CALENDRIER 2020

Jeudi 17 décembre, 14h00, en distanciel sur Microsoft Teams

Maheswor TIWARI
(LPTM CY CPU Cergy)

Mean-Field Theory for Quantum Spin Systems and the Magnetocaloric Effect**.**

The magnetocaloric effect, i.e., the response of a magnet to an adiabatic change of an applied field is a promising tool for low-temperature refrigeration. Here, we investigate this problem for the example of a quasi one-dimensional chain compound. MnN i(NO2)4(en)2, en = ethylenediamine, contains ferromagnetically coupled chains with alternating spins of magnitude 1 and 5/2. The antiferromagnetic interchain coupling gives rise to a low ordering temperature and a low saturation field that promise interesting magnetocaloric properties in terms of change in entropy. Using a Hamiltonian consisting of single-ion anisotropy (D) with antiferromagnetic exchange between the chains plus a Zeeman term coupling to a magnetic field parallel to the easy axis, the temperature and field dependence of ferromagnetic, antiferromagnetic, and spin-flop states are observed using the mean-field theory. Thermodynamic behavior of such systems is also studied using meanfield theory. A set of exact analytical expression in the form of matrices for susceptibility and specific heat capacity is derived and the results are presented. Interestingly, straight isentropes are observed while calculating the full H-T phase diagram for the entropy and specific heat capacity.

Jeudi 3 décembre, 14h00, en distanciel sur Microsoft Teams

Carlo DANIELI
(Max Planck Institute for the Physics of Complex Physics, Dresden, Germany)

From Single to Many Body Flat Band Localization.

Lattice wave systems in translationally invariant settings can have one or more spectral bands that are strictly flator independent of momentum in the tight binding approximation. Flat bands systems arise from either fine-tuned short range hopping, or symmetry protection, and they typically support compact localized eigenstates (CLS). Flat bands have been studied and experimentally observed in a variety of settings, ranging from ultracold atomic gases to photonic devices, and their sensitivity to perturbations – e.g. onsite disorder, interactions, external fields, among others – makes them perfect hosts for unconventional phases of matter. In this talk I will focus on the impact of interaction on flat band lattices. While in general interaction destroys single particle CLS, I will discuss how the fine-tuning of the lattice and the interaction terms allows to retain localized states. In particular, I will discuss how fine-tuning of additional nonlinear interactions allows to continue CLS into compact discrete breathers , and how combining fine-tuning for lattices with All Bands Flat and classical and quantum interactions leads to caging. Then, I will present the explicit derivation of Many-Body-Flat-Band Hamiltonians.

Jeudi 1er octobre, 14h00, en distanciel sur Microsoft Teams

Fernando PERUANI
(LPTM CY CPU Cergy)

Challenges in Active Matter.

Active systems are studied in large number of disciplines and include, on the one hand, artificial out-of-equilibrium systems such as synthetic swimmers, phoretic colloids, and active rollers, and on the other hand, biological systems at various scales: e.g. suspensions of bacteria, insect swarms, and sheep herds, among many other examples. In particular, active matter theory emerges as a novel, powerful, theoretical branch of non-equilibrium statistical physics that will help to elucidate complex processes of key importance not only in physics, but also in biology and medicine, for instance in relation to wound healing, tumor growth, and embryogenesis. Our current theoretical understanding of active matter is based on two paradigmatic mechanisms. (i) The so-called velocity alignment mechanism that exploits the analogy to spin systems to explain self-organized patterns in active systems and constitutes the cornerstone of Vectorial Active Matter. And (ii), motility-induced phase separation, a central element in Scalar Active Matter, that makes use of the analogy between classical and active phase separation by assuming an effective coupling between local density and local particle speed. It is worth noting that these two mechanisms are the results of theoretical speculations -- exploiting analogies with classical physical models -- formulated before the realization of specifically designed, quantitative, active-matter experiments. Several fundamental questions need to be addressed. Are these mechanisms robust? What are the limitations of descriptions based on these concepts? And finally, are there alternative mechanisms that produce similar macroscopic patterns? In this talk, we will visit the foundation of Active Matter Theory and address these issues.

Mardi 30 juin, 11h00, en distanciel sur Microsoft Teams

Grégory Dumont
(Group for Neural Theory, Ecole Normale Supérieure Paris)

Macroscopic Phase-Resetting Curve of a Spiking Neural Network Described by the Refractory Density Equation.

Brain rhythms are emergent processes. They result from episodes of high synchrony of connected spiking cells behaving in a stochastic way. Clues about their structure and informational properties could be brought by the phase-resetting curve (PRC). Unfortunately, despite its relevance for studying brain rhythms, inferring the PRC of emerging oscillations in a stochastic spiking neural network has remained problematic. In here, we tackle this issue by adopting a general framework where each cell is characterized by the amount of time passed by since its last action potential. In the thermodynamic limit, the network gives rise to a continuity equation known as the refractory density equation. We develop an adjoint method for this equation. Our method gives access to a semi-analytical expression of the infinitesimal PRC. Comparison with the PRC estimated by direct perturbation confirms the validity of our result. We conclude by mentioning how the PRC could be a useful tool to understand the information properties of stochastic fluctuations in an oscillatory regime.

Jeudi 25 juin, 14h00, en distanciel sur Microsoft Teams

Jacopo De Nardis
(Department of Physics and Astronomy — Ghent University , Gand, Belgique)

Generalised hydrodynamics and universalities of transport in integrable and non-integrable spin chains.

Hydrodynamics is one of most successful approach to predict the dynamics of a large number of interacting particles. While standard hydrodynamics has been established long ago, recently there has been a strong focus on understanding the emerging hydrodynamics of integrable systems in 1+1 dimensions. This is nowadays dubbed GHD (generalised hydrodynamics), it has been extensively developed in these past years, and tested in different experimental settings. I will give a review of such theories with a special focus on the diffusion or viscosity terms. Finally I will show how diffusion is replaced by different universality classes of dynamics (as the KPZ universality class) in quantum and classical spin chains with non-abelian symmetries.

Jeudi 18 juin, 14h00, en distanciel sur Microsoft Teams

Irénée FREROT
(ICFO, Institute of Photonic Sciences, Barcelona, Spain)

Quantum correlations in many-body systems: a statistical-physics perspective.

What fundamentally distinguishes many-body quantum systems, from many-body classical systems? How can we probe the consequence of basic quantum principles (quantum superpositions, quantum entanglement), onto many-body physics? Under which conditions, and in which sense, can we say that certain experimental many-body data are incompatible with a classical-physics description? In this talk, I will investigate these questions from a statistical-physics perspective. I will focus on two different problems. First, the violation of an equilibrium fluctuation-response relation as a consequence of quantum superpositions (and as a tool to measure them). The associated concept of "quantum variance" will allow us to reconstruct quantitatively the quantum-critical fan in the phase diagram surrounding a quantum-critical point. Second, I will discuss a deep link between John Bell's concept of "quantum non-locality", and inverse problems in classical statistical physics. This insight opens the way to devise new, scalable, methods to probe quantum entanglement in many-body systems.

Jeudi 11 juin, 14h00, en distanciel sur Microsoft Teams, à suivre sur CY-Warwick Theoretical Physics

Andreas HONECKER
(LPTM CY CPU)

Magnon crystallization in the kagome lattice antiferromagnet.

Highly frustrated quantum magnets remain a topic of intense research because the competing interactions that are inherent to them give rise to a plethora of exotic ground states. They also continue to constitute a challenge for theory since it is often very difficult to achieve the required accuracy. However, geometric frustration sometimes also allows for exact statements about these strongly interacting quantum many-body systems. So-called "localized magnons" constitute one example where a macroscopic number of ground states appears in a class of highly frustrated magnets once subjected to a strong magnetic field.

Here we present numerical evidence for the crystallization of localized magnons below the saturation field at non-zero temperatures for the spin-1/2 kagome Heisenberg antiferromagnet, a famous two-dimensional highly frustrated magnet. This phenomenon can be traced back to the existence of a flat single-magnon band. We present a loop-gas description of the resulting multi-magnon states and discuss the relation to the exactly solvable classical hard-hexagon model. The combination of these methods provides valuable insight into the phase diagram and universality class of this crystallization transition.

Although we focus on a specific lattice, the emergence of a finite-temperature continuous transition to a magnon-crystal is expected to be generic for quantum spin models in dimension D>1 where flat-band multi-magnon ground states break translational symmetry.

arXiv:1910.10448v2.

Jeudi 4 juin, 14h00, en distanciel sur Microsoft Teams

Silke HENKES
(University of Bristol, School of Mathematics)

Flow, fluctuate and freeze: Understanding active (almost) solids.

Epithelial cell sheets, consisting of a dense, cobble-stone like arrangement of cells, form a fundamental role in the developing embryo, and also in adult tissues including the gut and the cornea of the eye. Soft and active matter provides a theoretical and computational framework to understand the mechanics and dynamics of these tissues. I will begin by introducing the simplest model, active brownian particles, which exhibits glassy, liquid and phase separated regions of phase space. I will then add a different type of activity, division and death, and show that it always leads to a fluid state, instead of a glass. Finally I will show, using both particle and vertex models, how the extended ’swirly’ velocity fluctuations seen in sheets on a substrate can be understood using a simple model that couples linear elasticity with disordered activity. We are able to quantitatively match experiments using in-vitro corneal epithelial cells.

Jeudi 28 mai, 14h00, en distanciel sur Microsoft Teams

Tommaso ROSCILDE
(Laboratoire de Physique, Ecole Normale Supérieure de Lyon)

Certifying entanglement in a noisy quantum world.

A vast part of the research in quantum physics these days revolves around entanglement. One can view it as the essence of wave-particle duality at the many-body level — the fact that many particles can possess joint superposition properties — and as the origin of the non-local nature of quantum many-body systems. Or one can view it as the one aspect of nature that, however big, classical computers will never be able to efficiently capture in general terms. Therefore, on the flip side of the coin, entanglement is the resource that quantum devices must possess in order to exhibit some 'quantum advantage' and to beat the classical ones. If quantum technologies are at the center of a new industrial revolution — as some believe — then entanglement is the fuel that will run most of its machines.
Yet, despite its obvious importance, entanglement is still perceived in many respects as a theoretical concept which is not really tangible experimentally; and it is still struggling to become a routinely characterized aspect of "quantum matter” — although ultimately it may well be its defining feature. In this talk I will provide a short overview on entanglement certification in realistic (namely noisy) quantum states; and I will discuss how some of our recent theoretical results may make entanglement certification potentially accessible to a wide range of experimental setups. Particular emphasis will be devoted to unbiased (or 'device-independent’) entanglement certification, based on the violation of Bell inequalities in the many-body realm.

Jeudi 14 mai, 14h00, en distanciel sur Microsoft teams

Rudolf ROEMER
(Department of Physics | Faculty of Science | University of Warwick)

Rapid simulation of protein motion.

Protein function frequently involves conformational changes with large amplitude on timescales which are difficult and computationally expensive to access using molecular dynamics. In this talk, we report on the combination of three computationally inexpensive simulation methods—normal mode analysis using the elastic network model, rigidity analysis using the pebble game algorithm, and geometric simulation of protein motion—to explore conformational change along normal mode eigenvectors. Using a combination of ELNEMO and FIRST/FRODA software, large-amplitude motions in proteins with hundreds or thousands of residues can be rapidly explored within minutes using desktop/taskfarm computing resources. We apply the method to a representative set of proteins including the full family of protein disulphide isomerases, HIV protease, the immunosuppressant cyclosporin A, as well as structures newly emerging from SARS-CoV-2.

Mardi 10 mars, 11h00, salle 4.13

Matteo MARCUZZI
(School of Physics and Astronomy, University of Nottingham, UK)

Associative memory behaviour in open quantum systems.

Recent studies have started connecting the behaviour of associative memory models, such as the Hopfield neural network, to the physics of quantum systems. This has raised new questions such as whether new physics may stem from the quantum effects and whether this behaviour can be in fact observed even in the presence of decoherence and dissipation. I will first discuss a dissipative quantum Hopfield model and relate how its phase diagram differs from its classical counterpart, highlighting the emergence of a limit cycle phase. I will then introduce a disordered, open spin-boson model which, via a perturbative treatment, can be effectively described by a rate equation and show how the corresponding stochastic process displays, in a specific range of its parameters, some features reminiscent of those of associative memories and particularly the emergence of several distinct basins of attractions.

Vendredi 28 février, 11h30, salle 4.13

Nikolai KITANINE
(IMB Université de Bourgogne, Dijon)

XXX chain: spinons, bound states and form factors.

Even though the Heisenberg spin chain is one of the best studied examples of quantum integrable systems the crucial problem of analytic description of equilibrium and out-of equilibrium dynamics remains mostly unsolved for this fundamental model. In particular, there exist very few analytic results for time-dependent correlation functions even for the equilibrium case. The main obstacle is the lack of manageable analytic representations for the relevant form factors and overlaps. In this talk I'll discuss the new method we developed to compute explicitly the form factors for low-energy excited states of the XXX chain. I will show how to use this technique for simplest excitations and how to take into account bound states corresponding to the complex roots of the Bethe equations.

Jeudi 27 février, 11h00, salle 4.13

Venky SOMEPALLI
(LPTM CY Cergy Paris Université)

Structural and electronic properties of graphene/mos 2 heterostructures.

We report the structural and electronic properties of the graphene/MoS 2 bilayer heterostructures, for theoretical study calculations we used Density functional theory [Abinit] with Van der Waals corrections. We analyze the interlayer spacing between the graphene and MoS 2 layers and also the charge transfer between the layers. In particular, we focus on the structural and electrical properties of bilayer heterostructures with different supercell geometries, with and without optimized bilayer heterostructures. These heterostructures are created with different supercell geometries like graphene (4x4)/MoS 2 (3x3) [4:3], graphene (5x5)/MoS2(4x4)[5:4] and graphene (9x9)/MoS2(7x7)[9:7] having different magnitudes of lattice mismatch.

Jeudi 20 février, 14h00, salle 4.13

David ANGULO GARCIA
(IMA Universidad de Cartagena, Colombia)

Black-out transition in Power Grids induced by dynamical vulnerabilities.

In this work we make use of the well-known Kuramoto model with inertia to study the resilience of power grids to critical failures, using the case of study of the Colombian Power Grid. With the aim of evaluating the resilience of such a network, we use a percolation inspired indicator namely, the transition to black-out induced by targeted failures, based on transmission line and nodal dynamical vulnerability criteria. The targeted removal of both nodes and lines in the network produces a rapid percolation transition mainly due to the low degree distribution of the network, however total black-out transition is found at much larger removal fraction of nodes/links thanks to the ability of the disconnected sub-clusters to synchronize their dynamics within them. Finally, we show that the dynamical vulnerabilities are closely related with topological features of the network and we propose a control technique aimed to cure these vulnerabilities.

Vendredi 7 février, 11h00, salle 4.13

Bruno BERTINI
(Faculty of Mathematics and Physics, University of Ljubljana)

Non-equilibrium dynamics in dual-unitary quantum circuits.

I will consider the non-equilibrium dynamics of a recently introduced class of "statistically solvable" many-body quantum systems: the dual-unitary circuits. These systems furnish a minimal modelling of generic locally interacting many-body quantum systems: they are generically non-integrable and include a quantum chaotic subclass. I will first discuss the dynamics of initial-state dependent quantities, such as the entanglement entropies and local correlators, showing that it is possible to find (and classify) a family of initial states in MPS form that allow for an exact solution of the dynamics (also in the presence of quantum chaos). Then I will discuss the dynamics of an initial-state independent quantity, the so called "operator entanglement", that measures the growth of entanglement that the Heisenberg evolution induces in operator space. I will show that one can identify different subclasses of dual-unitary circuits. In particular I will describe a "maximally chaotic" subclass, where the entanglement of local operators grows linearly, and a "dynamically constrained" one, where the entanglement of local operators is bounded.

Jeudi 6 février, 14h00, salle 4.13

Ben CRAPS
(TENA, V.U. Brussels)

Quantum chaos, thermalization and holography.

Classical chaos refers to exponential sensitivity of phase-space trajectories to small changes in initial conditions. It is not straightforward to extend this notion to quantum systems, which undergo linear evolution and moreover do not exhibit precise phase space trajectories. One possible way to define quantum chaos is via statistical properties of energy levels, which have been related to those of random matrices. Recently, motivated by studies of black holes, exponential growth of out-of-time-order correlators has received a lot of attention as another possible diagnostic of quantum chaos, and an upper bound on the corresponding "Lyapunov exponent" has been obtained. Chaos is closely related to the thermalization of isolated quantum systems. Via holography, quantum chaos is reflected in the physics of black holes, which are dual to thermal states. In the same way, the study of black hole formation has given a new handle on the thermalization of strongly correlated systems. This talk contains a review of these ideas as well as brief discussions of some recent projects in our group.

Vendredi 10 janvier, 14h00, salle 4.13

Serhiy YANCHUK
(Institut fur Mathematik, TU Berlin, Allemagne)

Self-organized emergence of modular structures in adaptive networks.

Dynamical systems on networks with adaptive couplings appear naturally in real-world systems such as power grid, social, and neuronal networks. We investigate a paradigmatic system of adaptively coupled phase oscillators as well as a network of Hodgkin-Huxley neurons with synaptic plasticity. One important behavior of such systems reveals the splitting of the network into groups of oscillators with the same frequencies. Starting from one-cluster solutions we provide existence criteria for multicluster solutions and present their explicit form. The phases of the oscillators within one cluster can be organized in different patterns: antipodal, double antipodal, and splay type. We also provide stability conditions for one- and multicluster solutions. These conditions, in particular, reveal a high level of multistability. In the neural network, the amplitude of the mean-field in this regime undergoes low-frequency modulations, which may contribute to the mechanism of the emergence of slow oscillations of neural activity.

Mardi 7 janvier, 15h00, salle 4.13

Yérali GANDICA
(LPTM, Cergy)

Bali ancient rice terraces: A Hamiltonian approach.

In this talk, I will present a Hamiltonian approach inspired by the Subak irrigation system. In a previous work, Lansing et al. [1] found out that the cluster-size distribution of the rice patches in Bali-Subak fields is a power-law function with an exponent (approx. 1.9) similar to the one found on Hamiltonian systems. The application of the methods of statistical physics to social phenomena, where the interacting particles are now interacting human beings, has proved to be very fruitful in allowing for the understanding of many features of human behaviour. In this sense, Universality, which states that the emergent phenomena displayed by the collective behaviour of interacting particles depend on symmetries, dimensionality and conservation laws and not on the microscopic details of the intrinsic dynamics mechanism, seems to be present in many social situations. I will show how the beautiful mosaics characterising several rice-growing regions in Bali-Indonesia, which are the consequence of the self-organising process ruled by the Subak since the 11th century in that tropical island, can be explained by two main mechanisms behind Subak farmers' decisions. Pest stress is the local mechanism promoting order, namely, using the same schedule within neighbouring patches. On the other hand, an antiferromagnetic interaction controlled by water stress is set by a global mechanism, fixing a limit in the total number of cells in the same state. Our Subak Hamiltonian presents two phase transitions, one of them having a critical nature. I will present our first results, general conclusions and consequences of scaping from that critical balance. For the talk, first, I will briefly explain my research line, second my current works, and finally, the Hamiltonian approach.

CALENDRIER 2019

Vendredi 13 décembre, 11h00, salle 4.13

David METIVIER
(Los Alamos National Laboratory, CNLS & T-4, New Mexico, USA)

Efficient Polynomial Chaos Expansion for Uncertainty Quantification in Power Systems.

Growing uncertainty from renewable energy integration and distributed energy resources motivate the need for advanced tools to quantify the effect of uncertainty and assess the risks it poses to secure system operation. In general, Uncertainty Quantification (UQ) methods are used in complex systems research to give probabilistic guarantees.

I will introduce the context of this work, as well as the Polynomial chaos expansion (PCE) method that has been recently proposed as a tool for UQ in Power Systems. The method produces results that are highly accurate, but are computationally challenging to scale to large systems. We propose a modified algorithm based on PCE and using the system sparsity with significantly improved computational efficiency while retaining the desired high level of accuracy. In an example, we show how to solve the so called chance constrained power flow problem, e.g. we need a solution such that the power transmitted trough the lines should be lower than some safe value 99 percent of the time.

Jeudi 12 décembre, 11h00, salle 4.13

Daniel CABRA
(IFLP Universidad Nacional de La Plata, LA PLATA, Argentine)

Microscopic model for magneto-electric coupling through lattice distortions.

We propose a microscopic magneto-electric model in which the coupling between spins and electric dipoles is mediated by lattice distortions. The magnetic sector is described by a spin S=1/2 Heisenberg model coupled directly to the lattice via a standard spin-Peierls term and indirectly to the electric dipole variables via the distortion of the surrounding electronic clouds. Electric dipoles are described by Ising variables for simplicity, as tunneling quantum effects do not substantially modify the results. We show that the effective magneto-electric coupling which arises due the interconnecting lattice deformations is quite efficient in one-dimensional systems. More precisely, we show using bosonization and extensive DMRG numerical simulations that increasing the magnetic field above the spin Peierls gap, a massive polarization switch-off occurs due to the proliferation of soliton pairs. We also analyze the effect of an external electric field E when the magnetic system is in a gapped (plateau) phase and show that the magnetization can be electrically switched between clearly distinct values. We compare these findings with similar effects that have been recently observed in different materials. More general quasi-one-dimensional models and two-dimensional systems are also discussed.

Séminaire annulé

Mardi 10 décembre, 13h00, salle 4.13

Georges BOUZERAR
(Université Lyon 1, Villeurbanne FRANCE)

Phonon transport in disordered graphene monolayer.

The calculation of both thermal and thermoelectric properties depends crucially on the accurate and realistic determination of the energy and temperature dependent phonon lifetime τ (E,T). In the literature, the disorder contribution to the scattering rate, an essential and crucial ingredient for the, determination of the thermal conductivity κ (T), is often obtained from a second order perturbation theory (often combined with a virtual crystal approximation in alloys). Although such an approximation may seem reasonable in the case of isotopic disorder (substitution of 12 C b y 13 C in graphene), it is highly questionable in the presence of vacancies. Here, we present the effects of vacancies in graphene, where disorder is treated exactly within a real space approach, (i) on the phonon spectrum, (ii) on the quasiparticle linewidth for various branches LA, TA, ZA, and (iii) on the T - dependent thermal conductivity. To allow both large scale (beyond 1 0 6 atoms) and accurate calculations, we employ an exact representation of the phonon Green's functions in terms of Chebyshev Polynomials that properly includes both quantum interference effects and phonon localization (Anderson) . The realistic input parameters characterizing the graphene monolayer (with and without vacancies), the interatomic force constants and the T - dependent phonon – phonon collision rates (related to the anharmonic constans) are calculated within DFT (SIESTA and VASP). Hence, our approach has no adjustable parameters. We compare our theory with both available Boltzmann Transport Equation simulations, with Molecular Dynamics and with existing experimental data. We also discuss in details and compare the exact intrinsic energy dependent phonon linewidth found with the widely used perturbative expression found in the literature and known as the point defect scattering rate.

Jeudi 21 novembre, 14h00, salle 4.13

Thanos MANOS
(UFR ST, UCP, Cergy)

Neuronal mathematical models in the study of human brain (pathological) activity.

Mathematical modelling is an important tool in understanding the basic mechanisms of the human brain as well as determining its function and operation. In this talk, I will discuss how such models, based on ordinary differential equations can capture and describe the underlying dynamical evolution at different levels, that is, from individual neuron activity, to interactions between a relatively small number of neurons within some brain area, up to interactions between different brain regions (whole brain dynamics). Several brain diseases are characterized by abnormally strong neuronal synchrony. Mathematical models can help develop therapies to counteract such synchronization with external devices. The first part of the talk focuses on neurons whose firing activity is not static; it continuously evolves and adapts, i.e. some already existing neural synapses may get stronger or weaker (synaptic plasticity) while new synapses may be created or deleted (structural plasticity) as time evolves. Recently, there is an increasing effort to bring mathematical models closer to neuroimaging data (for example, MRI or EEG). Patient-based data can be used to improve the models to better compare and differentiate pathological from healthy brain behaviour. The second part of the talk is dedicated to models which take into account large amounts of experimental data and then are used as a virtual platform for experimenting and testing brain activity.
References:
[1] Manos T., Zeitler M. and Tass P.A. Short-term dosage regimen for stimulation-induced long-lasting desynchronization. Front. Physiol. 9:376, 2018.
[2] Manos T., Zeitler M. and Tass P.A. How stimulation frequency and intensity impact on the long-lasting effects of coordinated reset stimulation. PloS Comput. Biol. 14 (5), e1006113, 2018.
[3] Popovych O.V., Manos T., Hoffstaedter F. and Eickhoff S.B. What Can Simulations Contribute to Neuroimaging Data Analytics? Front. Syst. Neurosci. 12:68 2019.

Jeudi 14 novembre, 14h00, salle 4.13

Dmitri SOKOLOVSKI
(Departmento de Quimica-Fisica, UPV/EHU, Leioa, Spain)

No time at the end of the tunnel?

For a classical particle, one easily defines such time parameters as the net duration spent in a region of space, or a delay experienced due to the action of a force. Tunnelling, on the other hand, requires coherent superposition of various (classical-like) scenarios, so that the information about these times parameters is lost to interference, and an attempt to extract their values is frustrated by the uncertainty principle. Response of the particle to a small perturbation, or the study of its spatial or temporal delays, may only reveal the values of the corresponding probability amplitudes ,or their combinations. These values cannot be taken to represent physical durations. If they are, one would need to deal with particles ”moving faster than light”, or spending in a potential a ”time, exceeding the duration of the experiment” and, frankly, nobody should want that.

Mardi 12 novembre, 14h00, salle 4.13

Paul DOUKHAN
(AGM, UCP, Cergy)

Non stationary models and applications.

The notion of stationarity has more a mathematical origin than a tight relationship to real data sets. Namely the underlying idea of this assumption is the use of the ergodic theorem (the law of large numbers). The aim of the talk is to try to provide mathematical models adapted to several issues of real data. We aim also at precisely setting some technical ideas for fitting such models. We will describe some models for astronomical data sets, and some models devoted to online retail, in order to exhibit precise features of interest for real models, and we will try to avoid the standard mathematical traps to pass from stationary models to non stationary ones. Namely local stationarity, periods, exogenous data and isotonic assumptions are clearly seen to be reasonable. Weak dependence conditions are also quite valuable in such settings.

Jeudi 7 novembre, 14h00, salle 4.13

David PAPOULAR
(LPTM Cergy)

Evaporative cooling of a Rydberg atom chain to near its ground state.

We theoretically analyze a novel evaporative cooling scheme applicable to Rydberg chains. We consider an initially thermal chain of circular Rydberg atoms confined to a one-dimensional (1D) setting in the absence of periodic potentials. We show that the evaporation of about one half of the atoms of the chain brings it near its quantum ground state, which is a 1D Rydberg crystal. We describe the scheme thermodynamically, applying the truncated Boltzmann distribution to the collective excitations of the chain, and show that it leads to a novel quasi-equilibrium many-body state. The evaporation is driven by slowly compressing the chain. For a given atom number, this process is adiabatic down to a minimal chain size. At this point, a single atom is expelled, causing the energy and entropy per particle to decrease. Then, adiabatic compression resumes. For longer chains, comprising about 1000 atoms, we emphasize the quasi-universality of the evaporation curve.

Mardi 5 novembre, 11h00, salle 4.13

Rudolf ROEMER
(Dept. Physics/CSC, U. Warwick, UK; LPTM Cergy and IEA, UCP, France)

Resolution of the exponent puzzle for the Anderson transition in doped semiconductors.

The Anderson metal-insulator transition (MIT) is central to our understanding of the quantum mechanical nature of disordered materials. Despite extensive efforts by theory and experiment, there is still no agreement on the value of the critical exponent describing the universality of the transition—the so-called “exponent puzzle.” In this Rapid Communication, going beyond the standard Anderson model, we employ ab initio methods to study the MIT in a realistic model of a doped semiconductor. We use linear-scaling density functional theory to simulate prototypes of sulfur-doped silicon (Si:S). From these we build larger tight-binding models close to the critical concentration of the MIT. When the dopant concentration is increased, an impurity band forms and eventually delocalizes. We characterize the MIT via multifractal finite-size scaling, obtaining the phase diagram and estimates of ν. Our results suggest an explanation of the long-standing exponent puzzle, which we link to the hybridization of conduction and impurity bands.

Jeudi 17 octobre, 14h00, salle 4.13

Marco SEGNERI
(LPTM Cergy)

Exact Reduction of Multiscale Neural Dynamics.

This project aims to develop a mathematical theory for how large-scale brain dynamics and function may arise from collective behavior of the underlying neuronal circuits. It goes without saying that network organization of the brain is complex at almost every scale: from small neuronal circuits to large scale networks. This complex architecture poses serious challenges to modeling of neuronal activity and its relationship to cognitive function. In fact, direct simulations of biophysically based spiking neurons, while becoming technically possible due to increased computing power and programming techniques, quickly become unwieldy, difficult to understand beyond observation of simulated results and next to impossible to analyze. An alternative approach are reduced models of population neural activity studied to address large scale data, such as brain activity measured non-invasively with imaging techniques. These can be analyzed, yet are difficult to connect quantitatively with specific neuronal data such as local network structure, neuronal excitability and local network dynamics. We believe that it is precisely such quantitative connection between the different levels that is critical to further progress uncovering the links between biophysics and cognition. In this project we propose to apply a recently developed mathematical formalism, Exact Reduced Methodology (ERM) that takes exactly this step and further validate and apply it to critical questions. In particular, we will employ ERM to mimic the dynamics of realistic neuronal ensembles. Using this powerful formalism we will develop mesoscopic models that are able to summarize quantitatively the large scale collective dynamics, while taking into account properties of the constituent neurons and circuits. Notably we will focus on the ubiquitously observed brain oscillations and particularly on theta-gamma cross frequency coupled dynamics that have been linked to cognitive function.

Mardi 15 octobre, 16h00, salle 4.13

John BUSH
(MIT, USA)

Hydrodynamic quantum analogs: droplets walking on the impossible pilot wave.

Yves Couder and Emmanuel Fort discovered that droplets walking on a vibrating fluid bath exhibit several features previously thought to be exclusive to the microscopic, quantum realm. These walking droplets propel themselves by virtue of a resonant interaction with their own wave field, and so represent the first macroscopic realization of a pilot-wave system of the form proposed for microscopic quantum dynamics by Louis de Broglie in the 1920s. New experimental and theoretical results allow us to rationalize the emergence of quantum-like behavior in this hydrodynamic pilot-wave system in a number of settings, and explore its potential and limitations as a quantum analog.

Vendredi 27 septembre, 15h00, salle 4.13

Yuan MIAO
(Faculty of Science, ITF, University of Amsterdam, NL)

From quantum integrability to classical one and back: taming classicalness of XXZ spin chain.

I will discuss about the recent work on the classical limit of anisotropic spin-half XXZ chain. From asymptotic Bethe ansatz technique in XXZ spin chain, the Bethe equation can be formulated as a Riemann-Hilbert problem, hinting a connection to finite-gap solution of classical Landau-Lifshitz field theory. By solving the classical corresponding problem, and using the functional technique developed by Kostov, Gromov et al, an exact quantum-classical correspondence of the solution to quantum integrable chain and classical integrable field theory is implied.

Jeudi 19 septembre, 14h00, salle 4.13

Jean DECAMP
(Centre for Quantum Technologies, National University of Singapore)

Symmetry, Tan Contact and Spectral Gap in One-dimensional Fermions: A Graph Theory Treatment.

In the limit of strong repulsion, one-dimensional atomic mixtures of fermions realize an effective spin chain, and are thus a clean and controllable platform for the study of quantum magnetism or in the context of quantum computation. In the work I will present you, we interpret this model in terms of spectral graph theory. This well-studied mathematical framework allows us to completely characterize the symmetry properties of the system and to develop a powerful method to compute the Tan contacts associated with certain symmetry classes. In particular, compared to brute force diagonalization, our technique enables us to obtain much more efficiently the energy gap of complex spin mixtures, which is of central importance for the design of adiabatic control of correlated quantum systems.

Mardi 25 juin, 11h00, salle 4.13

Servet MARTINEZ
(CMM, Universidad de Chile, Santiago, CHILI)

Probabilistic analysis of a discrete-time evolution in recombination.

We study the discrete-time evolution of a recombination transformation in population genetics. The transformation acts on a product probability space, and its evolution is be described by a Markov chain on a set of partitions that converges to the finest partition. We describe the geometric decay rate to this limit and the quasi-stationary behavior of the Markov chain when conditioned to the event that the chain does not hit the limit.

Mardi 4 juin, 14h00, salle 4.13

Adriano BARRA
(Dpt. di Matematica & Fisica "Ennio De Giorgi", Università del Salento, Italie)

A journey in the statistical mechanical approach to neural networks: some novel results.

In this talk, provided a streamlined introduction to statistical learning and related information retrieval achieved by associative neural networks, I will deepen some recent progresses via their statistical mechanical formalization. I will focus on the nature of the information to store (i.e. analog vs digital patterns) and on the role of dilution in the underlying graphs where the neurons are hosted (particularly relating network 's dilution to spontaneous multi-tasking capabilities the net experiences as a whole). Finally, I will discuss how by 'letting these machines sleep' it is possible to sensibly increase their performances, much as their real (i.e. biological) counterparts.

Jeudi 18 avril, 14h00, salle 4.13

Vladimir ROUBTSOV
(LAREMA Université d'Angers)

Non-commutative Calogero–Painlevé systems and Ruijsenaars duality revisited.

All Painlevé equations can be written as a time-dependent Hamiltonian system, and as such they admit a natural generalization to the case of several particles with an interaction of Calogero type (rational, trigonometric or elliptic). Recently, these systems of interacting particles have been proved to be relevant in the study of β-models. An almost two decade old open question by Takasaki asks whether these multi-particle systems can be understood as isomonodromic equations, thus extending the Painlevé correspondence. We give an answer in the affirmative by displaying explicitly suitable isomonodromic Lax pair formulations. The famous Ruijsenaars duality applies to the Calogero–Painlevé I, II, IV and the self-duality phenomena in these systems is discussed.

Jeudi 11 avril, 14h00, salle 4.13

Antony VALENTINI
(Dept. of Physics and Astronomy, Clemson University, SC, USA)

Beyond the Quantum.

We discuss how quantum theory may be viewed as a special "equilibrium" case of a much wider "nonequilibrium" physics that allows nonlocal signalling and violations of the uncertainty principle. This is possible in the de Broglie-Bohm pilot-wave formulation of quantum theory, which allows the existence of ensembles that violate the Born probability rule. We show how the Born rule can be understood as arising from a process of dynamical relaxation, which presumably took place in the early universe. We discuss some of the features of the new physics of quantum nonequilibrium, in particular subquantum measurement (which allows trajectories to be tracked without disturbing the wave function) and its possible implications for quantum key distribution and quantum computation.

Jeudi 28 mars, 14h00, salle 4.13

Nikolaï KITANINE
(Institut Mathématiques Bourgogne, Université de Bourgogne, Dijon)

Spin chains: short history of form factors.

The computation of form factors for the spin chains has always been one of the most important problems of the theory of quantum integrable systems. It gained even more importance when it was shown that the dynamical structure factors can be computed using explicit analytic representations for the form factors and these numerical results give extremely good predictions for neutron scattering experiments. It was also recently demonstrated that the form factor analysis leads to a very powerful method of asymptotic computation of the correlation functions and dynamical structure factors. In this talk I'll review these recent developments and introduce the lqtest results on the form factors in the thermodynamic limit of the spin chains in zero magnetic field.

Jeudi 21 mars, 14h00, salle 4.13

Robert PETERS
(Department of Physics, Graduate School of Science, Kyoto University, JAPON)

Quantum oscillations in topological Kondo insulator.

One of the most puzzling recent experimental discoveries in condensed matter physics has been the observation of quantum oscillations in insulating materials SmB6 and YbB12 [1,2]. Both materials are strongly correlated f electron systems for which a gap develops due to a hybridization between conduction electrons and strongly correlated f electrons, and thus a large resistivity at low temperatures can be measured. Our understanding of quantum oscillations is rooted in the existence of a Fermi surface; electron bands, which form the Fermi surface, form Landau levels in a magnetic field. When the magnetic field strength is changed, the energy of these Landau levels changes which lead to an oscillatory behavior in almost all of the observable properties. However, insulating materials like SmB6 and YbB12 do not possess a Fermi surface, thus there are no electrons, which can form Landau levels, close to the Fermi energy. On the other hand, SmB6 and YbB12 are both good candidates for topological Kondo insulator. Naturally, the question arises, if these quantum oscillations can be due to the interplay between topology and strong correlations. We here answer this question by showing results of dynamical mean field theory in a magnetic field for a two dimensional topological Kondo insulator. We demonstrate that the gap closing, described for a noninteracting continuum model with momentum dependent hybridization [3], persists for a topological Kondo insulator on a two dimensional (2D) lattice. Furthermore, we demonstrate that the amplitude of quantum oscillations is strongly enhanced due to correlations, which makes them easily observable in quantities like magnetization and resistivity over a wide range of magnetic fields before the magnetic breakdown occurs.

Mardi 19 mars, 14h00, salle 4.13

Thi Thu PHUNG
(LPTM Cergy)

Numerical studies of magnetism and transport in graphene nanodevices.

Graphene is one of the most attracting two-dimensional materials past two decades on both theoretical and experimental researches due to its outstanding properties. In this work, we investigate the intrinsic magnetism induced by the electron-electron interaction within the self-consistent mean-field Hubbard model in finite graphene flakes. We first revisit the infinite graphene, where a Mott-Hubbard transition from a semi-metallic phase to an antiferromagnetic insulating phase is well established. For the finite graphene flakes, already weak electron-electron interactions induce magnetic moments on zigzag-shaped edges that decay rapidly to the bulk of flakes. The results show that the magnetism of finite systems depends strongly on the edge configuration, geometry as well as the size of flakes. In addition, we study the thermally induced transport properties of the antiferromagnetic graphene flakes sandwiched between two metallic leads by using the Landauer-Buttiker formalism in combination with the non-equilibrium Green's function method. As the temperature gradient is applied to the flakes, the spin-up and spin-down currents generated flow in opposite directions. This phenomenon can be induced due to the asymmetric distribution of the spin-up and spin-down transmission around Fermi energy. The perfect spin-Seebeck effect, the pure spin current without charge current, the high spin-filtering effect as well as the differential thermal resistance can be obtained by tuning the temperature at the leads, the temperature gradient and the gate voltage. The results in our study show fully promising application of graphene in spin caloritronics.

Mercredi 20 février, 11h00, salle 4.13

Fernando PERUANI
(Laboratoire J.A. Dieudonné, Université Nice Cote d'Azur)

Intermittent behavior across scales in biology.

Intermittent behavior is observed in biological systems at all scales, from bacterial systems to sheep herds. First, I will discuss how Escherichia coli explores surfaces by alternating stop and moving phases. Specifically, I will show that a Markovian three behavioral state model is consistent with the empirical data. The model reveals that the stop frequency of bacteria is tuned at the optimal value that maximizes the diffusion coefficient. These results provide a new perspective on how evolution may have reshaped the bacterial motility apparatus. Intermittent motion is also observed in sheep, where again a stochastic three behavioral state model provides a quantitative understanding of the empirical data. However, in sheep, individual transition rates depend on the behavioral state of other individuals and collective behaviors emerge. Specifically, I will show that small sheep herds display highly synchronized intermittent collective motion, with the herd behaving as a self-excitable system.

Jeudi 14 février, 14h00, salle 4.13

Moritz HELIAS
(Institute of Neuroscience and Medicine, Research Centre Jülich, Allemagne)

Statistical mechanics of correlated neuronal variability.

Neuronal networks are many particle systems with interesting physical properties: They operate far from thermodynamic equilibrium and show correlated states of collective activity that result from the interaction of large numbers of relatively simple units [1]. We here present recent progress towards a quantitative understanding of such systems by application of non-equilibrium statistical mechanics. Mean-field theory and linear response theory capture many qualitative properties of the "ground state" of recurrent networks [2]. A fundamental quantity required is the single neuron transfer function. Formally, it constitutes an escape problem driven by colored noise. We recently applied boundary layer theory to obtain a reduction to the technically much simpler white noise problem [3]. It allows us, for example, to formulate a theory of finite-size fluctuations in layered neuronal networks [4]. Verification of such theoretical predictions is fundamentally hindered by sub-sampling: We only see a tiny fraction of all neurons within the living brain at a time. Employing tools from disordered systems (spin glasses) combined with an auxiliary field formulation, we overcome this issue by deriving a mean-field theory that is valid beyond the commonly-made self-averaging assumption. It predicts that the heterogeneity of the network connectivity enables a novel sort of critical dynamics which unfolds in a low-dimensional subspace [5]. The functional consequences are analyzed by importing tools from field theory of stochastic differential equations. We obtain closed-form expressions for the transition to chaos and for the sequential memory capacity of the network by help of replica calculations [6]. We find that cortical networks operate in a hitherto unreported regime that combines instability on short time scales with asymptotically non-chaotic dynamics; a regime which has optimal memory capacity. As an outlook we present two directions in which field-theoretical methods enable insights into network dynamics: First, a novel diagrammatic expansion of the effective action around non-Gaussian solvable theories [7]; we exemplify this method by finally providing the long-searched for diagrammatic formulation of the Thouless-Anderson-Palmer mean-field theory of the Ising model. Second, the application of the functional renormaliztion group to neuronal dynamics [8]. It enables the systematic study of second order phase transitions in such networks.

Jeudi 31 janvier, 14h00, salle 4.13

Patrick NAVEZ
(University of Saskatchewan , Dept of Math. and Stat. , Saskatoon, Canada)

Designing quantum many body Hamiltonian from quantum circuits of superconducting qu-bit lines.

Quantum superconducting circuits have become recently a new alternative description of quantum phenomenae such as entanglement or quantum computation in low temperature microship devices. We report on the ability of a transmon (qu-bit) 1D array device embedded in a wave guide to act as an emitter of entangled pair of microwave radiation. The self and mutual capacitance of a series of such aligned transmon is used to allow the propagation a plasmon-like collective excitation with a tailored dispersion relation. These excitations are produced by a sudden sweep of the carrier number inside these devices. By a suitable design of a quadratic coupling from the Josephson junctions, they can decay collectively into a pair of entangled photons beam whose the maximum intensity is only bounded by the number of emitters. As a result, the quadratures obtained from a homodyne detection of these outputs beams form a pair of correlated continuous variables similarly to the EPR experiment. We calculate the decay rate of the transmon excitation both into a continuum of photon state and into a one-mode cavity. In the latest, we determine the Rabi-like frequency oscillation with the transmon mode resulting from a detuning.

Jeudi 24 janvier, 14h00, salle 4.13

Mariano BEIRO
(CONICET/ Facultad de Ingeniería de la Universidad de Buenos Aires, Argentine)

Tracking political evolution in Twitter during a presidential campaign.

Social networks are a powerful tool for studying complex social processes such as opinion formation, influence and persuasion. This phenomena are important not only for grasping a better understanding of communication in society but also for explaining some of the current threats to democracy and consensus. In fact, the processes that contribute to group formation, as homophily and social reinforcement are the same that produce echo chambers that can threaten diversity and induce the adoption of extreme positions and speech polarization.
The electoral period constitutes an excellent case study to investigate the consequences of social structure for democracy and political debate. In this work we analyze 54M tweets involving 300,000 users, captured during the last Argentinian presidential elections of 2015. We define discussion topics from the tweet's hashtags by constructing a weighted network, and we analyze the evolution of the alignment among different political groups of users during the period. Then we extract conclusions about how these political groups interact and change their behavior in different moments of the electoral period.

Mardi 22 janvier, 11h00, salle 4.13

Stefano BOCCALETTI
(Institute for Complex Systems, UOS Sesto Fiorentino, Italie)

Collective behavior of networked phase oscillators: explosive synchronization, dynamically interdependent networks and Bellerophon states.

I will discuss the spontaneous emergence of some complex collective dynamics in networked phase oscillators.
As a first step, I will discuss how synchronization can be set in the system. Synchronization is a process in which dynamical systems adjust some properties of their trajectories (due to their interactions, or to a driving force) so that they eventually operate in a collective and macroscopically coherent way. A common result is that the vast majority of transitions to synchronization are of the second-order type, continuous and reversible. However, as soon as networked units with complex architectures of interaction are taken into consideration, abrupt and irreversible phenomena may emerge, namely explosive synchronization, which rather remind first-order like transitions.
In the second part of my talk, I will try to concentrate on a novel coherent state, the Bellerophon state, which is generically observed in the proximity of explosive synchronization at intermediate values of the coupling strength. Bellerophon states are multi-clustered states emerging in symmetric pairs. In these states, oscillators belonging to a given cluster are not locked in their instantaneous phases or frequencies, rather they display the same long-time average frequency (a sort of effective global frequency). Moreover, Bellerophon states feature quantum traits, in that such average frequencies are all odd multiples of a fundamental frequency.
Finally, I will show a way to generalize the concept of interdependence of graphs when dynamical systems are considered to be the constituents of the networks, and in relationship to the setting of collective dynamics.

Jeudi 17 janvier, 11h00, salle 4.13

Christophe MORA
(LPA ENS Paris)

Parafermions and symmetry-enriched Majorana fermions in one-dimensional fermionic models.

Stabilizing and manipulating exotic emergent quasiparticles is one of the main goal of modern condensed matter physics.The quest for observing Majorana fermions and their non-Abelian braiding statistics in superconducting nanostructures is currently attracting a lot of attention, with fascinating prospects in fault-tolerant quantum computation.
Parafermions are the simplest generalization of Majorana fermions: they show non-Abelian fractional statistics and are typically associated with topological phases. We will discuss the possibility of harboring these exotic excitations in genuinely one-dimensional electronic platforms. We focus on a specific model of fermions in one dimension with a generalized ZN multiplet pairing extending the standard and so-called Kitaev chain model.
Using a combination of analytical techniques, we find an interesting topological phase intertwined with spontaneous symmetry breaking. Each symmetry-breaking sector is shown to possess a pair of boundary Majorana fermions encoding a topological character. A careful study of the quantum anomaly through pumping in the system finally reveals that parafermions exist in one dimension but only as non-local operators.

Mardi 15 janvier, 14h00, salle 4.13

Gianluca RASTELLI
(Universität Konstanz, Fachbereich Physik, Konstanz, Allemagne)

Electron-vibration and electron-photon interaction in nanoscale hybrid systems.

Engineered nanoscale systems, as nanomechanical resonators or microwave photon cavities coupled to mescoscopic conductors, have emerged as a versatile platform for fundamental science and applications. Their tailored properties offer paradigms for nonlinear dynamical couplings in the quantum regime, facilitating the unraveling of new phenomena. For example, these systems open the avenue to engineered quantum light sources, which can be tuned purely by applied voltages. Similarly, they provide a way to access the quantum regime of large mechanical systems containing many billions of individual atoms. To achieve the latter goal, a crucial requirement is cooling the mechanical resonator, integrated in an electrical circuit, to very low temperature.
I will present a theoretical study about the nonequilibrium states of nanomechanical resonators or microwave cavities coupled to quantum dots. One of the main results is that ground state cooling of the mechanical resonator can be realistically achieved using spin-polarised current [1,2] or superconducting contacts [3,4]. Furthermore, I will show that a spin-polarized current passing through a quantum dot can efficiently excite a photon cavity and it encodes a special single-atom laser that is characterized by the emergence of complex switching dynamics between multiple limit-cycles [5].
For the different proposals and in various regimes, I will discuss how the nonequilibrium states of the resonator can be readily detected by direct measurements of the dc current.

Jeudi 10 janvier, 14h00, salle 4.13

Dmitry KOVRIZHIN
(Dept. of Physics, University of Oxford, UK)

Casimir energy and semiclassical degeneracies for magnetic Skyrmions.

We study the role of zero-point quantum fluctuations in magnetic states which on the classical level are close to spin-aligned ferromagnets. These include Skyrmion textures which arise in the context of non-zero topological charge solutions of non-linear sigma-models, and topologically-trivial spirals generated by a competition of Heisenberg and Dzyaloshinskii-Moriya interactions. We show that the degeneracy of the Bogomolny-Prasad-Sommerfield (BPS) manifold is not lifted by quantum fluctuations in the case of general non-linear sigma-models with the target space given by Kähler manifolds presenting a physically-important example of the case of Grassmanian manifold relevant to quantum Hall effect in graphene. Further, we show that the phenomenon of vanishing zero-point motion can appear more generally in slowly-twisted almost ferromagnets. From a broader perspective, beyond the implications to exotic magnets, we suggest that this work provides two interesting angles on long-standing interesting issues in statistical physics and field theory. One is the existence of undressed states generally. The other item is the behaviour of 'non-universal' quantities, i.e. those involving information from the lattice scale, in the 'universal' continuum limit. Here, the Casimir energy of zero-point fluctuations vanishes in the continuum limit, but is nonzero for any lattice discretisation. This Casimir energy, however, does play a physical role, e.g. in the lifting of ground-state degeneracies in a process known as quantum order by disorder. Our results obtained for non-linear sigma models without supersymmetry about the absence of zero-point fluctuations in BPS manifolds may either be a feature entirely unrelated to the more familiar instances arising in relativistic field theory from the cancellation of fluctuations in bosonic and fermionic sectors, or they may be more pedestrian and perhaps intuitively accessible instances of the same physics.

CALENDRIER 2018

Vendredi 21 décembre, 14h00, salle 4.13

Aurélien MANCHON
(Spintronics Theory Group, Physical Science and Engineering Division,
King Abdullah University of Sciences and Technology, Thuwal, Saudi Arabia)

Spin-Orbit Physics at Magnetic Interfaces.

Chiral objects are ubiquitous in science and pose fundamental challenges, such as the importance of chiral molecules in commercial drugs or the dominance of matter over antimatter in the universe. Magnetic materials lacking inversion symmetry, called chiral magnets, constitute a unique platform for the exploration and control of chiral objects. In these systems, typically comprising multilayers of transition metal ferromagnets and heavy metals (W, Pt, Ta, Bi_2Se_3 etc.), interfacial spin-orbit coupling adopts a peculiar form, called Rashba-like interaction [1,2]. This interaction promotes a wealth of physical phenomena, among which the emergence of magnetic skyrmions – topological magnetic textures –, spin-orbit torques – an efficient means to electrically control magnetization dynamics –, as well as chiral magnetic damping – energy dissipation that depends on the texture chirality. Over the years, my group has developed several theoretical approaches to describe spin-orbit physics at interfaces, from minimal models to tight binding and first principle methods, in order to provide guidelines to better understand these effects. In this seminar, I will present various aspects of the interplay between spin transport and magnetization dynamics mediated by spin-orbit coupling in chiral magnets. I will first discuss the nature of interfacial spin-orbit coupling in magnetic multilayers and examine how it facilitates the onset of chiral magnetic textures [3]. I will then present the physics of spin-orbit torques [4,5], their general features in metals and specific characteristics in topological insulators [6]. Finally, the novel concept of chiral damping [7], i.e. the idea that energy dissipation depends on the chirality, will be introduced. In conclusion, I will show how such effects can be exploited to excite and control antiferromagnets and other frustrated magnets [8].

Jeudi 13 décembre, 13h30, salle 4.13

Marcello CIVELLI
(LPS Université Paris Sud-Paris Saclay)

Competition of gaps and unconventional high-energy Cooper pairing in cuprates: a Cluster Dynamical Mean Field Theory Perspective.

A most striking feature of high-Tc cuprate superconductors is the persistence of a gap above the superconducting transition temperature Tc, where an unconventional metallic phase, known as the pseudogap, sets in. The pseudogap is not well understood yet and it is generally believed to be at the roots of the high Tc superconducting mechanism. By exploiting cluster dynamical mean field theory results on the two dimensional Hubbard Model, we show that the pseudogap and the superconducting gap compete for the same electrons, producing an unconventional form of the superconducting pairing that involves electrons in high energy states. We show that these findings leave visible fingerprints in the Raman response, which displays a characteristic peak-dip feature. The good agreement between theoretical and experimental results reveal an unprecedented relationship between the pseudogap and superconducting gap, which eventually boosts up the Tc.

Jeudi 6 décembre, 11h00, salle 4.13

David ANGULO GARCIA
(GMC-DCS IMA, Universidad de Cartagena, Colombie; LPTM, UCP, Cergy)

Internal representation of hippocampal neuronal population span a time-distance continuum.

The hippocampus plays a critical role in episodic memory: the sequential representation of visited places and experienced events. This function is mirrored by hippocampal activity that self organizes into sequences of neuronal activation that integrate spatio-temporal information. What are the underlying mechanisms of such integration is still unknown. Single cell activity was recently shown to combine time and distance information; however, it remains unknown whether a degree of tuning between space and time can be defined at the network level. Here, combining daily calcium imaging of CA1 sequence dynamics in running head-fixed mice and network modeling, we show that CA1 network activity tends to represent a specific combination of space and time at any given moment, and that the degree of tuning can shift within a continuum from one day to the next. Our computational model shows that this shift in tuning can happen under the control of the external drive power. We propose that extrinsic global inputs shape the nature of spatio-temporal integration in the hippocampus at the population level depending on the task at hand, a hypothesis which may guide future experimental studies.

Jeudi 29 novembre, 14h00, salle 4.13

Mike ZHITOMIRSKY
(Pheliqs/INAC/CEA-Grenoble)

Dirty and frustrated: effects of structural disorder in magnets with competing interactions.

TBA.

Jeudi 22 novembre, 14h00, salle 4.13

Samuel COLIN
(LPTM, UCP)

Early Universe in the de Broglie-Bohm pilot-wave theory.

According to the de Broglie-Bohm pilot-wave theory, a quantum system is not only described by its wave-function, but also by a configuration, which is guided by the wave-function in a deterministic way (in the case of a non relativistic particle, this configuration is simply a particle position). A quantum ensemble, on the other hand, is described by a wave-function and by a distribution of configurations. The pilot-wave theory reproduces the predictions of standard quantum mechanics for ensembles in which the configurations are distributed according to the Born Law. In principle, the pilot-wave theory also allows ensembles in which the configurations are not distributed according to the Born Law: such ensembles are said to be in quantum non-equilibrium and for them standard quantum mechanics is violated, thereby leading to new physics. In the talk, I will give an overview of the pilot-wave theory and I will present this idea of quantum non-equilibrium. Then I will show that quantum non-equilibrium can provide an explanation for an anomaly in the data of the Planck satellite mission (it is an anomalous power deficit at large angular scales in the cosmic microwave background spectrum). Finally, I will give an example of the application of the pilot-wave approach to simple quantum cosmological models, to show that the existence of a configuration, beside the wave-function, allows to obtain cosmological scenarios unambiguously (here the example will be that of a bouncing universe with a dark energy phase during its expansion).

Jeudi 8 novembre, 14h00, salle 4.13

Stefan KIRCHNER
(Centre for Correlated Matter, Zhejiang University, P.R. China)

Possible routes to two-channel Kondo physics.

The standard model of metals, i.e., the Landau-Fermi liquid theory, predicts that the relaxation rate of metals -- and thus the conductivity -- at sufficiently low temperatures should be proportional to the square of temperature close to the Fermi surface. Metals that defy this Fermi liquid paradigm are often referred to as non-Fermi liquids or sometimes called 'strange metals'. One of the simplest theoretical routes to non-Fermi liquid behaviour is through two-channel Kondo physics, which however has been proven difficult to realize in experiment. This notwithstanding, there has been a recent revival of interest in the two-channel Kondo effect, both as a dynamical quantum defect as well as a bulk phenomenon. In this talk I will review the various routes to two-channel Kondo physics and discuss two particular realizations in greater detail: (a) As vacancies in the PbFCl structure (b) oxygen vacancies in nanowires of RuO2 and IrO2, which condense in the rutile structure type.

Jeudi 25 octobre, 14h00, salle 4.13

Cécilia LANCIEN
(Equipe Statistiques et Probabilités, Institut de Mathématiques de Toulouse)

High-dimensional entanglement in quantum states with positive partial transpose.

Genuine high-dimensional entanglement, i.e. the property of having a high Schmidt number, constitutes a resource in quantum processing protocols. On the contrary, states with a positive partial transpose (PPT) are generally considered weakly entangled, as they cannot be distilled into pure entangled states. This naturally raises the question whether high Schmidt numbers are possible for PPT states. This will be the main topic of the talk. I will begin with exhibiting an explicit construction of PPT state that achieves optimal Schmidt number scaling (in the dimension of the subsystems). I will then explain that, in fact, random PPT states typically share this feature. Finally I will study the somewhat opposite problem and show that the PPT property also imposes limitations on the Schmidt number.

The talk will be based on arXiv:1802.04975.

Jeudi 11 octobre, 14h00, salle 4.13

Frédéric MILA
(CTMC, EPFL Lausanne, Suisse)

Floating phase versus chiral transition in a 1D constrained model of quantum dimers, quantum loops and hard-bosons.

Motivated by the presence of Ising transitions that take place entirely in the singlet sector of frustrated spin-1/2 ladders and spin-1 chains, we study two types of effective dimer models on ladders, a quantum dimer model and a quantum loop model [1]. First of all, we show that both models can be mapped rigorously onto a hard-boson model proposed by Fendley, Sengupta and Sachdev [2] in the context of cold atoms. Then, building on a density-matrix renormalization group algorithm that takes full advantage of the constraints, we perform simulations on clusters with up to 9'000 sites and discuss the full phase diagram of these models, with special emphasis on the nature of the phase transition between the period-three charge-density wave and the disordered phase [3]. On the basis of results of unprecedented accuracy for the correlation length and the wave-vector of the incommensurate short-range correlations, we provide strong numerical evidence that there is an intermediate floating phase far enough from the integrable Potts point, while in its vicinity the numerical data are consistent with a unique transition in the Huse-Fisher chiral universality class [4].
[1] N. Chepiga and F. Mila, arXiv:1809.00746.
[2] P. Fendley, K. Sengupta and S. Sachdev, Phys. Rev. B 69, 075106 (2004).
[3] N. Chepiga and F. Mila, arXiv:1808.08990.
[4] D. Huse and M. Fisher, Phys. Rev. Lett. 49, 793 (1982).

Jeudi 4 octobre, 14h00, salle 4.13

Antonio POLITI
(ICSMB, University of Aberdeen, Scotland, UK)

Heat transport in chains of oscillators in the presence of two conservation laws.

Two centuries after Fourier laws was first formulated, its microscopic foundations are still not entirely settled. A particularly important setup is the one where two physical quantities are simltaneously transported (e.g. energy and mass, or energy and electric charge) for the mutual interactions between the two processes.
The talk will mostly focus on the discrete nonlinear Schroedinger equation, a realistic model for the description of DNA dynamics, cold atoms, and optical arrays. In this setup, energy and mass transport interact with one another giving rise a series of anti-intuitive phenomena, such as the emergence of "negative" temperatures, non-monotonous temperature profile and anomalous synchrony.

Jeudi 5 juillet, 14h00, salle 4.13

Fabio BENATTI
(Dept. of Physics, Universita degli Studi di Trieste, Italie)

Complete Positivity and Entanglement in Quantum Dynamics.

The talk aims at providing a friendly introduction to the notion of complete positivity in quantum dynamics, its relations to quantum entanglement and its physical consequences.

Jeudi 21 juin, 14h00, salle 4.13

Anastasia DOIKOU
(Dept. of Mathematics, SMCS, Heriot Watt University, Edinburgh, Scotland, UK)

Quantum Darboux-Bäcklund transformations.

We discuss the notion of the quantum auxiliary linear problem and the associated problem of quantum Darboux-Bäcklund transformation. In this frame we derive the analogue of the classical formula that provides the hierarchy of the time components of Lax pairs at the quantum level for both closed and open integrable lattice models. Particular emphasis is given to the time part of the quantum transformation as possible connections and applications to the problem of quantum quenches as well as the time evolution of local quantum impurities are evident. A discussion on the use of Bethe states as well as coherent states for the study of the time evolution is also presented. Connections with the quantum analogue of the Zakharov-Shabat method are also discussed.

Mardi 05 juin, 11h00, salle 4.13

Laura FOINI
(LPS ENS Paris)

Effective temperatures in isolated quantum systems.

Recent experimental progress in the field of cold atomic systems have triggered a renewal of interest in questions related to the equilibration and the thermalization properties of isolated quantum systems. In Gibbs equilibrium, fluctuation-dissipation relations can be generically used to probe the thermal behavior of the system and measure its temperature. However, when the system under study is integrable the dynamics fails to approach such a Gibbs state, reaching instead a generalized ensemble with a macroscopic number of temperature-like parameters which enforce the value of the underlying conserved quantities. In this setting we show that generalized fluctuation-dissipation relations for appropriately chosen -- yet very physical -- observables, can be used to infer such temperatures allowing us to reconstruct the non-thermal state. These results can be applied to a large variety of models including the one dimensional Bose gas where the relevant correlation function is provided by the structure factor, a quantity that can be experimentally accessed.

Jeudi 24 mai, 14h00, salle 4.13

Guillaume ROUX
(LPTMS Université de Paris Sud)

Artificial spin models: examples from topological bosons and Rydberg atoms.

The goal of this seminar is to present how spin models are relevant in the physics of quantum simulators through two examples. In the first one, we show that the strong interacting limit of a topological Bose-Hubbard model with two species maps onto a 2D XY spin model with frustrated couplings on the honeycomb lattice. This model displays an exotic phase thats breaks both parity and time reversal symmetry through the stabilization of a chiral order parameter. While the ground-state remains gapped and the original bosonic model is topological, we find a zero Chern number for the groundstate. In the second example, we discuss how spin models are realized in Rydberg based quantum simulators. We discuss a proposal envisionned by colleagues at College de France and perspectives on some relevant information that could be extracted from the Loschmidt echo.

Mardi 15 mai, 14h00, salle 4.13

Andrea DE LUCA
(Department of Physics, University of Oxford)

Solution of a minimal model for many-body quantum chaos.

I will present a minimal model for quantum chaos in a spatially extended many-body system. It consists of a chain of sites with nearest-neighbour coupling under Floquet time evolution. Quantum states at each site span a q-dimensional Hilbert space and the time evolution is specified as a random circuit, which is random in space but periodic in time (Floquet). Each site is coupled via a random matrix to its neighbour on one side during the first half of the evolution period, and to its neighbour on the other side during the second half of the period. I will introduce a diagrammatic formalism useful to average the many-body dynamics over realisations of the random matrices. This approach leads to exact expressions in the large-q limit and sheds light on the universality of random matrices in many-body quantum systems and the ubiquitous entanglement growth in out-of-equilibrium dynamics. I will also discuss universal behaviour which goes beyond random matrix theory and the role played by space dimensionality which emerges through a mapping into the classical Potts model, exact at large q.

Jeudi 3 mai, 14h00, salle 4.13

Sanjay RAMASSAMY
(Unité de Mathématiques Pures et Appliquées, ENS Lyon)

Graphes de Barak-Erdös et modèle infini d'urnes.

Les graphes de Barak-Erdös sont une version orientée acyclique des graphes aléatoires d'Erdös-Rényi : l'ensemble des sommets est {1,...,n} et pour tout $i<j$, avec probabilité p on ajoute une arête orientée de i vers j, indépendamment pour chaque paire $i<j$. La longueur du plus long chemin des graphes de Barak-Erdös croît linéairement avec le nombre de sommets et le taux de croissance C(p) est une fonction de la probabilité p de présence d'une arête. Foss et Konstantopoulos ont introduit un couplage entre les graphes de Barak-Erdös et un cas particulier d'un système de particules en interaction appelé modèle infini d'urnes. En utilisant ce couplage, nous verrons que C(p) est analytique pour $p>0$ et dérivable une fois mais pas deux en $p=0$. Nous verrons également que les coefficients du développement en série entière de C(p) autour de $p=1$ sont entiers, suggérant que C(p) est la fonction génératrice d'une classe d'objets combinatoires.

Jeudi 12 avril, 14h00, salle 4.13

Irina IGNATIOUK
(AGM Cergy)

Harmonic functions of random walks in a semigroup via ladder heights.

We investigate harmonic functions and the convergence of the sequence of ratios $(\P_\tau_\vartheta {>} n)/\P_e(\tau_\vartheta {>} n))$ for a random walk on a countable group killed up on the time τ_ϑ of the first exit from some semi-group with an identity element e. Several results of classical renewal theory for one dimensional random walk killed at the first exit from the positive half-line are extended to a multi-dimensional setting. For this purpose, an analogue of the ladder height process and the corresponding renewal function V are introduced. The results are applied to multidimensional random walks $(t))$ killed upon the times of first exit from a convex cone. Our approach combines large deviation estimates and an extension of Choquet-Deny theory.

Jeudi 29 mars, 11h00, salle 4.13

Grégoire MISGUICH
(IPhT, CEA Saclay/LPTM Cergy)

Out-of-equilibrium dynamics of quantum spin chain.

We study the dynamics of a quantum spin chain (S=1/2 XXZ model), which is prepared at t=0 in a domain-wall initial state, where the spins are initially pointing up on the left half-line and down on the right half-line. Using extensive time-dependent DMRG simulations we analyze the evolution of the magnetization profile, as a function of the anisotropy parameter (Delta) in the Hamiltonian. These numerical results are compared with the predictions of a recently developed hydrodynamics approach [Castro-Alvaredo et al., PRX 2016 and Bertini et al. PRL 2016], which generalizes the conventional hydrodynamics to integrable one-dimensional quantum systems. For this domain wall problem the situation of the isotropic Heisenberg model (Delta=1) is particularly interesting and not yet fully understood, and at this point our data suggest a diffusive behavior [Misguich, Mallick & Krapivksy, PRB 2017].

Jeudi 26 mars, 11h00, Maison Internationale de la Recherche, Neuville-sur-Oise

Synchronization and Transport in Complex Systems.

The meeting will address subjects in areas ranging from statistical physics to biology, from applied mathematics to computational neuroscience. In particular, the speakers will present specific talks on active matter (e.g. on cell migration and on dynamics of bacterial suspensions), as well as on neural systems (on seizure propagation in the brain and on synchronization of neural networks) and on transport in oscillator chains and in random graphs. The presentation of the subjects will allow participants from different disciplines to profit of the proposed talks.

Jeudi 8 mars, 14h00, salle 4.13

Giuliano ORSO
(LMPQ, Paris VII)

Anderson localization of atoms in speckle potentials.

When travelling in a disordered medium, a wave-packet generates aplethora of scattered waves, whose interferencecan lead to a complete suppression of its motion. This phenomenon,called Anderson localization, holds forany kind of waves, including matter waves describing the behavior ofatoms in the low-temperature quantum regime.Of special interest are Anderson transitions, where the behavior ofthe quantum particle changes from metallic to insulating as its energycrosses a critical value Ec, called the mobility edge.In this seminar I will present our numerical results on the mobilityedge of ultra-cold atoms in correlated disorder potentialsgenerated by laser speckles [1]. I will discuss Anderson transitionsbelonging to two different universality classes: the orthogonal class[1] and the symplectic class [2], the latter being driven byspin-orbit interactions.

Jeudi 8 février, 14h00, salle 4.13

Pierre-Elie LARRE
(LPTM, Cergy)

Quantum simulating many-body phenomena with propagating light.

We consider the propagation of a quantum light field in a cavityless nonlinear medium. In this all-optical platform, the space propagation of the field's envelope may be mapped onto the time evolution of a quantum fluid of interacting photons. The resulting many-body quantum system constitutes a particular class of quantum fluids of light and presently attracts a growing interest as a powerflul tool for quantum simulation. I will present recent theoretical and experimental progresses in this rapidly emerging research field, including investigations on superfluidity, elementary excitations, disorder, quantum quenches, prethermalization, thermalization, and Bose-Einstein condensation.

Jeudi 1er février, 14h00, salle 4.13

Pierre FROMHOLZ
(LPTM, Cergy)

Haldane phases with ultracold fermionic atoms inn double-well optical lattices.

We propose to realize one-dimensional topological phases protected by SU(N) symmetry using alkali or alkaline-earth atoms loaded into a bichromatic optical lattice. We derive a realistic model for this system and investigate it theoretically. Depending on the parity of N, two different classes of symmetry-protected topological (SPT) phases are stabilized at half-filling for physical parameters of the model. For even N, the celebrated spin-1 Haldane phase and its generalization to SU(N) are obtained with no local symmetry breaking. In stark contrast, at least for N=3, a new class of SPT phases, dubbed chiral Haldane phases, that spontaneously break inversion symmetry, emerge with a two-fold ground-state degeneracy. The latter ground states with open-boundary conditions are characterized by different left and right boundary spins which are related by conjugation. Our results show that topological phases are within close reach of the latest experiments on cold fermions in optical lattices.

Mardi 30 janvier, 13h30, MIR Neuville

Roberto LIVI
(Università di Firenze, Italy)

Complex dynamics in neuromorphic circuits.

Neural population made of inhibitory and excitatory units exhibit complex collective dynamics when they are organized according to suitable circuits. In particular, amplification and synchronization mechanisms may emerge as purely noise driven effects: These results disclose new perspectives in the design of neuromorphic circuits performing specific tasks, like, signal categorization and detection

CALENDRIER 2017

Jeudi 14 décembre 2017, 14h00, salle 4.13

Thibault BONNEMAIN
(LPTM, Cergy)

Non-linear Schrödinger approach to Mean Field Games.

Mean field games were introduced in the mathematical and engineering community as a way to deal with optimization problems involving a large number of interacting agents. I will show there is a strong formal link between an important class of mean field games models and the non-linear Schrödinger equation that allows for the implementation of effective approximation schemes to solve the mean field games equation. In particular, I will discuss the example of a simple (but non-trivial) model of population dynamics.

Jeudi 7 décembre 2017, 14h00, salle 4.13

Daniel UELTSCHI
(Mathematics Institute, University of Warwick)

From condensed matter physics to probability theory.

The basic laws governing atoms and electrons are well understood, but it is impossible to make predictions about the behaviour of large systems of condensed matter physics. A popular approach is to introduce simple models and to use notions of statistical mechanics. I will review quantum spin systems and their stochastic representations in terms of random permutations and random loops. I will also describe the *universal* behaviour that is common to loop models in dimensions 3 and more ("Poisson-Dirichlet").

Mercredi 22 novembre 2017, 14h00, salle 4.13

Hongjie BI
(LPTM, UCP)

Collective behavior in frequency weighted coupled oscillators and in adaptively coupled oscillators.

We report on a novel collective state, occurring in globally coupled nonidentical oscillators in the proximity of the point where the transition from the system's incoherent to coherent phase converts from explosive to continuous. In such a state, the oscillators form quantized clusters, where neither their phases nor their instantaneous frequencies are locked. The oscillators' instantaneous speeds are different within the clusters, but they form a characteristic cusped pattern and, more importantly, they behave periodically in time so that their average values are the same. Given its intrinsic specular nature with respect to the recently introduced Chimera states, the phase is termed the Bellerophon state. We provide an analytical and numerical description of Bellerophon states, and furnish practical hints on how to seek them in a variety of experimental and natural systems.

Jeudi 16 novembre 2017, 15h00, salle 4.13

Robert MACKAY
(Mathematics Institute, University of Warwick)

Phase transitions in spatially extended dynamical systems.

A dynamical system extended in N space dimensions can be viewed as an (N+1)-dimensional statistical mechanics system in space-time. Thus it was conjectured by Bunimovich and Sinai that there should be topologically transitive spatially extended dynamical systems with non-unique statistical state. With Gielis, I constructed some examples, based on Toom's results for probabilistic cellular automata. I have extended the ideas to make a variety of examples of non-unique state and families with phase transition. I propose that the concepts are crucial for the management of complex systems such as the economy.

Mercredi 15 novembre 2017, 14h00, salle 4.13

Patrik NAVEZ
(Department of Physics, University of Crete (Rethymno))

Expansion in large coordination number for the quantum Ising model.

Quantum lattice systems are encountered in many fields of physics: solid states, ultracold gases, quantum optics, and metamaterials. For this class of systems, we establish a set of hierarchy equations describing the non equilibrium time evolution of the n-site spatial correlation reduced density matrices and solve it iteratively through a 1/Z expansion where Z is the coordination number. As an illustration of the powerfulness of this method, we focus on the particular study of quench dynamics of the quantum Ising model. We also show the potentiality of this method to solve the Bose and Fermi-Hubbard model where the latest is likely to describe the high Tc superconductivity.

Jeudi 12 octobre 2017, 14h30, salle 4.13

Clàudia PAYRATO BORRAS
(LPTM, UCP)

Dynamical resilience and emergence of structural traits in mutualistic networks.

Any system formed by interacting agents can be, in general, translated into a network representation. This often enables us to introduce into other disciplines a physical perspective, as well as to apply a large set of tools aimed at analyzing the networks' features. In some cases the related agents interact mutualistically, that is, through an activity that naturally benefits both of them, like for instance the pollination of a flower by a bee which leads the plant to increase its reproductive success while the bee gets fed. The network representation results, in this case, into what is known as a mutualistic network. Such objects have been of particular importance in ecology, were they served to model mutualistic communities like plants and pollinators or seed- disperser birds and the corresponding fruit producing plants. In this seminar, I will begin by reviewing the state of the art in this field. Then, the discussion will be organized around two research questions: a first one concerning the interaction networks' structure and a second part related to their dynamics.
In more detail, I will start exploring the process of emergence of structural features in empirical ecosystems. I will show how, using a statistical physics approach, we have recently encountered that a widely known macroscopic characteristic called *nestedness* is actually determined by local traits, particularly the series of number of interactions per species (degree sequences). In the next part of the talk, I will turn into the dynamical aspect of plant-pollinator systems, in order to evaluate their resilience against external pressures such as global warming. I will present a stochastic model that incorporates a destabilizing noise, and then I will characterise the dynamical evolution of the network from a phase transition point of view. Our results indicate that these communities seems to be highly robust, mainly thanks to the heterogeneity in their pattern of contacts.

Jeudi 5 octobre 2017, 13h30, salle 4.13

Andreas HONECKER
(LPTM, UCP)

The magnetocaloric effect: history and perspectives.

The magnetocaloric effect, i.e., the change of temperature induced by an adi- abatic change of an external magnetic field was discovered by Warburg in 1881 during his investigations of iron. Subsequently, back in 1933, cooling by adiabatic demagnetization of paramagnetic salts was the first method to reach temperatures below 1 K. Until today, adiabatic demagnetization remains the method of choice to cool solids to the milli-Kelvin range or below. In addition, cooling by adiabatic demagnetization at intermediate temperatures (Kelvin-range) is under discussion for space applications and future linear colliders. Such applications would benefit from more efficient materials. On this background, we review recent ideas how to go beyond single-ion systems, and exploit interactions between magnetic moments of dipolar or Heisenberg nature to enhance magnetocaloric properties. Specifically, we discuss the enhanced magnetocaloric effect observed in geometrically frustrated magnets and close to field-induced quantum phase transitions.

Mardi 11 juillet 2017, 16h00, salle 5.54

Luca TAGLIACOZZO
(Physics Department, University of Strathclyde, Glasgow, Scotland)

On the continuum limit of tensor network states.

Tensor networks provide both a theoretical and numerical framework for studying strongly correlated systems on the lattice.
Recently tensor network states have also been constructed directly in the continuum.
Here I take an alternative approach and I review some of our recent results we have obtained concerning the construction of the continuum limit of tensor network states defined on the lattice.

Jeudi 22 juin, 16h00, salle 4.13

Oleg STARYKH
(University of Utah, USA)

Emergent Ising orders of frustrated magnets.

Much of the research in frustrated quantum magnets has focused on the elusive quest for magnetically disordered phases with highly entangled ground states - quantum spin liquids. Somewhat intermediate between these rare states and commonplace magnets are {\em nematic} phases which appear as a result of a two-magnon condensation and are characterized by the presence of a gap for excitations with spin one. As a result, nematic states exhibit no dipolar magnetic order.
In my talk I describe two simple models supporting spin nematic phases. The first of them is provided by the two-magnon instability of the 1/3 magnetization plateau state of the quantum triangular antiferromagnet. I show that the two-magnon instability, which takes place near the end-point of the magnetization plateau, leads to a novel two-dimensional vector chiral phase with alternating spin currents. This interesting state spontaneously breaks inversion symmetry and can be thought of as appearing due to a fluctuation-generated Dzyaloshinskii-Moriya interaction. The second example involves an easy-axis spin-1 antiferromagnet in which transition into nematic state occurs via condensation of spin excitons.

Jeudi 15 juin, 16h00, salle 4.13

Vladimir RITTENBERG
(Physikalisches Institut der Universitaet Bonn, Allemagne)

Conformal invariance in stochastic processes: Why the critical exponents are half of what they should be.

Abstract non communiqué…

Jeudi 8 juin 2017, 14h00, Salle 4.13

Alessandro TORCINI
(LPTM, Université de Cergy-Pontoise)

Death and rebirth of neural activity in sparse inhibitory networks.

Inhibition is a key aspect of neural dynamics playing a fundamental role for the emergence of neural rhythms and the implementation of various information coding strategies. Inhibitory populations are present in several brain structures, and the comprehension of their dynamics is strategical for the understanding of neural processing. In this paper, we clarify the mechanisms underlying a general phenomenon present in pulse-coupled heterogeneous inhibitory networks: inhibition can induce not only suppression of neural activity, as expected, but can also promote neural re-activation. In particular, for globally coupled systems, the number of firing neurons monotonically reduces upon increasing the strength of inhibition (neuronal death). However, the random pruning of connections is able to reverse the action of inhibition, i.e. in a random sparse network a sufficiently strong synaptic strength can surprisingly promote, rather than depress, the activity of neurons (neuronal rebirth). Thus, the number of firing neurons reaches a minimum value at some intermediate synaptic strength. We show that this minimum signals a transition from a regime dominated by neurons with a higher firing activity to a phase where all neurons are effectively sub-threshold and their irregular firing is driven by current fluctuations. We explain the origin of the transition by deriving a mean field formulation of the problem able to provide the fraction of active neurons as well as the first two moments of their firing statistics. The introduction of a synaptic time scale does not modify the main aspects of the reported phenomenon. However, for sufficiently slow synapses the transition becomes dramatic, and the system passes from a perfectly regular evolution to irregular bursting dynamics. In this latter regime the model provides predictions consistent with experimental findings for a specific class of neurons, namely the medium spiny neurons in the striatum.

Mardi 6 juin 2017, 14h00, Salle 4.13

Christian HAGENDORF
(IRMP, UC Louvain)

Curiosities at Delta = -1/2

The XXZ Heisenberg chain is one of the most important exactly-solvable models of interacting spins in one dimension. The special case where its anisotropy parameter takes the value Delta = -1/2 has received a lot attention. Not only display many properties of its ground state a surprising relation to enumerative combinatorics (such as the enumeration of so-called alternating sign matrices) but also the model exhibits an exact supersymmetry on the lattice. In this talk, I will explain how to use both the combinatorics and the supersymmetry in order to obtain exact ground-state results such as the so-called bipartite fidelity for the open XXZ chain at Delta = -1/2. Furthermore, I will discuss the scaling limit of this bipartite fidelity and compare it to its conformal-field-theory prediction.

References: Christian Hagendorf and Jean Liénardy, “Open spin chains with dynamic lattice supersymmetry”, J. Phys. A: Math. Theor. 50 (2017) 185202

Jeudi 11 mai 2017, 14h00, Salle 4.13

David CLEMENT
(Laboratoire Charles Fabry, Institut d'Optique Palaiseau)

Single-atom- and momentum-resolved investigation of the condensate depletion in interacting Bose gases.

The interplay of quantum fluctuations and interaction is at the core of intriguing phenomena of quantum many-body physics. An emblematic example, conceptually rather simple, of such a manifestation is the quantum depletion of a Bose condensate occurring at zero temperature. The resulting many-body ground-state, a vacuum of quasi-particles, is composed of single-particle excitations on top of the condensate, for which a direct observation has been missing. I will report on the single-atom-resolved measurement of the distribution of momenta k in interacting Bose gas of metastable Helium after a 330 ms Time-Of-Flight (TOF). We investigate two different potentials where atoms are trapped before being released. In a 3D harmonic trap, we monitor the TOF distribution at various temperatures and clearly separate and identify, by their k-dependence, two distinct contributions to the depletion of the condensate: the thermal and the quantum depletion [1]. In a 3D optical lattice, we show that the measured TOF distributions are in the far-field regime of expansion, an original configuration that allows us to precisely determine the temperature and the condensed fraction of lattice superfluids.

[1] R. Chang et al. Phys. Rev. Lett. 117, 235303 (2016).

Jeudi 27 avril 2017, 14h00, Salle 4.13

Maurizio FAGOTTI
(LPT, ENS Paris)

Intermediate-time dynamics in out-of-equilibrium spin chains.

In the first part of the talk, I consider the non-equilibrium time evolution of piecewise homogeneous states in the XXZ spin-1/2 chain. I overview the solution to the dynamics in the limit of large time and discuss some remarkable properties of the profiles of charges and currents. In the second part of the talk, I describe an unusual mechanism of prethermalization, based on the presence of a symmetry of the pre-quench Hamiltonian which is spontaneously broken at zero temperature and is explicitly broken by the post-quench Hamiltonian.

References:
[1] B. Bertini, M. Collura, J. De Nardis, and M. Fagotti, Transport in Out-of-Equilibrium XXZ Chains: Exact Profiles of Charges and Currents, Phys. Rev. Lett. 117, 207201 (2016).
[2] V. Alba and M. Fagotti, Prethermalization at low temperature: the scent of a spontaneously broken symmetry, arXiv:1701.05552 (2017).

Mardi 28février 2017, 11h00, Salle 5.54

Martin ROBERT DE SAINT VINCENT
(LPL, Universite Paris XIII)

Connecting Berezinskii-Kosterlitz-Thouless and BEC Phase Transitions by Tuning Interactions in a Trapped 2D Gas.

Extended coherence in quantum fluids can arise, typically in association with superfluidity, from a variety of mechanisms. Finite size two-dimensional (2d) Bose gases present a subtle interplay between Bose-Einstein Condensation, driven by quantum statistics, and the interaction-driven Berezinskii-Kosterlitz-Thouless (BKT) phase transition, at which free vortices become suppressed and quasi-long range order emerges. To explore the respective roles of quantum statistics and interactions, we study experimentally the critical point for the emergence of coherence in a harmonically trapped 2d Bose gas with tunable interactions. Over a wide range of interaction strengths we find excellent agreement with predictions based on the BKT theory of 2d superfluidity. This allows us to quantitatively show, without any free parameters, that the interaction-driven BKT transition smoothly converges onto the purely statistical Bose-Einstein condensation (BEC) transition in the limit of vanishing interactions.

Jeudi 2 février 2017, 14h00, Salle 4.13

Giovanni MARTONE
(LPTMS Orsay)

Quantum Tricritical Points and Phase Transitions in Spin-Orbit-Coupled Spin-1 Bose Gases.

The recent realization of synthetic spin-orbit coupling represents one of the most important achievements in the physics of ultracold atomic gases. In my talk I shall illustrate the properties of spin-orbit-coupled spin-1 Bose-Einstein condensates with equally weighted Rashba and Dresselhaus couplings. Different quantum phases can be found depending on the antiferromagnetic or ferromagnetic nature of the interactions, which include a zero-momentum phase, a spin-polarized plane-wave phase, and three kinds of striped phases exhibiting modulations in the density profiles with qualitatively diverse behaviors in each phase. In the striped phases translational invariance is spontaneously broken, in analogy with supersolids. Transitions between the above phases can be induced in experiments by independently varying the Raman coupling strength and the quadratic Zeeman field. I will discuss in detail the properties of these transitions and point out the emergence of quantum tricritical points, which are the direct consequence of the spin-dependent interactions.

CALENDRIER 2016

Jeudi 15 décembre 2016, 11h30, Salle 4.13

David PAPOULAR
(LPTM, Université de Cergy-Pontoise/CNRS)

Heteronuclear controlled-not quantum gate for single neutral atoms using the Rydberg blockade.

Quantum information processing with mixed-species architectures shows advantages in avoiding crosstalk and in quantum non-demolition detection. Implementing the C-NOT gate with these architectures is still a challenge. The C-NOT gate between two different ions has been demonstrated recently. However, for trapped neutral atom systems, which are unique in controlling the interaction strength and in forming tunable arrays for simulations, the C-NOT has only been realized with two identical atoms. We experimentally demonstrate the first heteronuclear C-NOT gate, using a single 87Rb atom and a single 85Rb atom. First, we realize a strong heteronuclear Rydberg blockade by exciting 87Rb to the 79D Rydberg state to suppress the Rydberg excitation of 85Rb which is 3.8 microns away. Then, we transfer this blockade to the heteronuclear C-NOT gate with a high fidelity. We model the Rydberg blockade theoretically and point out the important impact of the temperature on the blockade strength. Our work paves the way towards the use of multi-element neutral atoms in quantum computation, quantum simulation, and quantum metrology.

Jeudi 8 décembre 2016, 14h00, Salle 4.13

Wolfram BRENIG
(Solid-State Theory Division (AG FKT) Institute for Theoretical Physics, Technical University of Braunschweig , RFA)

Thermal Transport in Kitaev-Heisenberg Ladders.

We present results for the dynamical thermal conductivity of the Kitaev-Heisenberg model on ladders. In the pure Kitaev limit, and in contrast to conventional low-dimensional spin systems, we show that the system is a perfect heat insulator. We clarify this to be a direct fingerprint of fractionalization of spins into mobile Majorana matter and a static Z2 gauge field, which acts as an emergent thermally activated disorder. These result will be considered versus temperature and will also be contrasted against the conductivity discarding gauge fluctuations. Turning on Heisenberg exchange, we show that the system crosses over from a complete heat insulator to a normal heat conductor, consistent with a recombination of fractionalized spins into triplons. Our finding rests on several complementary calculations of the heat current correlation function, comprising a phenomenological mean-field treatment of thermal gauge fluctuations, a complete summation over all gauge sectors, as well as exact diagonalization and dynamical quantum typicality treatments of the original spin model. Moving away from ladders, we clarify similarities and difference to the thermal transport in Kitaev chains and planes.

Jeudi 24 novembre2016, 14h00, Salle 4.13

Thierry HUILLET
(LPTM, Université de Cergy-Pontoise)

Variations autour du modèle de Luria-Delbruck.

One of the most popular models for quantitatively understanding the emergence of drug resistance both in bacterial colonies and in malignant tumors was introduced in 1943 by Luria and Delbrück. Here, individual resistant mutants emerge randomly at birth events embedded in an exponentially growing sensitive population. The Luria-Delbrück experiment (known as the Fluctuation Test) demonstrates that genetic mutations of bacteria arise permanently, even in the absence of selection, rather than being a response to selection thereby justifying the latter scenario.
It was thus confirmed that mutations do not occur out of necessity (a Lamarckian approach), but instead can occur many generations before the selection strikes (the Darwinian point of view).
We shall unravel some of the probabilistic aspects of this problem together with some of its variations, including the opportunity of a linearly growing sensitive population.

Jeudi 17 novembre2016, 14h00, Salle 4.13

Thimothee THIERY
(Institute for Theoretical Physics, K.U. Leuven, Belgique)

Exactly solvable models of directed polymer on the square lattice.

There has been a recent interest in finding exact solutions of models in the KPZ universality class in 1+1D, in particular models of directed polymer (DP) in a two-dimensional random environment. In this talk I will focus on discrete models of DPs on the square lattice at finite temperature, and present the results of a classification of Bethe ansatz exactly solvable models. I will present the models in this classification, in particular the Inverse-Beta polymer, an anisotropic model which interpolates between previously known exactly solvable models of DPs on the square lattice, and the Beta polymer (introduced by Barraquand and Corwin in 2015), a model which has the peculiarity of also being a model of random walks in a time-dependent random environment. I will review how the Bethe ansatz solution of these models can be used to obtain information on the asymptotic fluctuations of the free-energy of the DPs in these models, exhibiting features expected from KPZ universality (Tracy-Widom fluctuations) or not (in the diffusive regime of the random walk for the Beta polymer).

Vendredi 4 novembre2016, 14h00, Salle 4.13

Karlo PENC
(Wigner Research Centre for Physics, Hungarian Academy of Sciences, Budapest)

Triplon Hall effect in the Shastry Sutherland material.

SrCu2(BO3)2 is the archetypal quantum magnet with a gapped dimer-singlet ground state and triplon excitations. It serves as an excellent realization of the Shastry Sutherland model, up to small anisotropies arising from Dzyaloshinskii Moriya (DM) interactions. We demonstrate that the DM couplings in fact give rise to topological character in the triplon band structure. The triplons form a new kind of a Dirac cone with three bands touching at a single point, a spin-1 generalization of graphene. An applied magnetic field opens band gaps leaving us with topological bands with Chern numbers ± 2. SrCu2(BO3)2 is thus a magnetic analogue of the integer quantum Hall effect and supports topologically protected edge modes. At a critical value of the magnetic field set by the strength of DM interactions, the three triplon bands touch once again in a spin-1 Dirac cone, and lose their topological character. We predict a strong thermal Hall signature in the topological regime.

Jeudi 14 octobre 2016, 14h00, Salle 4.13

François DUNLOP
(LPTM, Université de Cergy-Pontoise)

Goutte accrochée sur un plan incliné.

Une goutte posée à l'équilibre obéit à l'équation de Young, qui donne l'angle de contact en fonction du degré d'hydrophilie ou hydrophobie du substrat. En réalité la goutte est généralement dans un état métastable, avec une hystérèse entre un angle d'avancée et un angle de reculée. Sur un plan incliné la goutte peut être piégée dans un état métastable, avec un angle en aval et un angle en amont. Le profil de la goutte piégée obéit à l'équation de Laplace-Young, edp pour capillarité+gravité, non-linéaire par le terme de courbure moyenne. L'edp linéarisée est résolue exactement, et cette approximation est comparée aux solutions numériques obtenues avec "Surface evolver". Travail avec Thierry Huillet et Joël De Coninck.

Mardi 11octobre 2016, 14h00, Salle 4.13

Jayad VAHEDI
(Dept. Of Physics, Sari Branch, Islamic Azad University, Sari, Iran)

Heat dissipation and its relation to molecular orbital energies in single-molecule junctions.

We present a theoretical study of the heat dissipation in single-molecule junctions. In order to investigate the heat dissipation in the electrodes and the relationship between the transmission spectra and the electronic structures, we consider a toy model in which electrodes are linked by a two-level molecular bridge. By using the Landauer approach, we show how heat dissipation in the electrodes of a molecular junction is related to its transmission characteristics. We show that in general, heat is not equally dissipated in the left and right electrodes of the junction and it depends on the bias polarity and the positions of the molecule's energy levels with respect to the Fermi level. Also, we exploit the inline image molecule as a junction and the results show a good agreement with the toy model. Our results for the heat dissipation are remarkable in the sense that they can be used to detect which energy levels of a molecular junction are dominated in the transport process.

Mercredi 5 octobre 2016, 11h00, Salle 4.13

Daniel CABRA
(Instituto de Física de La Plata, Argentine)

Skyrmion lattices in antiferromagnetic systems.

The frustrated classical antiferromagnetic Heisenberg model with Dzyaloshinskii-Moriya (DM) interactions on the triangular lattice is studied under a magnetic field by means of semiclassical calculations and large-scale Monte Carlo simulations. We show that even a small DM interaction induces the formation of an Antiferromagnetic Skyrmion crystal (AF-SkX) state. Unlike what is observed in ferromagnetic materials, we show that the AF-SkX state consists of three interpenetrating Skyrmion crystals (one by sub-lattice), and most importantly, the AF-SkX state seems to survive in the limit of zero temperature. Evidence of a discontinuous transition from a spiral phase into the AF-SkX phase is shown and for high fields, a second (probably continuous) transition occurs into a featureless paramagnetic phase.

Mardi 4 octobre 2016, 11h00, Salle 4.13

Vincent Caudrelier
(School of Mathematics, University of Leeds, UK/LPTM Cergy, professeur invité)

Lagrangian and Hamiltonian structures in an integrable hierarchy.

The classical and quantum versions of the R matrix are the cornerstones in classical and quantum integrable systems, typically formulated in 1+1 dimensions. However, they traditionally concentrate all the attention on only one of the independent variables : the space one while time evolution is encoded more or less trivially. The latter point is in fact deeply related to the boundary conditions imposed on the system. A big success of the theory of classical integrable systems is the systematic Hamiltonian formulation of the corresponding PDEs. The essential object capturing the Hamiltonian properties (infinite number of conserved quantities, etc) is the so-called classical r-matrix. Motivated originally by the question of integrability of certain field theories in the presence of defects or (not necessarily integrable) boundary conditions, we will show how a dual Hamiltonian structure naturally emerges which gives a fully fledged r-matrix structure to the space variable. This is inspired and related to the notion of covariant field theory. The interplay between the standard classical r-matrix structure and the new one is what we call dual Hamiltonian structure. This raises many questions that we will mention at the end of the talk.

Mardi 27 septembre 2016, 14h00, Salle 4.13

Quentin DUPREY
(LPTM, Cergy)

Mesure non projective et trajectoire faible dans les systèmes quantiques.

Il est bien connu que la mesure d'une grandeur physique par un observateur introduit intrinsèquement une perturbation au système mesuré. Cette perturbation soudaine interrompt l'évolution "naturelle" du système et le projette sur un état propre de l'observable considérée. Au cours de ce séminaire, nous verrons qu'il est possible d'extraire une information d'un système quantique lors de son évolution : la valeur faible. Introduite par Aharonov, Albert et Vaidman en 1988 ("How the result of a measurement of a component of the spin of a spin-1/2 particle can turn out to be 100," Physical Review Letters), elle permet d'accéder dans certaines conditions à la valeur moyenne d'une observable grâce à une interaction non-destructive. Alors que la notion de trajectoire (dans la réalité) est un concept inapproprié en mécanique quantique, nous étudierons la notion de trajectoire faible dans des systèmes d'interférométrie où nous traiterons notamment de l'effet du "Chat du Cheshire".

Jeudi 16 juin 2016, 11h00, Salle 4.13

Urbasi SINHA
(Raman Research Institute, Sadashivanagar, Bangalore, India)

A tale of three slits.

This talk will cover two very interesting but widely varying applications of triple slit based aperture systems. The first one deals with a foundational problem in quantum mechanics and classical optics; the second one deals with quantum computing and quantum communication.

Mercredi 18 mai 2016, 14h00, Salle 4.13

Alexander HARTMANN
(Institut für Physik, Universität Oldenburg, Allemagne)

Large deviations for non-equilibrium processes.

Large deviations and rare events play an ever increasing role in science, economy and society. Often this concerns non-equilibrium processes, where large deviations play a crucial role for example for the estimation of impacts of storms, the calculation of probabilities of stock-market crashes or the sampling of transition paths for conformation change of proteins.
The basic principal to study large deviations using numerical simulations is quite old: make unlikely events more probable and correct in the end for the bias [1].
Here, we present a very general black-box method [2], based on sampling vectors of random numbers within an artificial finite-temperature (Boltzmann). This allows to access rare events and large deviation for almost arbitrary equilibrium and non-equilibrium processes. In this way, we obtain probabilities as small as 10^{-500} and smaller, hence rare events and large-deviation properties can be easily obtained.
Here, different non-equilibrium applications are displayed:
Fractional Brownian motion (fBm) characterized by the Hurst exponent H Distribution of end-points of non-absorbed walks for different values of H Distribution of work performed for a critical ($T=2.269$) two-dimensional Ising system of size $L\times L=128 \times 128$ upon rapidly changing the external magnetic field [2] (also applying theorems of Jarzynski and Crooks to obtain the free energy difference of such a large system) Distribution of perimeters and area of convex hulls of two-dimensional single and multiple random walks.

Lundi 18 avril 2016, 15h00, Salle 4.13

Alessandro TORCINI
(INMED INS Universite Aix Marseille / ISC CNR Sesto Fiotentino, Italie)

From Microscopic to Collective Dynamics in Neural Circuits.

In this talk I will revise my recent results on the application of nonlinear dynamics to the study of the emergence and stability of non trivial collective behaviours in pulse-coupled neural networks of Leaky Integrate-and-Fire neurons [1-5]. In particular, I will discuss how the network dynamics depends on the the connectivity of the underlying networks [1-3] as well as on the main aspects of the synaptic transmission, like the excitatory/inhibitory nature of the synapses and the time scale of the post-synaptic potentials [4-5]. I will conclude by reporting how a simple excitatory neural network can be employed to shed some ligth on recent experimental results on the dynamical orchestration of the developing hyppocampus [6] and how a simple inhibitory network can be employed to understand some of the main features of the dynamics of the Medium Spiny Neurons in the Striatum [7].
Reference
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Vendredi 15 avril 2016, 15h00, Salle 4.13

Christophe TEXIER
(LPTMS, Orsay)

Topological phase transitions in multichannel disordered wires in the chiral symmetry classes.

We have considered the one-dimensional multichannel Dirac equation where the mass is a random N*N matrix with elements uncorrelated in space. In order to analyze the spectral properties of the model, we have introduced a matricial random process (Riccati matrix), related to the scattering matrix describing the reflection on the semi-infinite medium. We have found that the stationary distribution of the Riccati matrix corresponds to an interpolation between the Wishart (Laguerre ensemble) and inverse-Wishart distributions. The knowledge of this distribution has allowed us to derive explicit representations for the density of states (DoS), under the form of determinants ; the DoS is shown to present a power law behaviour at low energy. Varying the mass over disorder ratio allows to drive N phase transitions where the DoS exponent vanishes and which are shown to be of topological nature as they correspond to the change of a topological quantum number (Witten index).

Jeudi7 avril 2016, 13h30, Salle 4.13

Alessandro FABBRI
(Instituto de Fisica Corpuscular, Universidad de Valencia, Spain)

Analogue de la radiation de Hawking dans les condensats de Bose-Einstein.

En 1974 S. Hawking montra que les trous noirs ne sont pas "noirs", mais émettent un faible rayonnement d'origine quantique. Cet effet, très difficile à détecter dans le contexte astrophysique, peut être reproduit en laboratoire avec des fluides supersoniques (les "trous noirs acoustique."'). En choisissant comme fluide un condensat de Bose-Einstein, je montrerai que nous pouvons mettre en évidence l'analogue du rayonnement de Hawking avec des mesures de corrélations, et d'en caractériser les propriétés quantiques.

Mardi 5 avril 2016, 13h15, Salle 4.13

Laurent JOLY
(Institut Lumière Matière, Université de Lyon 1)

Molecular modeling of liquid/solid friction for nanofluidic applications.

Nanofluidic systems (i.e. natural and artificial systems where fluids are confined at the nanoscale) play a key role in numerous present-day applications, from water treatment to sustainable energy harvesting. New behaviors arise in nanoconfined liquids due to the predominant role of surfaces. For instance, nanoflows are controlled by interfacial hydrodynamics, and can be enhanced by liquid/solid slip arising from low liquid/solid friction. Electrokinetic effects, coupling different types of transport (e.g. hydrodynamic, ionic, thermal) at interfaces, at the core of nanofluidic energy conversion systems, can also be enhanced by liquid/solid slip. It is therefore crucial to understand and optimize liquid/solid friction in order to design efficient nanofluidic devices. During this talk, I will illustrate with recent work how molecular dynamics simulations can help unravel the molecular mechanisms underlying liquid/solid friction, and explore its consequences on nanofluidic transport and in particular on nanofluidic energy conversion.

Jeudi24 mars 2016, 13h15, Salle 4.13

Vladimir A. BELAVIN
(I E Tamm Department of Theoretical Physics, P N Lebedev Physical Institute, Moscou, Russie)

Classical conformal blocks via AdS/CFT correspondance
La limite semi-classique des blocs conformes dans le contexte de AdS/CFT.

We discuss the holographic interpretation of a special class of classical conformal blocks in terms of particles propagating in an asymptotically AdS3 geometry. Using the world line approach we propose and explicitly describe the corresponding bulk configuration, which consists of a number of classical relativistic particles propagating in the conical defect background. We demonstrate the correspondence in the case of five-point block. The bulk analysis relies upon the special perturbative procedure which treats the n-point configuration as a deformation of the (n-1)-one. The boundary computation relies on the study of the monodromy properties of the auxiliary Fuchsian differential equation.

Nous discutons l'interprétation holographique d'une classe spéciale de blocs conformes dans la limite semi-classique en termes de particules dans un espace de type AdS. Nous décrivons explicitement la configuration correspondante dans AdS. Elle se compose d'un certain nombre de particules relativistes classiques qui se propagent dans le fond d'un défaut conique. Nous démontrons la correspondance dans le cas du bloc à cinq points. L'analyse dans AdS repose sur une procédure perturbative qui traite la configuration à n point comme une déformation de la configuration à (n-1) points. Le calcul dans la théorie conforme repose sur l'étude des propriétés de monodromie de l'équation différentielle Fuchsien auxiliaire.

Mardi 22 mars 2016, 13h30, Salle 4.13

Luca de' MEDICI
(ESRF, Grenoble)

The capricious electron correlation strength driven by Hund's coupling.

Hund's exchange coupling is a well-known main player (through Hund's rules) in the physics of isolated atoms and insulators. It was however recently shown that it has a crucial influence also on the dynamics of conduction electrons in correlated materials[1]. Taking this effect into account helps explaining the capricious dependence of electron correlation strength and the occurrence of Mott insulating states in transition metal oxides and similar materials, like the recently discovered Iron-based high-Tc superconductors[2]. Hund's coupling also favors a differentiation of correlation strength among conduction electrons[1,2], a potentially fertile ground for new phenomena in these materials, such as d-electron heavy-fermionic behavior. If time allows I will briefly touch on a potential application of prospective improvement in thermoelectric materials (possibly due to the exploration of these latter materials): self-cooling superconducting cables[3].

Jeudi 17 mars 2016, 11h15, Salle 4.13

Luca TAGLIACOZZO
(University of Strathclyde, Glasgow , Scotland)

Novel approaches to gauge theories based on ultra-cold atoms.

I review our theoretical proposals to perform quantum simulations of dynamical gauge theories based both on Rydberg atoms and bosonic mixtures. This provides the motivation to discuss some exotic gauge theories and their phase diagram.

Mardi 15 mars 2016, 13h30, Salle 4.13

Alessio CELI
(ICFO, Castelldefels (Barcelona), Spain)

High for Low: High Energy ideas and phenomena in quantum simulation.

After reviewing idea and motivations for quantum simulation, I will introduce the simulation of synthetic (background) gauge fields with ultracold atoms as paradigmatic example. Such quantum simulators allow to study quantum Hall effects, as well as the simulation of relativistic physics and other topological systems. Of all the possible strategies developed in order to engineer synthetic gauge fields, I will detail the one based on "synthetic dimensions" that we introduced in analogy to spacetime compactifications, and that has been recently realized in two different experiments. In the last part of the talk, I will briefly comment about other branches of my program, namely, how it is possible to simulate (certain) lattice gauge theories, i.e. models in which the synthetic gauge field becomes dynamical and quantum, and artificial gravity backgrounds.

Jeudi 10 mars 2016, 13h30, Salle 4.13

Oleg LISSOVYY
(LMPT, Université Francois Rabelais, Tours)

Equations de Painlevé et blocs conformes.

L'équation de Painlevé VI décrit les déformations isomonodromiques de systèmes Fuchsiens de rang 2 à 4 singularités régulières sur la sphère de Riemann. J'expliquerai comment construire explicitement sa solution générale ainsi que la solution du problème de Riemann-Hilbert isomonodromique associé en utilisant les blocs conformes de l'algèbre de Virasoro.

Jeudi 11 février 2016, 13h30, Salle 4.13

Harald JESCHKE
(Institute for Theoretical Physics, Goethe-Universitaet Frankfurt)

Effects of doping and pressure in copper based kagome materials: spin liquid and strongly correlated Dirac metal.

Herbertsmithite ZnCu3(OH)6C12 is one of the best candidates for a quantum spin liquid; its Cu(2+) ions form a kagome lattice. With half-filled Cu dx2-y2 bands, it is a Mott insulator. We have determined the parameters of the underlying Heisenberg Hamiltonian using density functional theory (DFT) methods. We propose to dope herbertsmithite with 1/3 extra electron per Cu by substituting Ga for Zn. At the 4/3 filling level, the kagome Hamiltonian exhibits topologically protected Dirac points. Ga-herbertsmithite would be a rare example of a material with strongly correlated Dirac electrons at symmetry-protected locations in the Brillouin zone. Such a metal with strongly correlated Dirac point electrons would have rather unique magnetic and transport properties. We investigate the stability of herbertsmithite variants by calculating formation energies. We predict that doping to the 2/3 filling level, into the flat band of the kagome lattice band structure, would yield a ferromagnetic material that displays a quantum anomalous Hall effect. An interesting polymorph of herbertsmithite is kapellasite which orders magnetically and has a ferromagnetic nearest neighbour exchange coupling. We discuss the positioning of kapellasite ZnCu3(OH)6C12, haydeeite MgCu3(OH)6C12 and hypothetical CdCu3(OH)6C12 in the phase diagram of the J1-J2-J3 Heisenberg model. We find kapellasite and haydeeite to be near the boundaries between magnetically ordered and disordered phases, and we predict that moderate pressures could bring the materials into the paramagnetic regime.

Mardi 9 février 2016, 11h15, Salle 4.13

Andreas KLUMPER
(Fachgruppe Physik , Bergische Universität Wuppertal, RFA)

Correlation functions of integrable quantum spin chains.

Integrable systems like the spin-1/2 Heisenberg chain provide the rare opportunity of calculating exact results like energies and thermodynamics for finite size and in the thermodynamic limit. We know many integrable systems for many decades, but actual calculations of physical properties have only rather recently been done if at all. A notorious problem is posed by the computation of correlation functions. For the infinite volume system, even static correlators present a major challenge. Currently, we know how to calculate short range correlators for the spin-1/2 Heisenberg chain at arbitrary temperature and magnetic field, where the first results for zero temperature and zero magnetic field have been obtained about 20 years ago. A central result of Jimbo, Miwa, Smirnov and others is the factorization of general static correlators into sums over products of nearest-neighbour correlators similar to the Wick theorem for ideal quantum systems however with much more complicated structure factors. There are applications in the field of non-equilibrium systems such as interaction quenches. I will talk about applications of the computational methods for the study of the stationary state approached through the equilibration process. A major subject of my talk will be the generalization of the study of correlation functions in direction of higher spin-S chains with su(2) symmetry and into the direction of higher rank symmetry like su(3).

Jeudi28 janvier 2016, 14h00, Salle 4.13

Alexei CHEPELIANSKII
(LPS Université Paris Sud)

An incompressible state of a two dimensional electron gas.

Two-dimensional electrons in a magnetic field can form new states of matter characterized by topological properties and strong electronic correlations as displayed in the integer and fractional quantum Hall states. In these states, the electron liquid displays several spectacular characteristics, which manifest themselves in transport experiments with the quantization of the Hall resistance and a vanishing longitudinal conductivity or in thermodynamic equilibrium when the electron fluid becomes incompressible. Several experiments have reported that dissipationless transport can be achieved even at weak, non-quantizing magnetic fields when the electrons absorb photons at specific energies related to their cyclotron frequency. Here we perform compressibility measurements on electrons on liquid helium demonstrating the formation of an incompressible electronic state under these resonant excitation conditions. This new state provides a striking example of irradiation-induced self-organization in a quantum system.

Jeudi21 janvier 2016, 14h00, Salle 4.13

Stefano NEGRO
(LPT ENS Paris)

The fermionic basis in sin(h)-Gordon model.

Recently a powerful approach to the computation of one-point functions in the quantum XXZ spin 1/2 chain has been proposed by Boos, Jimbo, Miwa and Smirnov; this framework relies on the existence of a particular basis in the state space of the theory: the fermionic basis. I will present the construction of these fermions for the scaling limit of inhomogeneous XXZ spin 1/2 chain, the sine-Gordon model, and for its twin, the sinh-Gordon model. If time allows it, I will briefly present a possible interpretation of the fermionic basis and one-point functions in terms of the action of a modified version of the sinh-Gordon model.

CALENDRIER 2015

Jeudi10 décembre 2015, 14h00, Salle 4.13

Nikolai KITANINE
(Institut de Mathématiques de Bourgogne, Dijon)

Spin chains with generic boundaries, separation of variables and scalar products.

In this talk I'll consider the XXZ spin chain with the most general boundary terms. It will be shown that the separation of variables method permits to construct the complete set of eigenstates and to describe the spectrum in terms of the solutions of the inhomogeneous version of the Baxter T-Q equation. In the constrained case this equation reduces to the usual homogeneous T-Q equation. Finally I'll discuss the ways to compute the correlation functions, overlaps and the form factors for the models solvable by the separation of variables technique using a simpler example of the anti-periodic spin chains.

Jeudi26 novembre 2015, 14h00, Salle 4.13

Andreas LAUCHLI
(I.T.P. Universität Innsbruck, Autriche)

Entanglement Spectroscopy of Quantum Matter.

The entanglement spectrum, i.e. the logarithm of the eigenvalues of reduced density matrices of quantum many body wave functions, has been the focus of a rapidly expanding research endeavor recently. Initially introduced by Li & Haldane in the context of the fractional quantum Hall effect, its usefulness has been shown to extend to many more fields, such as topological insulators, fractional Chern insulators, spin liquids, continuous symmetry breaking states, etc. > After a general introduction to the field we review some of our own contributions to the field, in particular the perturbative structure of the entanglement spectrum in gapped phases, the entanglement spectrum across the Mott-insulator transition in the Bose-Hubbard model, and the relation of the entanglement spectrum of (1+1) dimensional quantum critical systems to the operator content of their underlying CFT.

Jeudi19 novembre 2015, 14h00, Salle 4.13

Alexei TSVELIK
(CMPMS Department, Brookhaven National Laboratory, Upton, NY)

Kondo chain model: the transport and everything else.

We study a model of Kondo chain with anisotropic exchange interaction in the regime where the RKKY exchange dominates over the Kondo screening. Depending on the anisotropy the model has two phases one of which has broken helicity symmetry. The influence of disorder on low energy excitations is dramatically different in different phases. The phase with broken helicity has a long localization length.

Jeudi5 novembre 2015, 14h00, Salle 4.13

David PAPOULAR
(LPTM, Cergy)

Quantized conductance with bosonic atoms.

We analyze theoretically the quantization of conductance occurring with cold atoms trapped in two reservoirs connected by a constriction within which an attractive gate potential is added. We show that the Bose statistics strongly enhances the effect compared to fermions. We focus on temperatures slightly above the condensation threshold in the reservoirs, which contain a thermal gas. The Bose statistics leads to conductance plateaux whose large values depend on the thermodynamics of the gas in the reservoirs. We highlight the key role of weak repulsive interactions between the bosons in preventing them from collapsing into the constriction. We also point out the differences in the thermoelectric effects occurring with bosons and fermions in the quantized conductance regime.

Jeudi15 octobre 2015, 14h00, Salle 4.13

Antoine TILLOY
(LPT, ENS Paris)

Quantum jumps from continuous quantum trajectories.

When a quantum system is subjected to a continuous measurement, its evolution becomes stochastic and in a proper limit, it can be described by a continuous equation with Gaussian noise. On the other hand, it is known since Bohr that a quantum system subjected to successive von Neumann measurements undergoes rare quantum jumps. The objective of this talk is to show how this simple jumpy behavior can be obtained as a limit of the finer continuous picture. Starting from repeated interaction schemes, my first objective will be to introduce smoothly the formalism of quantum trajectories to explain what a continuous measurement even means in a quantum context. Then I will show, numerically, heuristically and perhaps even analytically that when the measurement rate increases, the evolution of a continuously monitored quantum system becomes "jumpy". I will show how the jump rates can be computed from the system parameters in the general case and I will finally demonstrate on an example that the continuous picture is much finer than what the naive quantum jump limit would suggest even in the infinitely strong measurement limit.

Jeudi 8 octobre 2015, 14h00, Salle 4.13

Antal JEVICKI
(Brown University Physics Department, USA)

Duality and construction of higher spin gravity.

An overview of Higher Spin Gravity will be given with emphasis on its Duality with critical Large N Quantum Field Theories. The basis of this Duality will be explained through a first quantized spinning particle representation.

Jeudi 24septembre 2015, 14h00, Salle 4.13

Salvatore MANMANA
(Institut für Theoretische Physik Universität Göttingen, Allemagne)

Mott Quantum Criticality in the Anisotropic 2D Hubbard Model.

We present evidence for Mott quantum criticality in an anisotropic two-dimensional system of coupled Hubbard chains at half filling. In this scenario emerging from variational cluster approximation and cluster dynamical field theory, the interchain hopping acts as control parameter driving the second-order critical endpoint of the metal-insulator transition down to zero. Below the volume of hole and electron Fermi pockets of a compensated metal vanishes continuously at the Mott transition. Above this value, the volume reduction of the pockets is cut by a first-order transition. We discuss the relevance of our findings to a putative quantum critical point in layered organic conductors whose location remains elusive so far.

Jeudi 17 septembre 2015, 14h00, Salle 4.13

Herbert FRIED
(Brown University, Providence RI, USA)

A sequential description of the birth and death of a universe.

Beginning with a new QED/QFT-based model of Dark Energy, an extension to encompass Inflation provides an immediate candidate for Dark Matter. A few moments' further thought suggests a simple model for the Why and the How of the Big Bang, and the subsequent Birth of a New, and Death of the Old Universe.

Lundi 29 juin 2015, 14h00, Salle 4.13

Jérôme DUBAIL
(GPS/IJL, Université de Lorraine)

Quantum quenches and the arctic circle.

We analyze a one-dimensional system of particles evolving from a domain-wall initial state. This 'quantum quench' problem is well-known in real-time; here we analyze in imaginary time. The main interest of this model is that it exhibits the 'arctic-circle phenomenon' originally discovered in dimer models by [Propp, Jokusch, Shor], namely a spatial phase separation between a critically fluctuating region and a frozen region. Large-scale correlations inside the critical region are expressed in terms of correlators in a (euclidean) massless Dirac theory. It is observed that this theory is inhomogenous: the metric is position-dependent, so it is in fact a Dirac theory in curved two-dimensional space. The technique used to solve the toy-model can be extended to deal with the transfer matrices of other models: dimers on the honeycomb lattice, on the square lattice, and the six-vertex model at the free fermion point ($\Delta=0$). In all cases, explicit expressions are given for the long-range correlations in the critical region, and for the underlying Dirac action.

Jeudi 18 juin 2015, 11h00, Salle 4.13

Rodrigo ALVES PIMENTA
(UFSCAR CCET , Sao Carlos, Brésil)

Modified algebraic Bethe Ansatz for the XXX Heisenberg chain on the segment.

The exact solution of the isotropic spin$-\frac{1}{2}$ Heisenberg chain on the segment is revisited. By means of the modified algebraic Bethe ansatz approach, the Bethe vector and its dual are constructed in different settings, corresponding to distinct forms of similar-transformed reflection matrices.

Jeudi 4 juin 2015, 14h45, Salle 4.13

Sahbi EL HOG
(LPTM Cergy - Séminaire Doctorant)

Blume-Emery-Griffiths Model In Thin Films of Stacked Triangular Lattices.

We study in this paper the Blume-Emery-Griffiths model in a thin film of stacked triangular lattices. The model is described by three parameters: bilinear exchange interaction between spins J, quadratic exchange interaction K and single-ion anisotropy D. The spin Si at the lattice site i takes three values (−1, 0, +1). This model can describe the mixing phase of He-3 (Si = +1, −1) and He-4 (Si = 0) at low temperatures. Using Monte Carlo simulations, we show that there exists a critical value of D below (above) which the transition is of second-(first-)order. In general, the temperature dependence of the concentrations of He-3 is different from layer by layer. At a finite temperature in the superfluid phase, the film surface shows a deficit of He-3 with respect to interior layers. However, effects of surface interaction parameters can reverse this situation. Effects of the film thickness on physical properties will be also shown as functions of temperature.

Jeudi 4 juin 2015, 14h00, Salle 4.13

Igor SWIECICKI
(LPTM Cergy - Séminaire Doctorant)

"Phase diagram" of a mean field game.

Mean field games were introduced by J-M.Lasry and P-L. Lions in the mathematical community, and independently by M. Huang and co-workers in the engineering community, to deal with optimization problems when the number of agents becomes very large. In this article we study in detail a particular example called the 'seminar problem' introduced by O.Guéant, J-M Lasry, and P-L. Lions in 2010. This model contains the main ingredients of any mean field game but has the particular feature that all agent are coupled only through a simple random event (the seminar starting time) that they all contribute to form. In the mean field limit, this event becomes deterministic and its value can be fixed through a self consistent procedure. This allows for a rather thorough understanding of the solutions of the problem, through both exact results and a detailed analysis of various limiting regimes. For a sensible class of initial configurations, distinct behaviors can be associated to different domains in the parameter space. For this reason, the 'seminar problem' appears to be an interesting toy model on which both intuition and technical approaches can be tested as a preliminary study toward more complex mean field game models.

Lundi 1er juin 2015, 14h00, Salle 4.13

Michio JIMBO
(Rikkyo University, Ikebukuro, Tokyo, Japon)

Toroidal gl(1) Algebra and Bethe Ansatz.

Since the seminal work of Bazhanov, Lukyanov and Zamolodchikov, diagonalization of integrals of motion has been an important issue in conformal field theory. Feigin,Kojima,Shiraishi and Watanabe introduced a commutative family of operators for the q-deformed Virasoro algebra. It turns out that their first Hamiltonian (and most likely all others) is derived from the transfer matrix acting on Fock representations of the toroidal gl(1) algebra. Making use of the shuffle algebra realization, we show that its spectrum is described by a Bethe-type equation. This is a joint work with B.Feigin, T.Miwa and E.Mukhin.

Jeudi 28 mai 2015, 14h00, Salle 4.13

Pascal BASEILHAC
(LMPT, Université de Tours)

Formulation q-hypergéométrique pour la classe de systèmes intégrables associées à l'algèbre q-Onsager.

Par analogie avec l'exemple élémentaire de l'oscillateur harmonique, des modèles intégrables de la classe Calogero-Sutherland-Moser, ou encore la chaîne de Toda ouverte pour lesquels une formulation (q-)hypergéométrique des fonctions propres (en termes des polynômes d'Hermite à une variable, Macdonald-Koornwinder multivariables ou cas limites type (q-)Whittaker ou Hall-Littlewood) est connue, je montrerai que la famille bispectrale des polynômes multivariables orthogonaux de Gasper-Rahman (généralisant ceux d'Askey-Wilson) offrent une base q-hypergéométrique permettant de construire les fonctions propres du Hamiltonien de la classe des modèles intégrables générés par l'algèbre q-Onsager (ex: Ising, chiral Potts superintegrable, XY, chaîne XXZ ouverte avec bords génériques,...). Dans une première partie, la structure des polynômes de Gasper-Rahman et leurs propriétés (orthogonalité, bispectralité) seront rappelées. Dans une seconde partie, la construction systématique de modules de dimension infinie et finie de l'algèbre q-Onsager en termes de ces polynômes sera décrite. Dans une troisième partie, l'action de la sous-algèbre Abélienne (génératrice des quantitiés conservées) dans la base polynomiale sera considérée. En particulier, les conditions d'existence de sous-espaces invariants seront identifiées. Les conséquences et perspectives pour les modèles intégrables précités seront brièvement décrites. Travail en collaboration avec X. Martin (LMPT Tours).

Jeudi 16 avril 2015, 14h00, Salle 4.13

Alexander C. TIEGEL
(Institute for Theoretical Physics, University of Göttingen, Germany)

Spectral functions of one-dimensional quantum magnets.

We present numerical results for experimentally relevant spectral functions of one-dimensional strongly correlated quantum systems at both zero and finite temperature. As an example, we study the the electron spin resonance (ESR) intensity of spin-1/2 XXZ Heisenberg chains with Dzyaloshinskii-Moriya interactions in magnetic fields. The spectral functions are computed directly in the frequency domain via a Chebyshev expansion of the Green's function in a density-matrix renormalization group (DMRG) framework using matrix product states (MPS). At finite temperature, the method is based on a purification of the density operator by exploiting a Liouville space formulation of the dynamics. Our results are discussed in the context of experimentally observed bound states and their field-theoretical descriptions.

Jeudi 22 janvier 2015, 14h00, Salle 4.13

Françoise CORNU
(LPTHE Orsay)

First passage fluctuation relations ruled by cycles affinities.

For a non-equilibrium stationary state described by stochastic thermodynamics it is well-known that the entropy production rate can be expressed in terms of the affinity associated with every transition bond in the graph representation of the master equation. We exhibit the invariance of cycle affinities in finite state Markov processes under various natural probabilistic constructions : for instance under conditioning and under a new combinatorial construction that we call ``drag and drop''. We also show that cycle affinities have a natural probabilistic meaning related to first passage fluctuation relations. Indeed, for semi-Markovian processes whose corresponding graph is made of a single cycle, we establish that the cycle current obeys a fluctuation relation for first passage times at integer winding numbers, which is dual to the fluctuation relation for the cycle current at fixed time : contrarily to seminal fluctuation relations about the probability for measuring a cumulative current during a given time, the latter fluctuation relations deal with the probability for the time needed for one cycle to be performed in one sense or in the opposite one.

Mardi 20 janvier 2015, 14h00, Salle 4.13

Stanislao GUALDI
(Ecole Centrale Paris - Laboratoire MAS)

Tipping points and monetary policy in a stylized macroeconomic agent-based model.

Traditional approaches in economics rely on the assumption that economic agents are identical, non-interacting and rational. Within this framework, economic instabilities would require large exogenous shocks, when in fact small local shocks can trigger large systemic effects when heterogeneities and interactions are taken into account. The need to include these effects motivate the development of agent-based models (ABMs), which are extremely versatile and allow to take into account more realistic behavioural rules. In this talk we introduce a simple ABM, explore the possible types of phenomena that it can reproduce and propose a methodology that characterizes a model through its “phase diagram”. We then generalize the model with the aim of investigating the role and efficacy of the monetary policy of a ‘Central Bank’. We show that the existence of different equilibrium states of the economy can cause the monetary policy itself to trigger instabilities and be counter-productive.

Jeudi 15 janvier 2015, 14h00, Salle 4.13

Jérémie BOUTTIER
(IPhT, CEA Saclay)

Distances dans les cartes planaires aléatoires et intégrabilité discrète.

Les propriétés métriques des cartes (graphes plongés dans des surfaces) aléatoires ont été beaucoup étudiées ces dernières années. Dans cet exposé, je présenterai une approche combinatoire à ces questions, exploitant des bijections entre les cartes et certains arbres étiquetés. Grâce à un phénomène inattendu d'«intégrabilité discrète», il est possible de compter exactement les cartes ayant deux ou trois points marqués à distances prescrites, et plus encore. Je parlerai ensuite des applications probabilistes à l'étude de la carte brownienne (obtenue comme limite d'échelle des cartes planaires aléatoires) et des cartes planaires uniformes infinies (obtenues comme limites locales). Si le temps le permet, j'expliquerai également l'origine combinatoire de l'intégrabilité discrète, liée au développement en fraction continue de la «résolvante» du modèle à une matrice. L'exposé repose sur des travaux en communs avec E. Guitter et P. Di Francesco.

Jeudi 8 janvier 2015, 14h00, Salle 4.13

Leticia CUGLIANDOLO
(LPTHE Jussieu)

Markov stochastic processes with multiplicative white noise:
formalism and applications to the dynamics of a magnetic moment.

I will discuss several subtle aspects of Markov Langevin equations with multiplicative white noise, putting special emphasis on the celebrated Landau-Lifshitz-Gilbert-Brown equation for the dynamics of a magnetic moment. I will derive equilibrium and out of equilibrium fluctuation theorems from the generating functional formalism. The numerical integration of these equations also needs special care. I will present an algorithm that deals with all subtleties in a rather simple way and I present results for a simple physical situation that justifies its correctness.

CALENDRIER 2014

Vendredi 12 décembre 2014, 13h30, Salle 4.13

Alexei TSVELIK
(Condensed Matter Theory Group, Brookhaven National Laboratoty, Upton, NY, USA)

Topological Kondo effect.

Jeudi 27 novembre 2014, 14h00, Salle 4.13

David J. PAPOULAR
(INO–CNR BEC Center and Dipartimento di Fisica, Universita di Trento, Italy)

Transport of Bose Gases Through Constrictions: Cooling by Heating and Fast Thermalisation.

The transport of an ultracold gas through a constriction connecting two reservoirs presents pluridisciplinary issues related to mesoscopic physics, disorder, and superfluidity. This geom- etry holds promises for the realization of a superleak for superfluid gases. First, assuming that a superleak is available, I shall describe a novel adiabatic cooling mechanism [1] which is related to the fountain effect of liquid helium. Second, I shall analyze theoretically the transport of a uniform weakly–interacting Bose gas through a constriction [2]. The transport of the superfluid part is assumed to be hydrodynamic, and the ballistic transport of the nor- mal part is described using the Landauer–Buttiker formalism. I shall show that Helmholtz (plasma) oscillations can be observed at finite temperatures below Tc. Furthermore, because of its strong compressibility, the Bose gas is characterized by a fast thermalisation compared to the damping time for plasma oscillations, accompanied by a fast transfer of the normal component. I shall also outline the possible realization of a superleak through the inclusion of a disordered potential.

Jeudi 6 novembre 2014, 14h00, Salle 4.13

Jean-Guy CAPUTO
(DGM, INSA Rouen)

Nonlinear waves in networks: model reduction for the sine-Gordon equation.

The propagation of localized waves in nonlinear networks is an ubiquitous problem. Examples are fluxon motion in arrays of Josephson junctions, pulse propagation in the circulatory system.. Modeling such problems is difficult and it is helpful to simplify the equation and the geometry. We will illustrate these issues with the analysis of the propagation of sine-Gordon waves through Y junctions.

Lundi 22 septembre 2014, 11h30, Salle 4.13

Thierry GIAMARCHI
(DPMC, Université de Genève)

Quantum magnets as quantum simulators.

The ability to control the properties of magnetic insulators by magnetic fields large enough to fully polarize the system has opened a host of possibilities. In addition to the intrinsic interest of such questions for magnetic systems, is has been shown that such systems could be efficiently used as quantum simulators to emulate problems pertaining to itinerant fermionic or bosonic systems. The magnetic field can then be viewed as similar to a gate voltage controlling the number of ``particles'' allowing an unprecedented level of control. In parallel with the experimental developments, progress on the theoretical front both on the numerical and the analytical side, have allowed a remarkable level of accuracy in obtaining the physical properties and in particular the correlation functions of these systems. A comparison between theoretical predictions without adjustable parameters or fudging with results from NMR, Neutrons or other probes such as ESR is thus now possible. This has allowed for example to test \emph{quantitatively} the physics of Tomonaga-Luttinger liquids and also to tackle the effects of the interactions between spinons by comparing the physics of weak rung ladders with the one of strong rung ones. I will review the recent results obtained in this domain with the different experimental compounds and will discuss the open questions and challenges. This concerns in particular the issues of finite temperatures, higher dimensional systems and effects of disorder.

Mardi 24 juin 2014, 14h00, Salle 4.13

Anastasia DOIKOU
(Heriot-Watt University, Edinburgh, Scotland)

Algebraic formulation of classical & quantum integrable defects.

A systematic approach to classical integrable defects is proposed, based on an underlying Poisson algebraic structure. Local integrals of motions are constructed as well as the time components of the corresponding Lax pairs for the sine-Gordon model. Continuity conditions imposed upon the time components of the Lax pair to all orders give rise to sewing conditions, which turn out to be compatible with the hierarchy of charges in involution. At the quantum level, using the Bethe ansatz methodology, we extract the transmission matrices for the XXZ model for two distinct types of defects. These describe the interaction between the particle-like excitations displayed by the model and the spin impurity. In the attractive regime of the XXZ model, we also derive the breather's transmission amplitude.

Lundi 19 mai 2014, 14h00, Salle 4.13

Benjamin DOYON
(King's College, London)

Entropie d'intrication dans les systèmes étendus.

Je donnerai une revue des résultats principaux sur le sujet de l'entropie d'intrication dans les systèmes étendus en une dimension d'espace. En particulier, je discuterai de ceux que j'ai obtenus avec mes collaborateurs J. Cardy et surtout O. A. Castro Alvaredo: dans les théories des champs quantiques en une dimension, et dans les situations générales avec brisure de symétrie continue. J'expliquerai le concept de "branch-point twist field" que nous avons introduit en théorie des champs et dans les chaînes de spin pour calculer l'entropie d'intrication. Si le temps le permet, j'expliquerai nos résultats récents qui généralisent toutes les formules d'intrication critique connues jusqu'ici aux théories conformes non-unitaires.

Mardi 15avril 2014, 14h00, Salle 4.13

Herbert M. FRIED
(Brown University Physics Department)

Inflation as the Precursor of Dark Energy.

Beginning with a new, QED-based Model of Dark Energy, it is possible to encompass Inflation within the same Model if one makes the unusual assumption that, for every electrically- charged lepton and quark pair fluctuating in the Quantum Vacuum, there is a massive, electrically-charged, fermionic tachyon and anti-tachyon pair fluctuating in the QV. (This assumption, while perhaps distasteful, cannot be negated by any experimental test.) Then one finds immediate agreement between cosmological requirements of times and energy densities at the beginning and end of Inflation. And one also obtains an automatic explanation of Dark Matter, since a charged, fermionic, tachyon of very high energy is a perfect candidate for a dark-matter particle. Finally, considerations of what can happen upon the very rare event of a very high energy T-Tbar annihilation, provide a possible understanding of the Why and the How of the Big Bang, leading to the Birth of a New Universe, and to the probable Death of the Old Universe.

Mardi 15avril 2014, 14h00, Salle 4.13

Adrian TANASA
(LIPN, Paris XIII Villetaneuse)

Combinatorics and geometry for random tensor models.

Random tensor models, seen as field theoretical models, represent a natural generalization of the celebrated 2-dimensional matrix models. These matrix models are known to be connected to 2-dimensional quantum gravity, and one of the main results of their study is that their perturbative series can be reorganized in powers of 1/N (N being the matrix size). The leading order in this expansion is given by planar graphs (which are dual to triangulations of the 2-dimensional sphere S^2).

Jeudi 10 avril 2014, 14h00, Salle 4.13

Andreas HONECKER
(ITP Universität Göttingen, RFA)

Dynamique des chaînes quantiques à température finie.

Nous discutons les propriétés dynamiques des chaînes de spins quantiques à température finie. Du point de vue des expériences, p. ex. les analyses de diffusion inélastique des neutrons des systèmes quantiques de basse dimensionnalité nécessitent une interprétation de l'évolution thermique des intensités de la diffusion. Du point de vue de la théorie, on sait peu sur la dépendance en température de la dispersion d'une particule dans de tels systèmes et encore moins concernant la dynamique de N particules à température finie. Le calcul de la dynamique à température finie reste toujours un défi. Nous faisons un résumé des méthodes numériques modernes, y compris la diagonalisation exacte, le développement de moment, l'évolution en temps réel dans le contexte du « density-matrix renormalization group », et notamment des récents progrès sur la réalisation de ces calculs directement dans l'espace des fréquences en utilisant une formulation en espace Liouville de la dynamique à température finie. Comme une première application, nous discutons le cas de chaînes de spins quantiques. Nous présentons ici des résultats concernant la fusion de l'état fondamental et les formes des lignes thermales. En second lieu, nous discutons l'exemple d'une échelle de spin très frustrée. Dans ce cas - et également dans une certaine mesure dans les chaînes de spin simples – des caractéristiques spectrales des excitations persistent à température étonnamment élevée et même infini.

Mardi 8avril 2014, 14h00, Salle 4.13

Sofyan IBLISDIR
(ICCUB, Universidad Barcelona, Espagne)

Markov chains for tensor network states.

Markov chains for probability distributions related to matrix product states and 1-dimensional quantum Hamiltonians are introduced. With appropriate 'inverse temperature' schedules, these chains can be combined into a random approximation scheme for ground states of such Hamiltonians. Numerical experiments suggest that a linear, i.e. fast, schedule is possible in non-trivial cases. A natural extension of these chains to 2-dimensional quantum Hamiltonians is next presented and tested. This extension is stable by construction and the obtained results compare well with euclidean evolution. The proposed Markov chains are inherently sign problem free (even for fermionic degrees of freedom), and the random approximation scheme can be tailored to escape local minima.

Vendredi 4avril 2014, 14h00, Salle 4.13

Patrick NAVEZ
(Fakultãt fũr Physik, Universitãt Duisburg Essen, RFA)

Large coordination number expansion for quantum lattice systems.

Quantum lattice systems are encountered in many field of physics: solid states, ultracold gas and photonic band gap materials. We establish a set of hierarchy equations describing the time evolution of the N-points spatial correlation reduced density matrix for such systems and apply it specifically to Bose and Fermi Hubbard gases or spin Heisenberg magnets. This set of equations is solved through a 1/Z expansion where Z is the coordination number i.e. number of interaction of a site with its nearest neighbors [1,2]. For a large class of quantum systems, we show how the generic leading order equation for the one-site reduced density matrix allows to derive linearized equation of motion for quasi-particle excitation operators whose solutions reproduce correctly the spectra found in the literature. In the next order in 1/Z, using the variable separation technique for the two-sites reduced correlated density matrix, we find that these excitations can be virtually produced in pairs in order to generate quantum fluctuations. We illustrate the powerfulness of these general concepts for several cases such as virtual particle-hole pairs in the Hubbard models that lower the ground state energy in the Mott phase or two virtual magnons of opposite spins in Heisenberg models that tend to reduce antiferromagnetism [3].

Jeudi 3 avril 2014, 14h00, Salle 4.13

Christophe OGUEY
(LPTM, Université de Cergy-Pontoise)

Topological moves in foams and liquid crystalline mesophases.

Topological movements are inherent to structured fluids when the structure undergoes large deformations, when it flows. These movements are dissipative and responsible for the special, non-Newtonian, rheology of complex fluids. In the first part, we'll study the time evolution of T1 flips in soap froths. Occasionally, when bubbles switch neighbours, the non-equilibrium configuration relaxes on several times scales. The process involves mechanical flow and surfactant concentration variations, coupled by the Marangoni effect. In the second part, we'll explore the types of elementary topological transformations that a 3-arm mikto copolymer mesophase can undergo. These star copolymers have three mutually immiscible branches. They self-assemble in a rich variety of ways which can be described as 3-coloured space partitions.

Jeudi 20 mars 2014, 14h00, Salle 4.13

Andrew FEFFERMAN
(LPS, ENS)

Dislocation Dynamics in Helium Crystals.

The microscopic mechanisms responsible for mechanical dissipation peaks in metals are controversial. We studied the shear modulus and dissipation of 4He crystals because their extreme purity simplifies the interpretation of their mechanical response. We found that dislocation motion in solid helium causes very unusual behavior, including an 80% decrease in the shear modulus with no stress threshold or yield point. This behavior occurs because the only impurities in 4He crystals are 3He atoms, and they are mobile even at zero temperature because they move by quantum tunneling. Because our dilution refrigerator has windows, we were able to make video recordings of the growth of each crystal and determine its orientation, allowing us to study the anisotropy of its shear modulus. By measuring the shear modulus and dissipation of our crystals as a function of temperature, drive frequency, drive amplitude and 3He impurity concentration, we showed that there are distinct regimes in which the dislocations interact with 3He impurities or thermal phonons in different ways.

Jeudi 20 mars 2014, 11h15, Salle 4.13

Luca TAGLIACOZZO
(ICFO – The Institute of Photonic Sciences, Castelldefels (Ba), Espagne)

Physics of the 1D long range Ising model in a transverse field.

Long range interacting systems can show different behaviour from their short range versions. Recent experiments with trapped ions have started to investigate them Among them the simplest is the long range Ising model in a transverse field in 1D. The ground state and low energy excitations will be discussed with special focus on the complexity of the ground state wave function in terms of entanglement and more traditional spin correlation functions [1]. We will also illustrate that, out of equilibrium, long range interacting systems could display violations of causality when the long range interactions decay sufficiently slow with the distance [2]. These predictions have been confirmed by recent experiments with trapped ions [3,4].

Lundi 17 mars 2014, 14h00, Salle 4.13

Nicolas PAVLOFF
(LPTMS, Orsay)

Trous noirs soniques et rayonnement de Hawking dans les condensats de Bose-Einstein.

L'analogue d'un trou noir peut être réalisé par l'écoulement d'un liquide dans un tuyau: si le flot est super-sonique dans une région de l'espace, une onde sonore émise dans cette région ne pourra plus remonter le courant. On parle de "trou muet". En 1981 B. Unruh a suggéré que les trous muets doivent permettre d'observer le rayonnement des trous noir qui est un effet quantique prévu par S. Hawking dans les années 70. Cette idée a récemment connu un regain d'intérêt dans le domaine de la condensation de Bose-Einstein. Une première raison en est la précision du contrôle expérimental qu'on peut obtenir sur ces systèmes (je présenterai des expériences en cours). Il y a également une motivation théorique que je discuterai en détail: il a été montré récemment que l'étude des corrélations de densité permet d'identifier le rayonnement de Hawking. Je présenterai certains des analogues de trous noirs gravitationnels (vagues en eau peu profonde, ondes lumineuses dans un milieu non-linéaire), puis je proposerai des configurations réalistes permettant d'observer le rayonnement de Hawking dans des condensats de Bose-Einstein atomiques et polaritoniques.

Vendredi 14 mars 2014, 15h00, Salle 4.13

Xavier LEYRONAS
(LPS, ENS)

Equation of state for ultracold fermions.

The field of ultracold fermions has been rapidly growing in the last ten years. In these systems, atomic fermionic isotopes can be in two internal states ("spin one half fermions"), like electrons in solids. The physics of ultracold fermions is particularly rich, since one can experimentally tune the strength of the interaction, or "polarize" the system. After a general introduction, including the presentation of the BEC-BCS crossover, I will present my work on the calculation of the equation of state in different situations. These calculations will be compared to accurate measurements on ultracold Li6 gases performed at ENS and MIT.

Mardi 11 mars 2014, 14h00, Salle 4.13

Christophe TEXIER
(LPTMS, Orsay)

Wigner time delay distribution in chaotic cavities and freezing transition.

The Wigner time delay is a useful concept capturing temporal aspects of a scattering process. It is also of great interest because it provides a measure of the density of states in the scattering region. In particular it was shown to be a central concept for describing charging effects in mesoscopic conductors (mesoscopic capacitance, charge relaxation resistance, etc). We analyse the statistical properties of the Wigner time delay in chaotic cavities within a random matrix theory approach. Using the joint distribution for proper time delays (eigenvalues of the WignerSmith timedelay matrix) derived by Brouwer, Frahm & Beenakker [Phys. Rev. Lett. 78, 4737 (1997)], we obtain, in the limit of large number of conducting channels, the large deviation function for the distribution of the Wigner timedelay (the sum of proper times) by a Coulomb gas method. The distribution is shown to present a rich structure. In particular, we show that the existence of a power law tail originates from narrow resonance contributions, related to a (second order) freezing transition in the Coulomb gas.

Jeudi 6 mars 2014, 11h00, Salle 4.13

Denis ULLMO
(LPTMS, Orsay)

Effet Kondo dans les boites quantiques: fluctuations mésoscopiques et effets de taille finie.

L'effet Kondo décrit les conséquences du couplage entre le degré de liberté de spin d'une impureté et les électrons de conduction d'un métal ou d'un semi-conducteur. Il y a eu un regain d'intérêt pour ce problème classique de la physique du solide en relation avec les boites quantiques, et plus généralement dans le contexte de la physique mésoscopique. Une raison pour cela est que les boites quantiques peuvent être fabriquées de manière à jouer le rôle d'atomes artificiels, et en particulier d'impuretés magnétiques très versatiles dont les paramètres peuvent être choisis et modifiés à volonté. En plus de cet aspect, l'effet Kondo dans ce contexte pose des questions nouvelles associées aux effets de taille finie, soit à l'échelle de l'énergie de Thouless (fluctuations mésoscopiques), soit à l'échelle de l'espacement moyen entre niveaux d'énergie. Dans cet exposé, après une brève revue du rôle de l'effet Kondo dans la physique des boites quantiques, j'aborderais plus en détails les questions associées au confinement du gaz d'électron.

Jeudi 20 février 2014, 14h00, Salle 4.13

Amaury MOUCHET
(LMPT, Université de Tours)

Progrès récents sur l'effet tunnel résonnant.

Après avoir présenté le contexte, les problématiques et les enjeux de l'étude de l'effet tunnel en présence de résonances classiques, je présenterai quelques idées-clef, introduites ces dernières années, qui ont permis d'obtenir des résultats suffisamment significatifs pour faire progresser notablement notre compréhension de l'effet tunnel dans les systèmes complexes.

Jeudi 13 février 2014, 14h00, Salle 4.13

Jean-Philippe KOWNACKI
(LPTM, Université de Cergy-Pontoise)

Transitions de phase dans les membranes polymérisées fantômes et renormalisation non perturbative.

Les surfaces aléatoires sont des objets physiques bidimensionnels dont la géométrie fluctue. Parmi ceux-ci, les membranes polymérisées, dont l'intérêt a été ravivé récemment pour leur lien avec le graphène, ont une structure interne fixe dûe aux forces entre les molécules qui les composent. L'élasticité qui en résulte donne lieu à l'existence d'une phase haute température froissée et d'une phase basse température plate. Les membranes sont dites fantômes si l'encombrement stérique n'est pas pris en compte. Dans cet exposé, on passera d'abord rapidement en revue les principaux résultats obtenus ces dernières décennies concernant la phase plate et la transition de froissement des membranes polymérisées fantômes. Puis, on présentera plus en détail l'approche récente de ces problèmes par le groupe de renormalisation non pertubative. On développera en particulier des résultats très récents qui suggèrent fortement que la transition de froissement est du premier ordre.

Jeudi 23 janvier 2014, 14h00, Salle 4.13

Mirta GORDON
(IMAG Grenoble, France)

Entanglement between Demand and Supply in Markets with Bandwagon Goods.

Whenever customers' choices (e.g. to buy or not a given good) depend on others choices (cases coined 'positive externalities' or 'bandwagon effect' in the economic literature), the demand may be multiply valued: for a same posted price, there is either a small number of buyers, or a large one -- in which case one says that the customers coordinate. This leads to a dilemma for the seller: should he sell at a high price, targeting a small number of buyers, or at low price targeting a large number of buyers? In this paper we show that the interaction between demand and supply is even more complex than expected, leading to what we call the curse of coordination: the pricing strategy for the seller which aimed at maximizing his profit corresponds to posting a price which, not only assumes that the customers will coordinate, but also lies very near the critical price value at which such high demand no more exists. This is obtained by the detailed mathematical analysis of a particular model formally related to the Random Field Ising Model and to a model introduced in social sciences by T C Schelling in the 70's.

Jeudi 16 janvier 2014, 14h00, Salle 4.13

Satya MAJUMDAR
(LPTMS, Université Paris Sud Orsay, France)

Top Eigenvalue of a Random Matrix: Large Deviations.

The statistical properties of the largest eigenvalue of a random matrix are of interest in diverse fields such as in the stability of large ecosystems, in disordered systems, in statistical data analysis and even in string theory. In this talk I'll discuss some recent developments in the theory of extremely rare fluctuations (large deviations) of the largest eigenvalue using a Coulomb gas method. Such rare fluctuations have also been measured in recent experiments in coupled laser systems. I'll also discuss recent applications of this Coulomb gas method in three different problems: entanglement in a bipartite system, conductance fluctuation through a mesoscopic cavity and the vicious random walkers problem.

Vendredi 10 janvier 2014, 14h00, Salle 5.54

Jean-Marie STEPHAN
(Dept. of Physics, University of Virginia, Charlottesville VA, USA)

Entropy and Mutual information in low-dimensional classical and quantum critical systems.

In studies of new and exotic phases of quantum matter, the Renyi entanglement entropy has established itself as an important resource. For example it is universal at one-dimensional quantum critical points: the leading term can be used to extract the central charge c of the underlying conformal field theory, and thus identify the universality class. In this talk I will show how an analogous quantity defined for classical systems, the Renyi Mutual Information (RMI), can be used to access universality classes in 2d. In particular for a rectangle cut into two rectangles, the shape dependence of the RMI can be computed exactly and is proportional to c. This makes it possible to extract c from (transfer-matrix) Monte Carlo simulations. I will also discuss how this Mutual information is related to the entanglement entropy of certain resonating valence bond states in 2d, as well as other basis-dependent entropies in 1d quantum systems.

Jeudi 9 janvier 2014, 14h00, Salle 4.13

Adam RANCON
(James Franck Institute, University of Chicago, USA)

Universal thermodynamics of the superfluid to Mott insulator transition.

The superfluid--Mott-insulator transition of a Bose gas in an optical lattice, when it occurs at constant density, belongs to the universality class of the quantum XY model. We discuss the thermodynamics of the two-dimensional quantum O(N) model for $N\geq 2$ in the vicinity of its zero-temperature quantum critical point, and in particular the universal scaling function ${\cal F}_N$ which determines the pressure $P(T)$. We show that the large-N approach is unable to predict the (non-monotonuous) shape of ${\cal F}_N$ for $N\lesssim 10$, but ${\cal F}_N$ can be computed from a non-pertubative renormalization- group approach. Finally, we discuss the spectral function of the amplitude mode (equivalent to a Higgs mode in presence of a gauge field) close to the quantum critical point and how the well defined mode at small N disappears as N increase.