Schedule of talks

Monday, June 17	Tuesday, June 18	Wednesday, June 19	Thursday, June 20	Friday, June 21
9h00–9h45 Welcome of participants	9h00–9h50 B. Dehman	9h00–9h50 S. Klainerman	9h00–9h50 Th. Duyckaerts	9h00–9h50 C. Kenig
9h45–10h00 Opening of the conference	10h00–10h50 N. Burq	10h00–10h50 J. Szeftel	10h00–10h50 L. Michel	10h00–10h50 P. Raphaël
10h00–10h50 A. Boutet de Monvel	*11h00–11h30* *Coffee break*	*11h00–11h30* *Coffee break*	*11h00–11h30* *Coffee break*	*11h00-11h30* *Coffee break*
11h00–11h50 E. Lenzmann	11h30–12h20 M. Ifrim	11h30–12h20 A. Vasy	11h30–12h20 E. Zuazua	11h30–12h20 F. Merle
12h00–14h00 *Buffet lunch*	*12h30–14h00* *Buffet lunch*	*12h30–14h00* *Buffet lunch*	*12h30–14h00* *Buffet lunch*	*12h30–14h00* *Buffet lunch*
14h00–14h50 D. Tataru	14h00–14h50 F. Linares		14h00–14h50 A. Koenig	
15h00–15h50 M. Ehrnström	15h00–15h50 H. Holden		15h00–15h50 N. Tzvetkov	
16h00–16h30 *Coffee break*	*16h00–16h30* *Coffee break*			
16h30–17h20 F. Planchon	16h30–17h20 Ch. Sun		17h00 Departure to dinner	

Anne Boutet de Monvel (Institut de Mathématiques de Jussieu-Paris Rive Gauche & Université Paris Diderot): *Long-time asymptotics for the 1D focusing NLS equation with nonzero boundary conditions: rarefaction and shock.*

Abstract: I will consider a solution $q(x,t)$ for the 1D focusing nonlinear Schrödinger equation $\mathrm{i}q_t + q_{xx} + 2|q|^2 q = 0$ with initial values $q(x,0) \approx A_1 \mathrm{e}^{\mathrm{i}\phi_1} \mathrm{e}^{-2\mathrm{i}B_1 x}$ as $x \to -\infty$ and $q(x,0) \approx A_2 \mathrm{e}^{\mathrm{i}\phi_2} \mathrm{e}^{-2\mathrm{i}B_2 x}$ as $x \to +\infty$. Its long-time asymptotics is qualitatively different in different sectors $\xi_{i+1} < \xi \coloneqq \frac{x}{t} < \xi_i$ of the (x,t) half-plane. The goal is to determine these sectors and the asymptotics in each of them. The case $B_1 = B_2$ has already been studied by Biondini and Mantzavinos (CPAM 2017).

I will concentrate on the rarefaction ($B_2 < B_1$) and shock ($B_1 < B_2$) cases. The shock case has already been analyzed by Buckingham and Venakides (CPAM 2007). It is actually rich in asymptotic scenarios that I will present. They depend on the relative values of the parameters A_j, B_j.

(This is joint work with Jonatan Lenells and Dmitry Shepelsky.)

Nicolas Burq (Université Paris-Sud, Orsay): *Control for rough wave equations, propagation estimates and C^0 ODE's. Part II.*

Abstract: The property of controllability for the wave equation has been intensively studied, mainly in a smooth framework (smooth metric and smooth domain). In this lecture, and the related one of Belhassen Dehman, we shall present some new results on observability/control for the wave equation with rough coefficients.

In the second lecture, we consider the case of a C^1 metric (the hamiltonian field is only continuous) and we prove the propagation up to the boundary, of semi-classical measures support along generalized geodesics. A generalized Geometric Control Condition is then sufficient for exact control.

These talks come from joint works with J. Le Rousseau (Université Paris 13).

Belhassen Dehman (Faculté des Sciences de Tunis): *Control for rough wave equations, propagation estimates and C^0 ODE's. Part I.*

Abstract: The property of controllability for the wave equation has been intensively studied, mainly in a smooth framework (smooth metric and smooth domain). In this lecture, and the related one of Nicolas Burq, we shall present some new results on observability/control for the wave equation with rough coefficients.

More precisely, in the first lecture, we show that the property of exact internal or boundary controllability for a wave equation with smooth coefficients is stable with respect to Lipschitz perturbations of the metric.

These talks come from joint works with J. Le Rousseau (Université Paris 13).

Thomas Duyckaerts (Université Paris 13): *Resonance width for a Helmholtz resonator.*

Abstract: A Helmholtz resonator is constituted of a cavity in a convex obstacle, connected to the exterior of the obstacle by a thin tube. The Dirichlet Laplace operator in this geometry admits resonances that are exponentially close, as the thickness of the tube goes to 0, to the eigenvalues of the same operator in the cavity. In this talk I will explain how one can obtain, using Carleman estimates, an upper bound for the lifetime of these resonances.

Joint work with Alain Grigis and André Martinez.

Mats Ehrnström (Norwegian University of Science and Technology): *Travelling water waves with exponentially localised vorticity.*

Abstract: We study travelling and stationary waves in a two-dimensional body of water that rests above a flat ocean bed and below vacuum. An external gravitational force acts in the bulk of the fluid, and the upper boundary is a free surface along which the pressure is constant and the effects of surface tension are felt. This system is described by the Euler equations with a moving boundary. Our main result states that there exists large families of such waves that exhibit an exponentially localized distribution of vorticity. This is accomplished using ideas drawn from the theory of spike-layer solutions to singularly perturbed elliptic equations, together with a delicately balanced contraction mapping argument.

This is joint work with Chongchun Zeng, Georgia Institute of Technology, and Samuel Walsh, University of Missouri.

Helge Holden (Norwegian University of Science and Technology): *A novel Lipschitz metric for the Camassa–Holm equation.*

Abstract: The Camassa–Holm equation

$$u_t + uu_x + p_x = 0, \quad p - p_{xx} = u^2 + \frac{1}{2}u_x^2$$

has received considerable attention since it was first studied by Camassa and Holm in 1993. Part of the interest stems from the fact that the solution develops singularities in finite time while keeping the H^1 norm finite. At wave breaking uniqueness is lost as the there are infinitely many ways to extend the solution beyond wave breaking. We study the so-called conservative solutions and show how to construct a Lipschitz metric comparing two conservative solutions.

Mihaela Ifrim (University of Wisconsin, Madison): *Dispersive decay of small data solutions for the KdV equation.*

Abstract: We consider the Korteweg-de Vries (KdV) equation, and prove that small localized data yields solutions which have dispersive decay on a quartic time-scale. This result is optimal, in view of the emergence of solitons at quartic time, as predicted by inverse scattering theory.

Joint work with H. Koch and Daniel Tataru.

Carlos Kenig (University of Chicago): *The focusing energy-critical nonlinear wave equation with random data.*

Abstract: We will discuss recent joint work with Dana Mendelson, on the 3 dimensional radial energy critical wave equation. In this work we construct perturbations of the ground-state solution, in rough spaces (of infinite energy), using probabilistic methods.

Sergiu Klainerman (Princeton University): *On the nonlinear stability of the Kerr family in General Relativity.*

Abstract:

Armand Koenig (Université de Nice Côte d'Azur): *(Non-)null-controllability of some degenerate partial differential equations.*

Abstract: We know since the 90s that the heat equation is null controllable with internal control, in arbitrarily small time and on arbitrarily small non-empty open control set. But if we replace in the heat equation the Laplace operator with a degenerate parabolic equation, the picture can change dramatically. We will study the Grushin equation $(\partial_t - \partial_x^2 - x^2\partial_y^2)g = 0$ and some Kolmogorov-type equations $(\partial_t - \partial_v^2 - v^\gamma \partial_x)g = 0$. We will see that depending on the control domain, there may be a minimal time for the null-controllability to hold, or null-controllability might not be true even in very large time. In particular, we will draw a link between the fractional heat equation and the Grushin and Kolmogorov equation, thus quantifying the fact that these equations have less diffusion than the heat equation, which is the key to prove the lack of null-controllability.

Enno Lenzmann (Universität Basel): *Recent progress on energy-critical half-wave maps.*

Abstract: In this talk, I will review recent progress on the Lax pair structure for energy-critical half-wave maps equation (HWM). In addition, I will also discuss the rigorous derivation of (HWM) as the continuum limit from discrete completely integrable spin systems of Calogero-Moser type.

This is joint work with Patrick Gérard (Orsay) and Jérémy Sok (Basel).

Felipe Linares (IMPA, Rio de Janeiro): *Unique continuation properties for solutions to the Camassa-Holm equation.*

Abstract: In this talk we present recent results regarding unique continuation for solutions of the of the initial value problem for the Camassa-Holm equation. More precisely, we show that if $u(x,t)$ is a solution of the IVP which vanishes in an open set $\Omega \subset \mathbb{R} \times [0,T]$, then $u(x,t) = 0$, $(x,t) \in \mathbb{R} \times [0,T]$. This result also applies to solutions of the initial periodic boundary value problems associated to the Camassa-Holm equation. The argument of proof can be placed in a general setting to extend the above results to a class of non-linear non-local 1-dimensional models which includes the Degasperis-Procesi equation.

Frank Merle (Université de Cergy-Pontoise et IHES): *On characteristic points of the blow up surface for subcritical wave equations.*

Abstract:

Laurent Michel (Université de Bordeaux): *Sharp spectral gap for a non-reversible metastable diffusion.*

Abstract: Consider the overdamped Langevin equation $dx_t = -U_h(x_t) + \sqrt{2h}dB_t$ associated to a vector field $U_h(x)$ in the law temperature regime $h \to 0$. We study the spectrum of the associated diffusion $L_h = -h\Delta + U_h \cdot \nabla$ under the assumption that it admits a stationary distribution $e^{-V/h}$ for some smooth function $V : \mathbb{R}^d \to \mathbb{R}$. Assuming additionally that the function V is a Morse function we prove that L_h admits exactly n_0 eigenvalues in the strip $\{\mathrm{Re}(z) < Ch\}$ (where n_0 is the number of minima of V) and that these eigenvalues have exponentially small modulus. Under a generic assumption we also give a sharp asymptotics of these eigenvalues in terms of Arrhenius numbers. This is a joint work with D. Le Peutrec.

Fabrice Planchon (Université de Nice Côte d'Azur): *Dispersive estimates inside convex domains.*

Abstract: We will review recent results on the wave equation, both positive and negative, toward a complete picture of dispersion and Strichartz estimates at least on the model convex domain.

This is an ongoing series of joint works with O. Ivanovici, R. Lascar and G. Lebeau.

Pierre Raphaël (Université de Nice Côte d'Azur): *On blow up with anisotropy.*

Abstract: I will review some constructions of type I and type II blow up bubbles for energy super critical models, and will explain how the developped technology allows to one to construct the first examples of finite energy anisotropic blow up solutions.

Chenmin Sun (Université de Cery-Pontoise): *Optimal time observability for high frequencies of 2D Grushin Schrödinger equation.*

Abstract: The Grushin Schrödinger

$$i\partial_t + (\partial_x^2 + x^2\partial_y^2)u = 0$$

is a toy model for Schrödinger evolution equation with hypoelliptic operator. It mixes the behaviour of the half-wave and Schrödinger equation. We consider the problem of observability of this equation by a horizontal strip. In the half wave regime, the eigenmodes concentrate at $x = 0$ and propagate at speed 1 in the vertical direction. This phenomenon destroys the validity of the observability for small time $T < T_*$, depending on the size of the strip of observation. We show that, at least for high frequencies in y, these highly concentrated eigenmodes are the only obstacles for the small time observability.

This talk is based on an ongoing work of N. Burq.

Jérémie Szeftel (Sorbonne Université et CNRS): *The nonlinear stability of Schwarzschild.*

Abstract: I will discuss a joint work with Sergiu Klainerman on the stability of Schwarzschild as a solution to the Einstein vacuum equations with initial data subject to a certain symmetry class.

Daniel Tataru (University of California, Berkeley): *Long time dynamics in two dimensional water waves.*

Abstract: The water wave equations describe the motion of the free surface of a fluid (e.g. water) under the action of various physical forces. Understanding the long time properties of water wave flows is a very interesting yet also very challenging class of problems. The talk will provide an overview of recent and ongoing work in this direction.

This is joint work with Mihaela Ifrim.

Nikolay Tzvetkov (Université de Cergy-Pontoise): *Solving nonlinear PDE's in the presence of singular randomness.*

Abstract: We will start by presenting two basic probabilistic effects for questions concerning the regularity of functions and nonlinear operations on functions. We will then overview well-posedenss results for the nonlinear wave equation, the nonlinear Schrödinger equation and the nonlinear heat equation, in the presence of singular randomness.

András Vasy (Stanford University): *Linear stability of slowly rotating Kerr spacetimes.*

Abstract: I will describe joint work with Dietrich Hafner and Peter Hintz in which we study the asymptotic behavior of linearized gravitational perturbations of Schwarzschild or slowly rotating Kerr black hole spacetimes. We show that solutions of the linearized Einstein equation decay at an inverse polynomial rate to a stationary solution (given by an infinitesimal variation of the mass and angular momentum of the black hole), plus a pure gauge term. Our proof uses a detailed description of the resolvent of an associated wave equation on symmetric 2-tensors near zero energy, which is the analytic ingredient the talk will focus on.

Enrique Zuazua (DeustoTech-Bilbao & UAM-Madrid & LJLL-Paris): *Control under constraints in long time horizons.*

Abstract: The free heat equation is well known to preserve the non-negativity of solutions. On the other hand, due to the infinite velocity of propagation, the heat equation is null-controllable in an arbitrary small time interval.

The following question then arises naturally: Can the heat dynamics be controlled under a positivity constraints on the state, requiring that the state remains non-negative all along the time dependent trajectory?

We will show that, if the control time is large enough, constrained controllability holds. We will also show that it fails to be true if the control time is too short. In other words, despite the infinite velocity of propagation, under the natural positivity constraint on the state, controllability fails when the time horizon is too short. The wave equation will also be discussed showing that controllability under constraints on the control can be achieved.

Links with other related topics such as finite-dimensional systems, sparse control and the turnpike property will also be discussed. A number of open problems will also be formulated.

This presentation is based on joint work with Jérôme Lohéac (CNRS-Nantes) and Emmanuel Trélat (Paris 6) and Dario Pighin (UAM-Madrid).