Workshop *"New Aspects of Localization"*
Toulouse, November 27-28 2017

Monday 27

- 10:00 **Tba**
  35'+5' questions
  Speaker: Bart van Tiggelen (LPMMC, Grenoble, France)

- 10:40 **Coffee break** *20'*

- 11:00 **Entanglement and correlations in a Many-Body Localizable system.**
  35'+5' questions
  Speaker: **Francesca Pietracaprina** (Sapienza, Università di Roma, Italy)
  Abstract: *I will discuss the details of the distribution of the entanglement spectrum of a disordered spin chain exhibiting a many-body localization (MBL) transition. From its analysis we extract a correlation length $L_s(h)$ determining the minimum system size to enter the asymptotic region. We find that $L_s(h)$ diverges at the MBL transition and we discuss the nature of the subleading corrections to the entanglement spectrum distribution and to the entanglement entropy.*

- 11:40 **Anderson (de-)localization on finite Cayley trees and on random regular graphs.**
  35'+5' questions
  Speaker: **Alexander Mirlin** (Karlsruhe Institute of Technology, Germany)
  Abstract: *I will discuss Anderson (de-) localization on two types of graphs: (i) finite Cayley trees, and (ii) random regular graphs (RRG), which have locally the structure of a tree but do not have boundary (and thus possess large-scale loops). We show that properties of these two models are crucially different. On a finite Cayley tree, wave function moments exhibit multifractal scaling with the "volume" (number of sites) N in the limit of large N. The multifractality spectrum depends on disorder strength and on the position of the lattice, as we show both analytically and numerically [PRB 94, 184203 (2016) and arXiv:1708.04978]. In contrast, in the delocalized phase on RRG, eigenfunctions are ergodic in the sense that their inverse participation ratio scales as $1/N$ and the spectral statistics is Wigner-Dyson in the large-N limit. This limit is reached via a finite-size crossover from small ($N \ll N_c$) to large ($N \ll N_c$) system, where N_c is the correlation volume diverging exponentially at the transition. A distinct feature of this crossover is a non-monotonicity of the spectral and wave-function statistics, which is related to properties of the critical phase in the RRG model [PRB 94, 220203 (2016)]. Our results for RRG support an earlier analytical predictions on ergodicity in the large-N limit and on the scaling of N_c. Finally, I will briefly discuss a connection between the delocalization on RRG and in many-body problems with power-law interaction [PRB 93, 245427 (2016) and in preparation].*

- 12:20 **Lunch break** *1h40'*

- 14:00 **Competition between localization and delocalization in a dirty quantum magnet.**
  35'+5' questions
  Speaker: **Maxime Dupont** (LPT, Toulouse, France)
  Abstract: *It is known that a class of quantum antiferromagnets displays a Bose-Einstein condensation (BEC) at high magnetic field, as experimentally observed in numerous Mott insulators. In this scope, I will first present the antiferromagnetic insulator compound $NiCl_2$-$4SC(NH_2)_2$ which exhibits BEC. Going beyond this clean case, doping with bromine impurities (randomly substituting Cl) was believed to provide the first experimental realization of the elusive Bose-glass phase in a quantum magnet [R. Yu et al. Nature 489, 379-384 (2012)] at high magnetic fields. I will review our recent experimental and theoretical works [1-4] in which we discovered that this many-body localized phase is actually undermined by the resurgence of long-range order with a delocalization of the underlying impurities degree of freedom, leading to a novel "order-by-disorder" mechanism.*
  [1] *A. Orlova et al. Phys. Rev. Lett. 118, 067203 (2017)*
  [2] *M. Dupont et al. Phys. Rev. Lett. 118, 067204 (2017)*
  [3] *M. Dupont et al. Phys. Rev. B 96, 024442 (2017)*
  [4] *A. Orlova et al. (manuscript in preparation).*

- 14:40 **Anderson localization of vector waves.**
  35'+5' questions
  Speaker: **Sergey E. Skipetrov** (LPMMC, Grenoble, France)
  Abstract: *We discuss the impact of the vector nature of waves (light, elastic waves) on the Anderson localization transition in three-dimensional disordered media. The finite-size scaling approach is applied to estimate the critical parameters of localization transitions for light scattering by two-level atoms in a strong external magnetic field and elastic wave scattering by point-like resonant scatterers.*

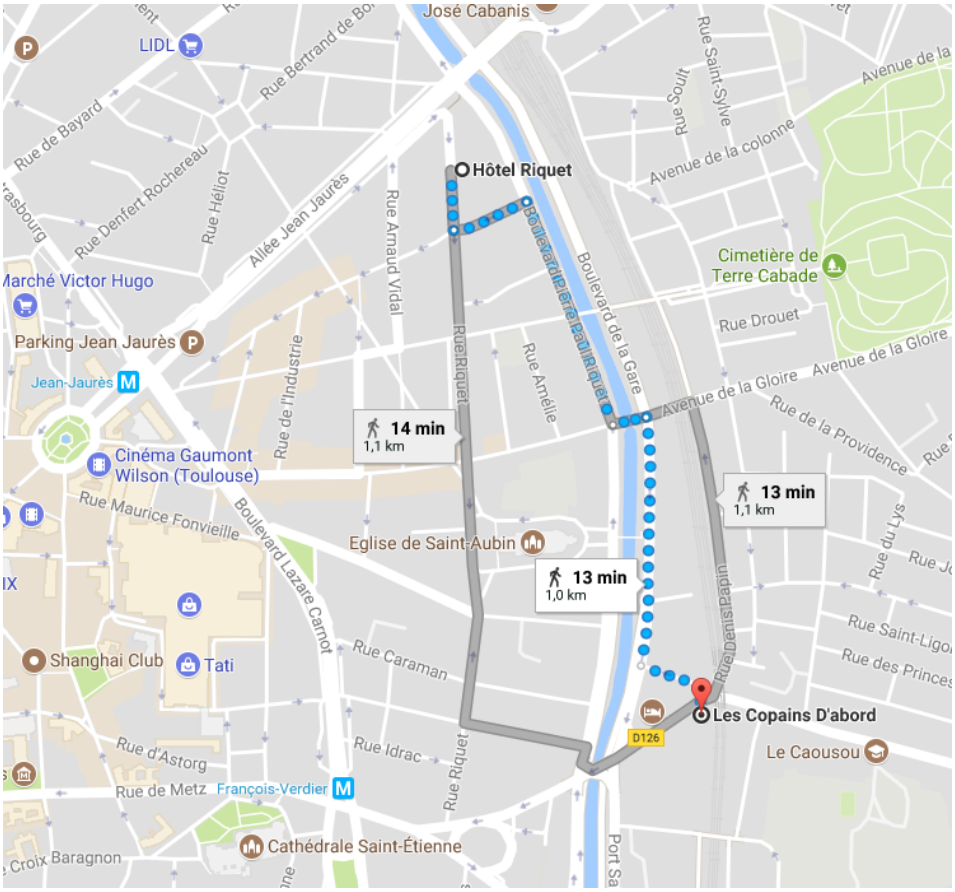
- 15:20 **Coffee break** *20'*

- 15:40 **Dynamical localization in interacting driven systems.**
  35'+5' questions
  Speaker: **David J. Luitz** (Technische Universität München, Germany)
  Abstract: *I will present recent results on interacting quantum systems in the presence of a periodic drive. While such interacting systems generically heat to a featureless state, in noninteracting systems a periodic drive which exerts a spatially uniform force on lattice systems can lead to frozen dynamics, a phenomenon known as dynamical localization. Our numerical results [SciPost Phys. 3, 029 (2017)] demonstrate, that dynamical localization is destroyed by the addition of generic interactions, leading to diffusive transport with a diffusion constant proportional to the interaction strength. Nevertheless, a fine tuned driving protocol can be constructed, which leaves dynamical localization intact for an interacting quantum system, leading to subharmonic or quasiperiodic revivals of the full many-body wavefunction with a tunable period of the revivals [arXiv:1710.11132]. I will finish by discussing the stability of such systems to the addition of static disorder.*

- 16:20 **Kolmogorov turbulence defeated by Anderson localization.**
  35'+5' questions
  Speaker: **D.L. Shepelyansky** (LPT, Toulouse, France)
  Abstract: *Anderson localization, Bose-Einstein condensate, dynamical thermalization, classical and quantum chaos, Fermi-Pasta-Ulam problem, Gross-Pitaevskii equation, Ketterle trap 1995, Kolmogorov-Arnold-Moser integrability, Kolmogorov turbulence, Sinai-oscillator trap (main keywords).*

- 17:00 **Coffee break** *20'*

- 17:20 **New perspectives on localization in dilute ultracold atomic gases.**
  35'+5' questions
  Speaker: **Michael Pasek** (Collège de France, Paris, France)
  Abstract: *I will present a theorist's perspective on past and future ultracold atom experiments aiming to characterize the Anderson transition with disordered optical potentials. I will also touch upon the results of recent spectral function measurements of such disordered dilute gases.*



Monday 27, 20:00

Social dinner at Restaurant "Les Copains d'abord"

38, Rue du Pont Guihemery

31000 TOULOUSE

05 62 47 39 98

Tuesday 28

- 09:00 **Tba**
  35'+5' questions
  Speaker: Dominique Delande (LKB, Paris, France)

- 09:40 **Chaos-assisted tunneling in the presence of Anderson localization.**
  35'+5' questions
  Speaker: **Elmer Doggen** (Karlsruhe Institute of Technology, Germany)
  Abstract: *Tunneling between two classically disconnected regular regions can be strongly affected by the presence of a chaotic sea in between. This phenomenon, known as chaos-assisted tunneling, gives rise to large fluctuations of the tunneling rate. Here we study chaos-assisted tunneling in the presence of Anderson localization effects in the chaotic sea. Our results show that the standard tunneling rate distribution is strongly modified by localization, going from the known Cauchy distribution in the ergodic regime to a log-normal distribution in the strongly localized case. We develop an analytical single-parameter scaling theory which accurately describes the numerical data, for both a deterministic and a disordered model. Several possible experimental implementations using cold atoms, photonic lattices or microwave billiards are discussed.*

- 10:20 **Coffee break** *20'*

- 10:40 **Non-ergodic phases on Bethe lattice: replica symmetry breaking solutions and population dynamics numerics.**
  35'+5' questions
  Speaker: **Vladimir Kravtsov** (ICTP, Trieste, Italy)

- 11:20 **Scaling theory of the Anderson transition in random graphs: ergodicity and universality.**
  35'+5' questions
  Speaker: **Rémy Dubertrand** (Université de Liège, Belgium)
  Abstract: *We study the Anderson transition on a generic model of random graphs with a tunable branching parameter $1 < K < 2$, through large scale numerical simulations and finite-size scaling analysis. We find that a single transition separates a localized phase from an unusual delocalized phase which is ergodic at large scales but strongly non-ergodic at smaller scales. In the critical regime, multifractal wavefunctions are located on few branches of the graph. Different scaling laws apply on both sides of the transition: a scaling with the linear size of the system on the localized side, and an unusual volumic scaling on the delocalized side. The critical scalings and exponents are independent of the branching parameter, which strongly supports the universality of our results.*

- 12:00 **Lunch break** *1h40'*

- 13:40 **The Anderson model on the Bethe lattice: delocalized non-ergodic crossover and Many-Body "glassy" dynamics.**
  35'+5' questions
  Speaker: **Marco Tarzia** (LPTMC, Paris, France)
  Abstract: *This talk is focused on the non-ergodic behavior found in the Anderson model on the Bethe lattice within the delocalized phase. First, we present new preliminary results based on the solution of the self-consistent equations on large but finite instances, which support the idea that full ergodicity is eventually restored on an energy scale which becomes exponentially small as the Anderson transition is approached. However finite size samples do not display fully ergodicity even far from the transition and for very large sizes. This leads to a very wide crossover region in which the system looks as if it were in a mixed phase for all practical purposes. Using the tight-binding model on the Bethe lattice as a toy model for Many-Body Localization, we show that this might have a dramatic impact on the dynamics of realistic systems which, on large but finite time scales, can only explore regions smaller than the ergodic crossover scale. This leads to a new general mechanism for unusual slow transport and power-law relaxation observed in simulations and experiments of isolated disordered interacting quantum systems, complementary to the one based on Griffiths regions.*

- 14:20 **Bose-glass physics: recent results.**
  35'+5' questions
  Speaker: **Nicolas Laflorencie** (LPT, Toulouse, France)
  Abstract: *The Bose-Glass state of matter is expected to occur for interacting bosons in a (sufficiently strong) disordered background, with a remarkable vanishing of superfluid coherence. While discussed and debated for more than 3 decades, its physical properties still remain elusive. Here we'll discuss one and two dimensional lattice models which exhibit a zero-temperature superfluid to Bose-glass transition [1,2]. Building on large-scale numerical simulations, several key issues will be addressed: universality and quantum critical scaling, rare events physics, glassy properties...*
  [1] *Weak- versus strong-disorder superfluid—Bose glass transition in one dimension, E.V.H. Doggen, G. Lemarié, S. Capponi, and N. Laflorencie, Phys. Rev. B 96, 180202(R) (2017).*
  [2] *Critical Properties of the Superfluid—Bose-Glass Transition in Two Dimensions, J.-P. Álvarez Zúñiga, D.J. Luitz, G. Lemarié, and N. Laflorencie, Phys. Rev. Lett. 114, 155301 (2015).*

- 15:00 **Coffee break** *20'*

- 15:20 **The many-body delocalization transition as an avalanche.**
  35'+5' questions
  Speaker: **Thimothée Thiery** (Institute for Theoretical Physics, Leuven, Belgium)
  Abstract: *I will present a multi-scale diagonalization procedure designed to describe the transition between many-body localization (MBL) and thermalization in 1-dimensional disordered quantum spin chains. The originality of our procedure is that the eigenstate thermalization hypothesis (ETH) and random matrix theory are used as guiding principles to treat ergodic inclusions in MBL systems. By construction our procedure leads to a description of the MBL phase in terms of local integrals of motion (LIOMs), and of the thermal phase in terms of the ETH. At the transition it yields to new predictions. The procedure can be analyzed in a mean-field fashion and using numerical simulations. Some of the predictions of the approach are (i) the typical localization length remains bounded as the transition is approached from the MBL side; (ii) the transition is driven by an instability of the MBL phase that allows, under certain conditions, a small bath to thermalize an infinite MBL system; (iii) the critical point is localized with an average half-chain entanglement entropy that satisfies a law intermediate between area and volume law; (iv) single parameter scaling is broken at the transition, which appears discontinuous from the thermal side. Based on joint works with W. De Roeck, F. Huveneers and M. Müller (arXiv:1706.09338 and to appear).*

- 16:00 **Signatures of the Anderson transition in momentum space.**
  35'+5' questions
  Speaker: **Christian Miniatura** (MajuLab, Singapore)
  Abstract: *Starting from an initial plane wave state, Anderson localisation in momentum space is characterised by the appearance, in the course of time, of a novel interference peak known as the Coherent Forward Scattering (CFS) peak, mirroring its well-known cousin, the Coherent Backscattering (CBS) peak on top of a diffusive background. By performing a finite-time scaling analysis of the CFS contrast, we extract the critical exponents, the mobility edge and the multifractal exponent D_1 (also known as the information dimension) of the 3D Anderson transition in the orthogonal class.*