

Rencontre du GDR "Dynamique Quantique", Grenoble, 1-5 Février 2016

PROGRAM

Monday 1st February

12:30 - 14:00: *Welcome and lunch (buffet)*

14:00 - 14:10: *Opening of the conference*

14:10 - 15:10: **Benjamin Schlein** (Univ. Zürich)

[Quantum fluctuations around the nonlinear Schroedinger equation](#)

15:10 - 15:40: **Marcin Napiórkowski** (IST, Austria)

[Diagonalization of bosonic quadratic Hamiltonians by Bogoliubov transformations](#)

15:40 - 16:00: *Coffee break*

16:00 - 17:00: **Anna Minguzzi** (Univ. Grenoble Alpes)

[Interacting bosons on a ring with a gauge field](#)

Tuesday 2nd February

09:30 - 11:00: **Jan Philip Solovej** (Univ. Copenhagen)

Lecture 1: [Hartree-Fock-Bogoliubov and BCS Theory](#)

11:00 - 11:30: *Coffee break*

11:30 - 12:00: **Chiara Saffirio** (Univ. Zürich)

[From the Hartree-Fock dynamics to the Vlasov equation](#)

12:00 - 12:30: **Boris Pawilowski** (Univ. Rennes)

[Mean field limit for discrete models and nonlinear discrete Schrödinger equation](#)

12:30 - 14:00: *Lunch*

14:00 - 15:00: **Yvan Castin** (ENS Paris)

[Les gaz unitaires](#)

15:00 - 15:30: *Coffee break*

15:30 - 16:30: **François Huveneers** (Univ. Paris-Dauphine)

[Pre-thermalization and slow \(or even absence of\) energy absorption in periodically driven many-body systems](#)

16:30 - 17:00: **David Gontier** (ETH Zürich)

[A mathematical study of the GW0 method for computing electronic excited states of molecules](#)

Wednesday 3rd February

09:30 - 11:00: **Jan Philip Solovej** (Univ. Copenhagen)

Lecture 2: [Hartree-Fock-Bogoliubov and BCS Theory](#)

11:00 - 11:30: *Coffee break*

11:30 - 12:00: **Sari Ghanem** (Univ. Grenoble Alpes)

[Les champs de Yang-Mills sur des espaces-temps courbes en présence d'un trou noir](#)

12:00 - 12:30: **Julien Cortier** (Univ. Grenoble Alpes)

[On the center of mass for asymptotically hyperbolic initial data sets](#)

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14:00 - 15:00: **Alain Bachelot** (Univ. Bordeaux)

[Bubble of Nothing and Wormhole](#)

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[Decay of correlations and absence of superfluidity in the disordered Tonks-Girardeau gas](#)

16:30 - 17:00: **Sébastien Dutercq** (Univ. Orléans)

[Interface dynamics of a metastable mass-conserving diffusion](#)

Thursday 4th February

9:30 - 10:30: **Claude-Alain Pillet** (Univ. Toulon)

[Nonequilibrium statistical mechanics of harmonic networks](#)

10:30 - 11:00: **Tristan Benoist** (Univ. Toulouse)

[Energy statistics of quantum statistical systems in the adiabatic limit and Landauer's principle](#)

11:00 - 11:30: Coffee break

11:30 - 12:30: **Ion Nechita** (Univ. Toulouse)

[Block-modified random matrices, operator-valued free probability, and applications to entanglement theory](#)

12:30 - 14:00: Lunch

14:00 - 14:30: **Virgile Robbe** (Univ. Nantes)

[Small eigenvalues for some non local semiclassical linear Boltzmann equations](#)

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[Spectra of large Toeplitz matrices subject to small random perturbations](#)

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[On the bound states of Schrödinger operators with delta-interactions on conical surfaces](#)

16:00 - 17:00: **André Voros** (CEA Saclay)

[Simplification of the Keiper–Li approach to the Riemann Hypothesis](#)

20:00: Conference dinner at the restaurant "Le 5", Musée de Grenoble

Friday 5th February

9:30 - 10:30: **San Vũ Ngọc** (Univ. Rennes)

[Spectral theory of confining magnetic fields via symplectic geometry](#)

10:30 - 11:00: Coffee break

11:00 - 11:30: **Yannick Bonthouneau** (ENS Paris)

[Weyl laws for manifolds with cusps](#)

11:30 - 12:00: **Tobias Weich** (Univ. Paderborn)

[Resonance chains in open chaotic quantum systems](#)

12:00-13:30: Lunch

ABSTRACTS

Monday 1st February

14:10 - 15:10: **Benjamin Schlein** (Univ. Zürich)

"Quantum fluctuations around the nonlinear Schroedinger equation"

We consider a class of bosonic systems characterised by a two-body potential interpolating between mean field and Gross-Pitaevskii interaction. The limiting dynamics can be approximated by a nonlinear Schroedinger equation with a local nonlinearity. We study fluctuations around the nonlinear Schroedinger equation and prove that they can be described on the Fock space by an evolution with a quadratic generator. This is joint work with Serena Cenatiempo and Chiara Boccato.

15:10 - 15:40: **Marcin Napiórkowski** (IST, Austria)

"Diagonalization of bosonic quadratic Hamiltonians by Bogoliubov transformations"

I will provide general conditions for which bosonic quadratic Hamiltonians on Fock spaces can be diagonalized by Bogoliubov transformations. Our results cover the case when quantum systems have infinite degrees of freedom and the associated one-body kinetic and pairing operators are unbounded. This is joint work with Phan Thành Nam and Jan Philip Solovej.

16:00 - 17:00: **Anna Minguzzi** (Univ. Grenoble Alpes)

"Interacting bosons on a ring with a gauge field"

We consider an interacting one-dimensional Bose gas on a ring. The gas is subjected to a rotating barrier potential, which induces an artificial $U(1)$ gauge field and a persistent current flow on the ring. We study the ground state and the lower-excited states of the gas. We show that it is possible to realize macroscopic superpositions of current states by suitably tuning the gauge field, the barrier and interaction strength. We also find that, at intermediate interactions, the persistent current amplitude is maximal, due to a subtle interplay of effects due to the barrier, interactions and quantum fluctuations. We finally show that barrier renormalization is a very general property, also affecting other dynamical properties, eg the frequency of the collective modes for a Bose gas in a split trap.

Tuesday 2nd February

09:30 - 11:00: **Jan Philip Solovej** (Univ. Copenhagen)

Lecture 1: "Hartree-Fock-Bogolubov and BCS Theory"

In the lectures I will discuss the general mathematical formalism leading to the variational Hartree-Fock-Bogolubov (HFB) model. This requires introducing the notion of quasi-free states, quadratic Hamiltonians (Hamiltonians quadratic in creation and annihilation operators), and Bogolubov transformations. I will focus mainly on fermions, but I will also discuss briefly the case of bosons, which from an abstract level is more complicated. I will introduce the HFB model as the variational theory obtained by restricting to quasi-free (fermionic) states. I will then turn to the special case of

translation invariant models and discuss the simplification that leads to the Bardeen-Cooper-Schrieffer (BCS) model used to explain superconductivity. I will discuss the gap equation characterizing the phase transition. Finally, I will give a brief sketch of the recent proof that BCS theory in an appropriate limit gives rise to the Ginzburg-Landau (GL) model of superconductivity. Most of what I will talk about was done in different collaborations with Bach, Frank, Hainzl, Hamza, Lieb, and Seiringer. For the latter part on BCS and GL there is an excellent recent review by Hainzl and Seiringer: <http://arxiv.org/abs/1511.01995>.

11:30 - 12:00: **Chiara Saffirio** (Univ. Zürich)

"From the Hartree-Fock dynamics to the Vlasov equation"

We will discuss the convergence (in the semiclassical limit) of a solution to the Hartree-Fock equation towards an operator, whose Wigner transform is a solution to the Vlasov equation. We will consider both cases of positive and zero temperature. This is a joint work with N. Benedikter, M. Porta and B. Schlein.

12:00 - 12:30: **Boris Pawilowski** (Univ. Rennes)

"Mean field limit for discrete models and nonlinear discrete Schrödinger equation"

We deal with approximations of the time-dependent linear many body Schrödinger equation with a two particles interaction potential, by introducing a discrete version of the equation and mean field limits. We consider the bosonic Fock space in a finite dimensional setting. Mathematical tools include the reduced density matrices and Wigner measure techniques exploiting the formal analogy to semi-classical limits.

14:00 - 15:00: **Yvan Castin** (ENS Paris)

"Les gaz unitaires"

Un gaz est à la limite unitaire lorsque les particules le constituant interagissent par un potentiel de longueur de diffusion infinie et de portée négligeable. Il présente alors d'intéressantes propriétés d'invariance d'échelle, dont nous présenterons quelques conséquences physiques. En particulier, nous parlerons de l'effet Efimov à 3 corps ou à 4 corps, qui brise cette invariance d'échelle, et nous présenterons les progrès et les enjeux dans le calcul analytique des coefficients du viriel d'un gaz unitaire. Nous ferons bien entendu le lien avec les expériences d'atomes froids en cours à l'ENS, dans l'équipe de Christophe Salomon.

15:30 - 16:30: **François Huveneers** (Univ. Paris-Dauphine)

"Pre-thermalization and slow (or even absence of) energy absorption in periodically driven many-body systems"

In this talk, I will discuss the emergence of quasi, or sometimes strictly, conserved quantities in periodically driven many-body quantum systems. In the generic case of an ergodic Hamiltonian, I will show that the rate of absorption of energy becomes exponentially small in the driving frequency (in the large frequency limit).

In the particular case of a many-body localized Hamiltonian, characterized by a full set of local

integral of motions (LIOMs), I will show that the driven system itself admits a full set of strictly conserved LIOMs, if the driving frequency is high enough.

Moreover, I will show that the ideas developed in the context of driven systems can be generalized to describe the emergence of pre-thermal behavior for several closed quantum systems. I will discuss some physical implications of these findings. (from joint work with D. Abanin, W. De Roeck, W. W. Ho)

16:30 - 17:00: **David Gontier** (ETH Zürich)

"A mathematical study of the GW0 method for computing electronic excited states of molecules"

The aim of this talk is to present a mathematical framework to understand the properties of the GW0 method for finite systems, which has been proven very successful to predict electronic excited energies.

This method relies on the study of the one-body Green's function for electronic systems. The GW0 equations are obtained from many-body perturbation theory. They involve many operator-valued distributions, among which the dynamically screened Coulomb operator, the self-energy and the Green's function.

The mathematical definition of these operators will be clarified during the talk, and we will prove that the GW0 equations are well-posed in some perturbative regime. This is joint work with Éric Cancès and Gabriel Stoltz.

Wednesday 3rd February

09:30 - 11:00: **Jan Philip Solovej** (Univ. Copenhagen)

Lecture 2: "Hartree-Fock-Bogolubov and BCS Theory" (see above)

11:30 - 12:00: **Sari Ghanem** (Univ. Grenoble Alpes)

"Les champs de Yang-Mills sur des espaces-temps courbes en présence d'un trou noir"

Je vais présenter la preuve de la non-explosion de la courbure de Yang-Mills sur des espaces-temps courbes quelconques, fixes, en utilisant une formule de représentation de type Kirchoff-Sobolev établie par Klainerman et Rodnianski, combinée avec des inégalités de type Grönwall appropriées. Alors que l'argument de Chruściel et de Shatah nécessite un contrôle de deux dérivées de la courbure de Yang-Mills, nous pouvons en sortir en contrôlant uniquement une seule dérivée, et écrire une nouvelle preuve indépendante de tout choix de jauge de la non-explosion de la courbure de Yang-Mills sur des variétés Lorentziennes courbes quelconques, fixes, suffisamment lisses, globalement hyperboliques, à quatre dimensions. Puis, je vais parler des champs de Yang-Mills sur un espace-temps courbe en présence d'un trou noir.

12:00 - 12:30: **Julien Cortier** (Univ. Grenoble Alpes)

"On the center of mass for asymptotically hyperbolic initial data sets"

In general relativity, one can describe isolated gravitational systems by 3-manifolds carrying geometric data induced from an embedding in asymptotically Minkowskian spacetimes. There are various ways to assign "global charges" to them as in special relativity, such as energy-momentum, center of mass and angular momentum.

In the case of a negative cosmological constant, it is natural to consider rather asymptotically hyperbolic 3-manifolds. I will describe a recent work with Carla Cederbaum and Anna Sakovich in which we define the center of mass for such initial data sets. It relies on the properties of foliations of a neighborhood of infinity by constant mean curvature surfaces.

14:00 - 15:00: **Alain Bachelot** (Univ. Bordeaux)

"Bubble of Nothing and Wormhole"

We investigate the waves propagation in two universes of the quantum cosmology, the Bubble of Nothing of Witten, and its remarkable submanifold, the lorentzian Hawking Wormhole.

15:30 - 16:30: **Simone Warzel** (Technische Univ. München)

"Decay of correlations and absence of superfluidity in the disordered Tonks-Girardeau gas"

In view of the woefully short list of rigorous results on disordered systems with interaction, limiting or integrable model systems present a testing ground for numerical works, conjectures and ideas. In the bosonic case, the limiting case of hard-core repulsive interaction is such an example: in the lattice set-up this amounts to studying the XY-spin Hamiltonian with a random magnetic field, and in the continuum this is the Tonks-Girardeau model with a random potential. Both models can be related to non-interacting fermions in an external random potential.

In this talk I will mainly report on results concerning the Tonks-Girardeau gas subject to a random external potential.

If the disorder is such that the underlying one-particle Hamiltonian displays localization, which is known to be generically the case, correlations in the many-body eigenstates are shown to decay exponentially. Moreover, there is no Bose-Einstein condensation and no superfluidity, even at zero temperature.

(This is based on joint works with R. Sims and R. Seiringer.)

16:30 - 17:00: **Sébastien Dutercq** (Univ. Orléans)

"Interface dynamics of a metastable mass-conserving diffusion"

We will consider a diffusion process defined by the stochastic differential equation $dx_t = -\nabla V_\gamma(x_t)dt + \sqrt{2\epsilonpsilon}dW_t$ where V_γ is a potential with a conservation law and invariant under a group of symmetries. First we will describe the metastable states of the system, and then we will define a hierarchy on these metastable states. We will see how we can interpret the dynamics of this system in terms of the motion of its interfaces, and give sharp results on expected first-hitting times and its spectral gap.

Thursday 4th February

9:30 - 10:30: **Claude-Alain Pillet** (Univ. Toulon)

"Nonequilibrium statistical mechanics of harmonic networks"

We consider a general network of harmonic oscillators driven out of thermal equilibrium by coupling to several heat reservoirs at different temperatures. The action of the reservoirs is implemented by Langevin forces. Assuming the existence and uniqueness of the steady state of the resulting process, we construct a canonical entropy production functional $S(t)$ which satisfies the Gallavotti-Cohen fluctuation theorem. More precisely, we prove that cumulant generating function of $S(t)$ has a large-time limit $e(a)$ which is finite on a closed interval centered at $a=1/2$, infinite on its complement and satisfies the Gallavotti-Cohen symmetry $e(1-a)=e(a)$ for all a . It follows from well known results that $S(t)$ satisfies a global large deviation principle with a rate function $I(s)$ obeying the Gallavotti-Cohen fluctuation relation $I(-s)-I(s)=s$ for all s . We also consider perturbations of $S(t)$ by quadratic boundary terms and prove that they satisfy extended fluctuation relations, i.e., a global large deviation principle with a rate function that typically differs from $I(s)$ outside a finite interval. This applies to various physically relevant functionals and, in particular, to the heat dissipation rate of the network. Our approach relies on the properties of the maximal solution of a one-parameter family of algebraic matrix Riccati equations. It turns out that the limiting cumulant generating functions of $S(t)$ and its perturbations can be computed in terms of spectral data of a Hamiltonian matrix depending on the harmonic potential of the network and the parameters of the Langevin reservoirs. This makes our approach well adapted to both analytical and numerical investigations. This is joint work with Vojkan Jaksic and Armen Shirikyan.

10:30 - 11:00: **Tristan Benoist** (Univ. Toulouse)

"Energy statistics of quantum statistical systems in the adiabatic limit and Landauer's principle"

We present results obtained in collaboration with M. Fraas, V. Jaksic and C.-A. Pillet on the statistics of work and heat variation for driven quantum statistical system in the adiabatic limit. We show weak convergence of the respective distributions consistent with the classical thermodynamics of quasi static isothermal processes. We specialize these results to the study of the saturation of Landauer's bound on the minimal heat produced by the erasure of information.

11:30 - 12:30: **Ion Nechita** (Univ. Toulouse)

"Block-modified random matrices, operator-valued free probability, and applications to entanglement theory"

Motivated by the problem of entanglement detection in quantum information theory, we study the spectrum of random matrices which have been modified by a linear map acting on their blocks. More precisely, for a unitarily invariant random matrix acting on a tensor product space, we consider the matrix obtained by acting with a fixed, hermiticity preserving map, on one factor of the tensor product. We discuss the limiting spectral distribution of the modified matrix, in terms of the initial distribution of the random matrix, and of the linear map acting on the blocks. The key ingredient in the proof is a freeness result, with amalgamation over some commutative, finite dimensional algebra. This is joint work with Octavio Arizmendi and Carlos Vargas.

14:00 - 14:30: **Virgile Robbe** (Univ. Nantes)

"Small eigenvalues for some non local semiclassical linear Boltzmann equations"

We are interested in some low-temperature linear Boltzmann equations. We will discuss some results near 0 for the spectrum and the resolvent by use of semiclassical tools and commutator technics. A main property of one of those equations is the supersymmetric structure of the associated operator which we will also present here.

14:30 - 15:00: **Martin Vogel** (Univ. Paris Sud, Orsay)

"Spectra of large Toeplitz matrices subject to small random perturbations"

I will present recent results about the spectral properties of large Toeplitz matrices subject to small Gaussian random perturbations. We will focus in particular on the cases of large Jordan block matrices and large bi-diagonal matrices.

15:30 - 16:00: **Thomas Ourmières-Bonafos** (BCAM Bilbao)

"On the bound states of Schrödinger operators with delta-interactions on conical surfaces"

Hamiltonians in strong homogeneous magnetic fields or photonics crystals with high-contrast are approximated by Schrödinger operators with delta-type interactions supported on sets of zero Lebesgue measure (points, curves, surfaces or hypersurfaces). In quantum mechanics, the spectrum of such Schrödinger operators is related to admissible values of the energy and a natural issue is to understand how the geometry of the support of the delta-interaction influences the spectrum. In this talk we consider, in dimension greater than or equal to three, a Laplacian coupled with an attractive delta-interaction supported on a cone whose cross section is the sphere of co-dimension two. We prove that there is discrete spectrum only in dimension three and that, in this case, the eigenvalues are non-decreasing functions of the aperture of the cone.

The main result of this work is the exhibition of the precise logarithmic accumulation of the discrete spectrum below the threshold of the essential spectrum. Joint work with Vladimir Lotoreichik.

16:00 - 17:00: **André Voros** (CEA Saclay)

"Simplification of the Keiper--Li approach to the Riemann Hypothesis"

We review Keiper and Li's constants λ_n , $n=1,2, \dots$, real numbers whose large n behavior sharply reflects whether the Riemann Hypothesis (RH) is true or not - a key open question in number theory. That sequence generates conceptually most concrete and practical tests for RH (thus, appealing for physicists): the prime example is Li's criterion. On the dark side, those numbers have a very elusive nature, and also numerically they become intractable at quite early n . Our analysis, partly semiclassical, makes the Keiper/Li approach more explicit and easier to implement numerically.

Friday 5th February

9:30 - 10:30: **San Vũ Ngọc** (Univ. Rennes)

"Spectral theory of confining magnetic fields via symplectic geometry"

I will present recent results giving precise eigenvalue asymptotics for the magnetic Laplacian for large magnetic fields (semiclassical limit), in the case of a confining, non-uniform field, in dimensions 2 and 3. The essential ingredient is the symplectic geometry of the zero-energy manifold in the magnetic phase space, and the quantization of the various oscillations of the Hamiltonian flow for long times. This is joint work with B. Helffer, Y. Kordyukov and N. Raymond.

11:00 - 11:30: **Yannick Bonthonneau** (ENS Paris)

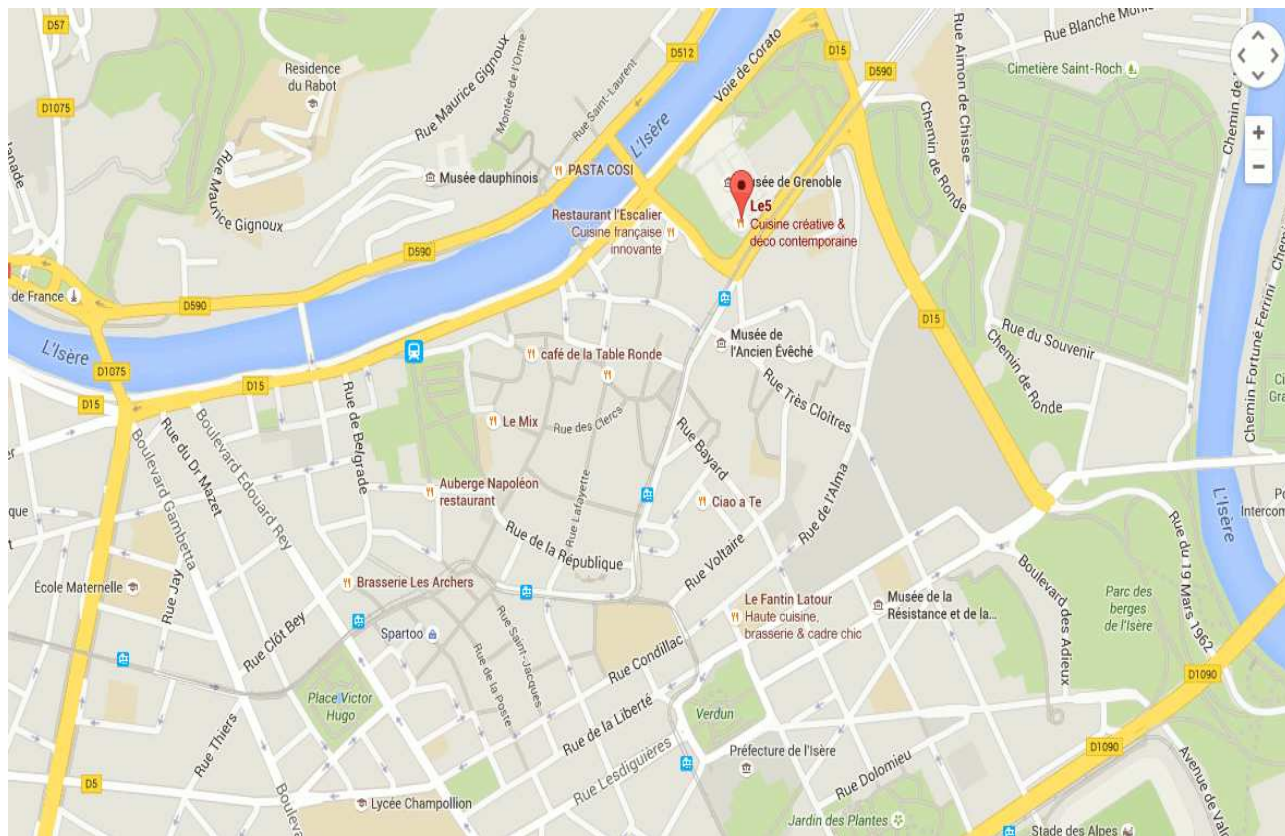
"Weyl laws for manifolds with cusps"

I will present a group of results on the spectral counting function for the Laplacian on manifolds with hyperbolic cusps. I will also give precise counting estimates for resonances.

11:30 - 12:00: **Tobias Weich** (Univ. Paderborn)

"Resonance chains in open chaotic quantum systems"

In certain open and chaotic quantum systems it has been observed numerically, that the quantum resonances form striking patterns along characteristic chains in the complex plane. In this talk we will investigate the reasons for the formation of these chains and prove their existence on three funneled Schottky surfaces in a certain geometrical limit in the Teichmüller space.



**Conference dinner: Thursday 4th February at 8 p.m.
at the restaurant “Le 5”, Musée de Grenoble**

Address of the restaurant: 5, place Lavalette - 38000 GRENOBLE, Phone: 04.76.63.22.12

From the campus, take the tramway **line B** direction “Grenoble Presqu’île” and gett off at the stop “**Notre-Dame Musée**”. From the railway station, take tramway **line B** in the opposite direction “Gières Plaine des sports” and gett off at “**Notre-Dame Musée**”.

For those of you interested by the guided tour of the museum collection, we will meet at **18:15 at the main entrance of the museum**. The address of the museum is the same as that of the restaurant.