippe Gravejat and Mathieu Lewin).

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Serguei Tcheremchantsev

Dynamical bounds for the Fibonacci Hamiltonians.

We study the long-time behaviour of the solution to the time-dependent Schrödinger equation in the Hilbert space $l^2(\mathbb{Z})$. The Schrödinger operator is of the form

$$[Hu](n) = u(n+1) + u(n-1) + V(n)u(n),$$

where V is the Fibonacci potential. We establish upper and lower bounds for the fast propagating part of the wave packet via complex analysis methods.