Large-time Dynamics of Classical and Quantum Systems

Report of Contributions

https://indico.math.cnrs.fr/e/large-time-classical-quantum

Contribution ID: **1** Type: **not specified**

Marcello Porta

Tuesday, November 12, 2024 9:30 AM (45 minutes)

Title: Dynamics of high density Fermi gases on a local scale

Abstract: In this talk I will discuss the dynamics of extended, relativistic Fermi gases, at high density. I will focus on the derivation of the Hartree equation, at zero temperature, as an effective description of many-body quantum dynamics. I will present a result that establishes convergence to the Hartree equation in the sense of expectation values of local observables, supported in regions with volume of order 1, independent of the density. The result applies to initial data describing systems at equilibrium confined in arbitrarily large domains, under the assumption that a suitable local Weyl-type estimate holds true. The proof is based on the approximation of the initial data through low temperature quasi-free states, for which a strong form of local semiclassical structure can be established, that also allows to capture decay of correlations in space. This plays a crucial role in the control of the growth of fluctuations created by the many-body dynamics on a local scale. Joint work with Luca Fresta (Bonn) and Benjamin Schlein (Zürich).

Contribution ID: **2** Type: **not specified**

Michal Wrochna

Tuesday, November 12, 2024 10:45 AM (45 minutes)

Title: Modular theory and entropy in QFT on curved spacetimes

Abstract: In this talk I will review how modular theory enters the formalism of Quantum Field Theory on curved spacetimes, stressing the similarities with Quantum Statistical Mechanics. In particular I will discuss the Araki-Woods representation and the problem of defining and computing entanglement entropy, then outline possible directions of research for the ANR project (joint project with T. Benoist, D. Djordjevic, V. Jaksic).

Contribution ID: **3** Type: **not specified**

Christopher Cedzich

Tuesday, November 12, 2024 11:35 AM (30 minutes)

Title: Exponential tail estimates for quantum lattice dynamics

Abstract: We consider the quantum dynamics of a particle on a lattice for large times. Assuming translation invariance, and either discrete or continuous time parameter, the distribution of the ballistically scaled position Q(t)/t converges weakly to a distribution that is compactly supported in velocity space, essentially the distribution of group velocity in the initial state. We show that the total probability of velocities strictly outside the support of the asymptotic measure goes to zero exponentially with t, and we provide a simple method to estimate the exponential rate uniformly in the initial state.

Contribution ID: **4** Type: **not specified**

Vojkan Jaksic

Tuesday, November 12, 2024 2:00 PM (45 minutes)

Title: Some remarks on entropy production in quantum statistical mechanics

Abstract: I will introduce quantum mechanical entropic notions that play a role in the recent series of papers (joint work with T. Benoist, L. Bruneau, A. Panati, C-A. Pillet).

1. A note on two-times measurement entropy production and modular theory
2. On the thermodynamic limit of two-times measurement entropy production
3. Entropic Fluctuations in Statistical Mechanics II. Quantum Dynamical Systems
4. Entropic fluctuation theorems for spin-fermion model

This talk is an introduction to the follow up talk by L. Bruneau.

Contribution ID: **5** Type: **not specified**

Clément Tauber

Tuesday, November 12, 2024 2:50 PM (30 minutes)

Title: Approach to equilibrium in quantum systems

Abstract: This talk is about the problem of approach to equilibrium in quantum systems. I will formulate the problem for translation invariant quantum systems (spins or fermions) on a lattice within the approach of algebraic quantum statistical mechanics. Then, I will discuss some recent results relating the zeroth law of thermodynamics (approach to equilibrium) and the second law (increase of entropy). The main result is that approach to equilibrium is necessarily accompanied by a strict increase of the specific (mean) entropy. This talk is based on joint work with Vojkan Jaksic and Claude-Alain Pillet.

Contribution ID: **6** Type: **not specified**

Laurent Bruneau

Tuesday, November 12, 2024 3:45 PM (45 minutes)

Title: Some recent developments about quantum entropic fluctuations

Abstract: Since the seminal works of Evans, Searles, Gallavotti and Cohen in the early 90's the study of entropic fluctuations has encountered a fast growing interest in the last decades, and many developments at least in classical systems. Its quantum counterpart however turned out to be very challenging. In this talk I will present some recent developments about possible extensions of these entropic fluctuations to the quantum domain, as well as some open problems.

The talk is based on the following recent series of papers (in collaboration with T. Benoist, V. Jaksic, A. Panati and C.-A. Pillet):

1) A note on two-times measurement entropy production and modular theory. Lett. Math. Phys. (2024).
2) On the thermodynamic limit of two-times measurement entropy production. To appear in Rev. Math. Phys.
3) Entropic fluctuations in statistical mechanics II. Quantum dynamical systems. Preprint arXiv 2409.15485
4) Entropic fluctuation theorems for Spin-Fermion model. In preparation

Contribution ID: **7** Type: **not specified**

Alain Joye

Wednesday, November 13, 2024 9:30 AM (45 minutes)

Title: Quantum Walks Dynamics for use by the ANR

Abstract: We will begin by presenting a construction of unitary and open quantum walks on arbitrary graphs, called scattering quantum walks, and describe some of their key properties. Next, we will discuss the large times dynamics of ensembles of quantum walkers interacting with reservoirs. Finally, we will address several open problems that remain to be tackled within the framework of the ANR Dynacqus project.

Contribution ID: **8** Type: **not specified**

Horia Cornean

Wednesday, November 13, 2024 10:45 AM (45 minutes)

Title: A mathematical approach to N(on)E(quilibrium)G(reen)F(unctions)

Abstract: Quantities like local particle densities and charge currents in mesoscopic systems are computed by a large community of solid-state physicists via the so-called NEGF formalism. We will rigorously define these Green functions and focus on the Dyson equation for the advanced/retarded interacting Green's function, by constructing its (irreducible) self-energy using the theory of Volterra operators. This is joint work with C.-A. Pillet and V. Moldoveanu.

Contribution ID: **9** Type: **not specified**

Noé Cuneo

Wednesday, November 13, 2024 11:35 AM (30 minutes)

Title: Multifractal analysis of decoupled measures: what we know so far

Abstract: I will present some ongoing work with Vojkan Jakšić and Renaud Raquépas about multifractal analysis of decoupled measures. Our focus is on determining the fractal dimension of level sets for certain observables on shift spaces. I will introduce the necessary definitions and describe how Large Deviation results can be leveraged to compute the dimension of these level sets. If time permits, I will outline some challenges that remain in our approach.

Contribution ID: **10** Type: **not specified**

Michele Correggi

Wednesday, November 13, 2024 2:00 PM (45 minutes)

Title: Quasi-classical Limit of a Spin Coupled to a Reservoir

Abstract: We consider a spin in contact with a bosonic reservoir, whose state contains a parameter interpolating between quantum and classical reservoir features. For energy conserving interactions we study decoherence and markovianity properties of the effective dynamics of the spin for all values of the parameter. Our main finding is that the spin decoherence is enhanced (full decoherence) when the spin is coupled to quantum reservoir states while it is dampened (partial decoherence) when coupled to classical reservoir states. The markovianity properties depend in a subtle way on the classicality parameter and on the finer details of the spin-reservoir interaction. We further examine scattering and periodicity properties for energy exchange interactions.

Joint work with M. Falconi, M. Fantechi, M. Merkli.

Contribution ID: **11** Type: **not specified**

Léo Daures

Wednesday, November 13, 2024 2:50 PM (30 minutes)

Title: A large deviation principle for discrete, possibly reducible, Markov chains.

Abstract: This talk is part of my ongoing PhD research. I will begin by presenting the subadditive method, an elegant approach for deriving large deviation principles (LDPs). This method is particularly effective for systems with strong decoupling assumptions, such as irreducible Markov chains, where it has become standard under strong recurrence conditions. However, when these assumptions are relaxed—specifically when the Markov chain is no longer irreducible—further adaptations of the method are required. I will highlight the additional challenges posed by this setting and discuss a construction that addresses them, enabling the use of the subadditive method. This construction ultimately leads to the derivation of a weak LDP for any Markov chain on a discrete state space.

Contribution ID: **12** Type: **not specified**

Armen Shirikyan

Wednesday, November 13, 2024 3:45 PM (45 minutes)

Title: 10 challenging problems in classical dynamics

Abstract: We discuss four groups of problems arising in the theory of randomly forced PDEs. They are related to mixing of a random flow, Donsker-Varadhan type large deviations, estimation of a parameter, and the vanishing noise limit. For each problem, we give a rather precise formulation, summarise some known results, and outline the main difficulties.

Contribution ID: **13** Type: **not specified**

Tristan Benoist

Thursday, November 14, 2024 9:30 AM (45 minutes)

Title: Repeated quantum measurements, recent results and outlook

Abstract: I will give a short overview of recent results concerning ergodicity and limit theorems for repeated quantum measurements, both at the level of the measurement outcomes dynamical system and the underlying quantum trajectory Markov chain. I will then present a few conjectures, open questions and interesting extensions to be developed.

Contribution ID: **14** Type: **not specified**

Claude-Alain PIllet

Thursday, November 14, 2024 10:45 AM (45 minutes)

Contribution ID: **15** Type: **not specified**

Anna Szczepanek

Thursday, November 14, 2024 11:35 AM (30 minutes)

Title: Real-analyticity of the pressure function for products of matrices under irreducibility

Abstract: The regularity of the pressure function (also known as the generalized Lyapunov exponent) plays an important role in various fields, e.g. in statistical mechanics or multifractal analysis. Pressure function s->k(s) is known to be differentiable on (0,∞) under (weak) irreducibility assumption, and analytic under an additional assumption of contractivity (a.k.a. purification). We claim the latter assumption can be lifted, i.e. irreducibility alone is sufficient for the analyticity of pressure.
The proof consists in constructing an operator G(s) for which k(s) is a simple eigenvalue and spectral radius. The key step then is to show that a related Markov operator Q(s) is quasi-compact: this guarantees that k(s) is an isolated eigenvalue of G(s) and the analyticity of s -> k(s) follows by holomorphic functional calculus. I will discuss how to prove the quasi-compactness of Q(s) via Doeblin-Fortet inequality, using methods recently developed in the context of quantum trajectories. Joint work with T. Benoist, A. Hautecoeur, C. Pellegrini.