Abstracts of the talks of the Paris-London Analysis Seminar

Session 39, December 15, 2017 in Paris (Institut Henri-Poincaré)

Sylvie Benzoni-Gavage (Université Claude-Bernard, Lyon 1),
Stability of Hamiltonian periodic waves.

Abstract. The stability of nonlinear periodic travelling waves has been studied intensively in the last fifteen years. Nevertheless, stability criteria can hardly ever be checked analytically for general partial differential equations. The talk will be concerned with two asymptotic regimes in a rather general Hamiltonian framework. More specifically, I will consider waves of either small amplitude or large wavelength. The main purpose will be to show how the expansion of stability criteria reveals non degeneracy conditions for small amplitude waves, and the relationship with the stability of solitary waves for large wavelength waves.

Mark Pollicott (University of Warwick),
Transfer operators, determinants and some applications.

Abstract. The transfer operators we are interested in are linear operators closely related to composition operators on the Hardy Hilbert spaces. They are examples of trace class operators, and one can associate a determinant function, i.e., an entire function of a complex variable. This viewpoint is useful, for example, in studying: (i) Zeros of the Selberg zeta function in geometry; (ii) Numerical estimation of the Hausdorff Dimension of some sets. No prior knowledge will be assumed.

Peter Topping (University of Warwick),
Ricci flow and Ricci limit spaces.

Abstract. Ricci flow theory has been developing rapidly over the last couple of years, with the ability to handle Ricci flows with unbounded curvature finally becoming a reality. This is vastly expanding the range of potential applications. I will describe some recent work in this direction with Miles Simon that shows the right way to pose the Ricci flow PDE in this setting in order to make applications to the understanding of Ricci limit spaces. (No knowledge of Ricci flow and Ricci limit spaces etc. will be assumed.)

Franck Sueur (Université de Bordeaux),
Controllability of the Navier-Stokes equation in a rectangle with a little help of an interior phantom force.

Abstract. We consider the 2D incompressible Navier-Stokes equation in a rectangle with the usual no-slip boundary condition prescribed on the upper and lower boundaries. We prove that for any positive time, for any finite energy initial data, there exist controls on the left and right boundaries and a distributed force such that the corresponding solution is at rest at the given final time. The distributed force can be chosen arbitrarily small in any Sobolev norm in space, and supported away from the uncontrolled boundaries. This is joint work with Jean-Michel Coron, Frédéric Marbach and Ping Zhang.

Session 38, October 6, 2017 in London (Imperial College London)

Alexander Borichev (Aix-Marseille Université),
Geometry of families of reproducing kernels in Fock spaces.

Abstract. We study families of reproducing kernels in (weighted) Fock spaces. Main questions we are interested in are when such a family is a Riesz basis, a strong Markuschevich basis, and when the biorthogonal family is complete.

Claudia Garetto (Loughborough University),
A survey on hyperbolic equations and systems with multiplicities.

Abstract. In this talk I present some recent results for hyperbolic equations and systems with multiplicities obtained in collaboration with M. Ruzhansky (Imperial College London) and C. Jäh (Loughborough University). Particular attention will be given to the regularity of the coefficients and the role

played by the lower order terms.

Gregory Seregin (University of Oxford),
Liouville type theorems for Navier-Stokes equations.

Abstract.The talk is addressed the regularity theory for the Navier-Stokes equations via rescaling and Liouville type theorems. As a related question, Liouville type theorems for steady-state Navier-Stokes equations will be discussed as well.

Armen Shirikyan (Université Cergy-Pontoise),
An elementary introduction to fluctuation relation and fluctuation theorem in chaotic dynamical systems.

Abstract. We begin with a general description of fluctuation relation for stochastic systems. After introducing some simple objects related to the entropy production, we show that the fluctuation relation as proposed by Evans-Searles, Gallavotti-Cohen, and Lebowitz-Spohn is a consequence of the large deviations principle (LDP). We next turn to a class of chaotic dynamical systems and study the validity of LDP and fluctuation relation. Under rather general hypotheses allowing for phase transitions, we prove that the empirical measures satisfy an LDP with a convex good rate function for which a fluctuation relation holds. This is a joint work with N. Cuneo, V. Jaksic, and C.-A. Pillet.

Session 37, June 23, 2017 in Paris (Institut Henri-Poincaré)

Olivier Glass (Université Paris-Dauphine),
Control of the motion of a fluid at low Reynolds number.

Abstract. I will describe a result obtained with Thierry Horsin (Conservatoire national des arts et métiers, Paris), concerning the possibility of prescribing the motion of a zone of a fluid inside a domain, by means of a boundary control. When the fluid is very viscous (and modeled by the stationary Stokes equation), we obtain results proving that prescribing this motion is indeed possible in an approximate way. This relies on an adaptation for the Stokes equation of Runge's theorem concerning the approximation of holomorphic functions by rational functions.

Oana Pocovnicu (Heriot-Watt University),
A two-soliton with transient turbulent regime for a focusing cubic nonlinear half-wave equation on the real line .

Abstract. In this talk we consider a nonlocal focusing cubic half-wave equation on the real line. Evolution problems with nonlocal dispersion naturally arise in physical settings which include models for wave turbulence, continuum limits of lattice systems, and gravitational collapse. The goal of the talk is to present the construction of an asymptotic global-in-time modulated two-soliton solution of small mass, which exhibits the following two regimes: (i) a turbulent regime characterized by an explicit growth of high Sobolev norms on a finite time interval, followed by (ii) a stabilized regime in which the high Sobolev norms remain stationary large forever in time. This talk is based on joint work with P. Gérard (Orsay, France), E. Lenzmann (Basel, Switzerland), and P. Raphael (Nice, France).

Michael Ruzhansky (Imperial College London),
Very weak solutions to wave equations.

Abstract. In this talk we will discuss the wave type equations with time-dependent very singular (distributional) coefficients. Examples will include the wave equation for the Landau Hamiltonian as well as equations arising in acoustics and in shallow water problems. We present two type or results: for equations with Hölder coefficients (in the spirit of Colombini, de Giorgi, and Spagnolo), and for equations with distributional coefficients (very weak solutions). There appear some interesting phenomena that we will discuss (also numerically). If time permits, we will also give results on for the corresponding wave equations for the sub-Laplacian on stratified Lie groups (e.g. on the Heisenberg group) as well as for higher order operators (such as Rockland operators on graded Lie groups). The talk will be mostly based on different joint works with Claudia Garetto and Niyaz Tokmagambetov.

Joseph Viola (Université de Nantes),
The Hamilton flow and Schrödinger evolution for degree-2 complex-valued Hamiltonians.

Abstract. Given a (complex-valued, degree 2) polynomial on phase space, we can study both the (classical) Hamilton flow and the (quantum) Schrdinger evolution. We discuss the relationship between these two objects: most

concretely, we will show how to use the Hamilton flow to find the L^2 operator norm of the Schrödinger evolution, when this evolution operator is compact.

Session 36, March 31, 2017 in London (King's College, London)

Michael Farber (Queen Mary University of London),
Topology of large random spaces.

Abstract. I will discuss probabilistic models generating random simplicial complexes. One is able to predict their topological properties with probability tending to one when the spaces are large, i.e. depend on a growing number of independent random variables.

Evelyne Miot (Universit Joseph-Fourier, Grenoble),
Uniqueness and stability for the Vlasov-Poisson system with spatial density in Orlicz spaces.

Abstract. We study uniqueness and stability issues for the Vlasov-Poisson system with spatial density belonging to a certain class of Orlicz spaces. In particular, we provide a quantitative stability estimate for the Wasserstein distance between two weak solutions with spatial density in such Orlicz spaces, in the spirit of Dobrushin's proof of stability for mean-field PDEs. Our proofs are built on the second-order structure of the underlying characteristic system associated to the equation. This is joint work with T. Holding.

Gilles Pisier (Universit Pierre-et-Marie-Curie, Paris and Texas A&M University),
Lacunary series in duals of compact groups and generalizations.

Abstract. We will recall some of the classical theory of Sidon sets of characters on compact groups (Abelian or not). We will then give several recent extensions to Sidon sets, randomly Sidon sets and subgaussian sequences in bounded orthonormal systems, following recent work by Bourgain and Lewko, and by the author, both currently available on arxiv. The case of matricial systems, analogous to Fourier-Peter-Weyl series on compact groups, connects the subject to random matrix theory. An unpublished result of Rider (circa 1975) will also be highlighted.

Igor Wigman (King's College London),
Nodal intersections of random toral eigenfunctions against a test curve.

Abstract. This talk is based on joint works with Zeev Rudnick, and Maurizia Rossi.
We investigate the number of nodal intersections of random Gaussian Laplace eigenfunctions on the standard 2-dimensional flat torus (arithmetic random waves) with a fixed reference curve. The expected intersection number is universally proportional to the length of the reference curve, times the wavenumber, independent of the geometry.
Our first result prescribes the asymptotic behaviour of the nodal intersections variance for generic smooth curves in the high energy limit; remarkably, it is dependent on both the angular distribution of lattice points lying on the circle with radius corresponding to the given wavenumber, and the geometry of the given curve. For these curves we can prove the Central Limit Theorem. We then construct some examples of exceptional "static" curves where the variance is of smaller order of magnitude, and the limit distribution is non-Gaussian.

Session 35, December 9, 2016 in Paris (Institut Henri-Poincaré)

David Chiron (Université de Nice - Sophia Antipolis),
Multiple branches of travelling waves in the Gross-Pitaevskii equation.

Abstract. We consider the Nonlinear Schrdinger or Gross-Pitaevskii equation in the plane. This equation possesses travelling waves solutions, first studied by Jones and Roberts, for speeds between 0 and the speed of acoustic waves $\sqrt{2}$. These travelling waves are well described for c close to 0, where the solution exhibit vortices, and for c close to $\sqrt{2}$, where they are asymptotically described by the Kadomtsev-Petviashvili-I (KP-I) equation. In this talk, we shall give some numerical results showing the existence of other branches of travelling waves, corresponding to excited states, coming from both of the limits c close to $\sqrt{2}$ and c going to 0. This is a joint work with C. Scheid (Nice).

Jimmy Lamboley (Université Paris-Dauphine),
Minimization of the compliance of a connected 1-dimensional set

Abstract. In this talk, we describe the features of the following optimization

problem, whose unknown is a connected 1-dimensional set in $\mathbb{R}^2$:

$$\min\{\mathcal{C}(\Sigma) + \lambda\mathcal{H}^1(\Sigma), \Sigma \text{ closed connected subset of } \overline{\Omega}\},$$

where Ω is a fixed open set of $\mathbb{R}^2$, $\lambda > 0$, $\mathcal{H}^1(\Sigma)$ denotes the length of Σ (its 1-dimensional Hausdorff measure), and $\mathcal{C}(\Sigma)$ denotes the compliance of $\Omega \setminus \Sigma$, that is the opposite of the Dirichlet energy of $\Omega \setminus \Sigma$ (for an external force term $f \in L^2(\Omega)$).
This problem can be interpreted as to find the best location for attaching (on Σ) a membrane Ω subject to a given external force f so as to minimize its compliance. It can be seen as an elliptic PDE version of the average distance problem/irrigation problem which has been extensively studied in the literature, and is also deeply related to the famous Mumford-Shah problem. We particularly focus on the regularity and the topology of minimizers, we prove that they are made of a finite number of smooth curves meeting only by three at 120 degree angles, containing no loop, and possibly touching $\partial\Omega$ only tangentially. We will describe the classical tools and the new ones we developed for this purpose.
This is a joint work with A. Chambolle, A. Lemenant and E. Stepanov.

Alexander Pushnitski (King's College London),
Inverse spectral problem for positive Hankel operators

Abstract. Hankel operators are infinite matrices with entries a_{n+m} depending on the sum of indices. I will discuss an inverse spectral problem for a certain class of positive Hankel operators. The problem appeared in the recent work by P.Gerard and S.Grellier as a step towards description of evolution in a model integrable non-dispersive equation. Several features of this inverse problem make it strikingly (and somewhat mysteriously) similar to an inverse problem for Sturm-Liouville operators. I will describe the available results for Hankel operators, emphasizing this similarity. This is joint work with Patrick Gerard (Orsay).

Gwyneth Stallard (The Open University),
The structure of the escaping set in complex dynamics

Abstract. Complex dynamics concerns the behaviour of points in the complex plane under iteration by a holomorphic function. This talk is particularly concerned with the iterative behaviour of transcendental entire functions such as exponential functions. The escaping set is the set of points that

escape to infinity under iteration and plays a key role in complex dynamics. Much research in recent years has been motivated by Eremenko's conjecture that all the components of the escaping set are unbounded and has led to a much deeper understanding of the possible structures of the escaping set. This talk gives an overview of work in this area, particularly of joint work with Phil Rippon.

Session 34, October 14, 2016 in London (University College London)

Aline Bonami (Université d'Orléans),
Fourier multipliers of the Sobolev space $W^{1,1}$.

Abstract. We will consider Fourier multipliers of the space $W^{1,1}(\mathbb{R}^d)$ (resp. the homogeneous space $\dot{W}^{1,1}(\mathbb{R}^d)$). It is well known that Fourier multipliers of the space $L^1(\mathbb{R}^d)$ coincide with Fourier transforms of bounded measures. The same characterization is valid for Fourier multipliers of $\dot{W}^{1,1}(\mathbb{R}^d)$ when $d = 1$, but the situation is different for $d > 1$. Namely, Poornima proved the existence of other multipliers by using a delicate construction of Ornstein. On the other hand, no non constant homogeneous function of degree 0 is a Fourier multiplier of $\dot{W}^{1,1}(\mathbb{R}^d)$. It was proved recently by Kazaniecki and Wojciechowski that such Fourier multipliers are continous functions.
We will give the analogue in this context of De Leeuw Theorems for Fourier multipliers of $L^p(\mathbb{R}^d)$, that is, prove that the restriction of a Fourier multiplier to some subgroups of $\mathbb{R}^d$ is still a Fourier multiplier. We will also consider extension theorems and give new examples of Fourier multipliers of $W^{1,1}(\mathbb{R}^d)$ and $\dot{W}^{1,1}(\mathbb{R}^d)$.

This is work in progress with Madan and Mohanty (IIT Kanpur, India).

Gabriel Paternain (University of Cambridge),
Recovering a connection from parallel transport along geodesics

Abstract. I will discuss the inverse problem of recovering a unitary connection from the parallel transport along geodesics of a compact Riemannian manifold with strictly convex boundary. It is possible to solve this geometric inverse problem in two disjoint settings: manifolds of negative curvature and manifolds of non-negative curvature. The solutions are based on a range of techniques, including energy estimates, regularity results for the transport equation associated with the geodesic flow and microlocal analysis.

Nadia Sidorova (University College London),
Delocalising the parabolic Anderson model

Abstract. The parabolic Anderson problem is the Cauchy problem for the heat equation on the integer lattice with random potential. It is well-known that, unlike the standard heat equation, the solution of the parabolic Anderson model exhibits strong localisation. In particular, for a wide class of iid potentials (including Pareto potentials) it is localised at just one point. In the talk, we discuss a natural modification of the parabolic Anderson model on Z, where the one-point localisation breaks down for heavy-tailed Pareto potentials and remains unchanged for light-tailed Pareto potentials, exhibiting a phase transition at the Pareto parameter 2. This is a joint work with Stephen Muirhead and Richard Pymar.

Laurent Stolovitch (Université de Nice-Sophia Antipolis),
Real submanifolds of maximum complex tangent space at a CR singular point
1 Abstract. In this joint work with Xianghong Gong (Madison), we study a

germ of real analytic n-dimensional submanifold of $\mathbf{C}^n$ that has a complex tangent space of maximal dimension at a CR singularity. Under some assumptions, it is a perturbation of a quadric and we show its equivalence to a normal form under a local biholomorphism at the singularity. We also show that if a real submanifold is formally equivalent to a quadric, it is actually holomorphically equivalent to it, if a "small divisors condition" is satisfied.

Session 33, June 17, 2016, in Paris (Institut Henri-Poincaré)

Valeria Banica (Université d'Evry),
Collision of almost parallel vortex filaments.

Abstract. We investigate the occurrence of collisions in the evolution of vortex filaments through a system introduced by Klein, Majda and Damodaran and by Zakharov. We first establish rigorously the existence of a pair of almost parallel vortex filaments, with opposite circulation, colliding at some point in finite time. The collision mechanism is based on the one of the self-similar solutions of the model, described in our previous work. We also extend this construction to the case of an arbitrary number of filaments, with polygonal symmetry, that are perturbations of a configuration of parallel vortex filaments forming a polygon, with or without its center, rotating

with constant angular velocity. This is a joint work with Erwan Faou and Evelyne Miot.

Julio Delgado (Imperial College London),
Schatten-von Neumann properties on compact manifolds

Abstract. In this talk we present some recent results on the study of Schatten-von Neumann properties for operators on compact manifolds. We will explain the point of view of kernels and full symbols. The special case of compact Lie groups is treated separately. We will also discuss about operators on L^p spaces by using the notion of nuclear operator in the sense of Grothendieck and deduce Grothendieck-Lidskii trace formulas in terms of the matrix-symbol . (This a joint work with Michael Ruzhansky.)

Nader Masmoudi (New York University, USA),
Stability of the 3D Couette Flow

Abstract. We discuss the dynamics of small perturbations of the plane, periodic Couette flow in the 3D incompressible Navier-Stokes equations at high Reynolds number. For sufficiently regular initial data, we determine the stability threshold for small perturbations and characterize the long time dynamics of solutions near this threshold. For rougher data, we obtain an estimate of the stability threshold which agrees closely with numerical experiments. The primary linear stability mechanism is an anisotropic enhanced dissipation resulting from the mixing caused by the large mean shear; the main linear instability is a non-normal instability known as the lift-up effect. Understanding the variety of nonlinear resonances and devising the correct norms to estimate them form the core of the analysis we undertake. Joint work with Pierre Germain and Jacob Bedrossian.

Clément Mouhot (University of Cambridge),
Hölder continuity of solutions to Vlasov-Fokker-Planck type equations with rough coefficients

Abstract. The celebrated De Giorgi-Nash theory about Hölder continuity of solutions to elliptic or parabolic equations with rough –i.e. merely measurable– coefficients in the late 1950s is a cornerstone of modern PDE analysis. We extend this theory to a class of kinetic equation of Vlasov-Fokker-Planck type ("hypoelliptic of type II" in the terminology of Hörmander) where a first-order hyperbolic operator interacts with a partially elliptic operator with rough coefficients. We also extend the theory of Moser about Harnack inequalities for these equations. This is a joint work with F. Golse, C. Imbert and A. Vasseur.

Session 32, march 18, 2016, in London (Queen Mary University of London)

Thierry Levy (Université Pierre et Marie Curie),
The Douglas-Kazakov phase transition.

Abstract. Douglas and Kazakov predicted about twenty years ago that the pure Euclidean Yang-Mills theory on the two-dimensional sphere with structure group $U(N)$ exhibits a phase transition, in the limit where N tends to infinity, when the area of the sphere crosses the critical value π^2. In probabilistic language, this can be expressed as a phase transition for

the Brownian bridge on the unitary group $U(N)$ in the large N limit, when the length of the bridge crosses the same critical value π^2. I will describe this phase transition from two points of view, on one hand by discussing the distribution of the eigenvalues of certain random unitary matrices, and on the other hand by looking for the dominant Fourier modes of the heat kernel on the unitary group. This is joint work with Mylène Maïda (Lille).

Ivan Todorov (Queen's University Belfast),
Operator systems, non-signalling correlations and quantum graph parameters

Abstract. Operator systems have played a central role in Operator Algebra Theory since their introduction in the 1970's. Capturing the features of non-commutative order, they and their morphisms "completely positive maps" have been prominent in C^*-algebra Theory, Operator Space Theory and, lately, Quantum Information Theory. The talk will be centred around their use in the description of classes of quantum correlations and in the introduction and study of quantum graph parameters, including quantum chromatic numbers and projective ranks. Their connection with Tsirelson's Problem and Connes' Embedding Problem will be discussed, and the link between these problems and the introduced graph parameters will be highlighted.

Christophe Lacave (Université Paris-Diderot),
Incompressible fluids through a porous medium

Abstract. In a perforated domain, the asymptotic behavior of the fluid motion depends on the rate (inter-hole distance)/(size of the holes). We will present the standard framework and explain how to find the critical rate where "stange terms" appear. Next, we will compare the critical rate for the Laplace, Navier-Stokes and Euler equations.

Gustav Holzegel (Imperial College London),
Linear Stability of the Schwarzschild solution under gravitational perturbations

Abstract. The well-known Schwarzschild solution is a spherically symmetric static solution of the vacuum Einstein equations describing a black hole. In my talk, I will outline a recent proof, obtained in collaboration with

Dafermos and Rodnianski, of the linear stability of the Schwarzschild solution under gravitational perturbations. The proof combines insights on the behaviour of linear waves on black hole backgrounds (proven in the last ten years) with a hierarchical structure in the system of linearised Einstein equations.

Session 31, December 11, 2015 in Paris (Institut Henri-Poincaré)

Mariapia Palombaro (University of Sussex),
Higher gradient integrability for two-phase conductivities in dimension two.

Abstract. I will present some results concerning the higher gradient integrability of σ-harmonic functions u with discontinuous coefficients σ, i.e. weak solutions of $\operatorname{div}(\sigma\nabla u) = 0$. When σ is assumed to be symmetric, then the optimal integrability exponent of the gradient field is known thanks to the work of Astala and Leonetti & Nesi. I will discuss the case when only the ellipticity is fixed and σ is otherwise unconstrained and show that the optimal exponent is attained on the class of two-phase conductivities: $\sigma : \Omega \subset \mathbb{R}^2 \mapsto \{\sigma_1, \sigma_2\} \subset \mathbb{M}^{2\times 2}$. The optimal exponent is established, in the strongest possible way of the existence of so-called exact solutions, via the exhibition of optimal microgeometries. (Joint work with V. Nesi and M. Ponsiglione.)

Benoît Grebert (Université de Nantes),
On reducibility of quantum harmonic oscillator on $\mathbb{R}^d$ with quasi periodic in time potential.

Abstract. We prove that a linear d-dimensional Schrdinger equation on $\mathbb{R}^d$ with harmonic potential x^2 and small t-quasiperiodic potential

$$i\partial_t u = -\partial_x^2 u + |x|^2 u + \varepsilon V(t\omega, x)u, \quad x \in \mathbb{R}^d$$

reduces to an autonomous system for most values of the frequency vector ω. As a consequence any solution of such a linear PDE remains bounded in all Sobolev norms.

Claude Warnick (Imperial College, London),
Scattering resonances and black holes.

Abstract. Many types of black hole respond to linear perturbations by ringing like a bell. The associated characteristic frequencies are complex, representing behaviour that is both oscillatory and decaying. I will present recent work establishing rigorously the properties of the spectrum for a large class of black holes. I will connect the problem to the study of the meromorphicity of the resolvent for asymptotically hyperbolic manifolds, and show that the methods introduced for the black hole problem give a novel proof of a classical result of Mazzeo-Melrose.)

Frédéric Rousset (Université Paris 11 - Orsay),
Quasineutral limit for Vlasov-Poisson systems.

Abstract. We shall discuss the quasi-neutral limit of the Vlasov Poisson system in Sobolev spaces. We will prove in particular the local well-posedness of the limit system, which is a Vlasov type equation with Dirac interaction potential, for initial data in Sobolev spaces for which the profile in the velocity variable satisfies a stability condition. (Joint work with D. Han-Kwan)

Session 30, October 23, 2015 in London (Imperial College)

Spyros Alexakis (University of Toronto, Canada),
Control of wave equations from data on time-like surfaces, and applications to the profile of singularities

Abstract. We review some recent results, joint with A. Shao (and partly Volker Schlue), regarding the control one can obtain for some linear and non-linear wave equations, from Cauchy data on suitably large portions of time-like surfaces. We obtain control of the solution on specific space-like surfaces which have the property that any null ray crossing the surface “registers” on the Cauchy data set. This is applied to understand the singularity profile of some focusing non-linear waves.

Camille Laurent (CNRS, Université Pierre-et-Marie-Curie, Paris),
Quantitative unique continuation for operators with partially analytic coefficients. Application to approximate control for waves.

Abstract. Unique continuation is very often proved by Carleman estimates or Holmgren theorem. The first one requires the strong geometric assumption of pseudoconvexity of the hypersurface. The second one only requires

that the hypersurface is non characteristic, but the coefficients need to be analytic.
Motivated by the example of the wave equation, several authors (Tataru, Robbiano-Zuily, Hrmander) finally proved in great generality that there could be unique continuation in some intermediate situation where the coefficients are analytic in part of the variables. In particular, for the wave equation, it allowed to prove the unique continuation across any non characteristic hypersurface for non analytic metric.
In this talk, after presenting these works, I will describe some recent work where we quantify this unique continuation. This leads to the optimal (in general) logarithmic stability estimates. We will also give some applications to controllability. This is joint work with Matthieu Lautaud (Université Paris-Diderot).

José Rodrigo (University of Warwick),
On non-resistive MHD systems connected to magnetic relaxation.

Abstract. In this talk I will present several results connected with the idea of magnetic relaxation for MHD, including some new commutator estimates (and a counterexample to the estimate in the critical case). (Joint work with various subsets of D. McCormick, J. Robinson, C. Fefferman and J-Y. Chemin.)

Roman Novikov (CNRS, École Polytechnique, Palaiseau),
Inverse scattering at fixed energy with non-overdetermined data.

Abstract. We consider the problem of reconstruction of the potential in the Schrödinger equation from the scattering amplitude at a fixed energy in dimension $d = 2, 3, \ldots$. The main purpose of this talk consists in consideration of this problem in non-overdetermined formulation, that is when the scattering amplitude at fixed energy is given on appropriate d-dimensional sub-manifolds of its domain of definition. The main attention is paid to the three-dimensional case: $d = 3$. Our results include, in particular, the first efficient approximate reconstruction algorithm and related stability estimates for the non-overdetermined three-dimensional inverse scattering problem at sufficiently high fixed energy.

Session 29, June 19, 2015 in Paris (Institut Henri-Poincaré)

held within a 3 month-program on inverse problems

Daniel Tataru (UC Berkeley, USA),
The energy critical Maxwell Klein Gordon evolution.

Abstract. The Maxwell Klein Gordon fits into the class of geometric nonlinear wave equations, and is closely related to wave maps and the hyperbolic Yang-Mills system. In 4+1 dimensions this problem is energy critical. I will describe recent work, joint with Joachim Krieger and Jacob Sterbenz (for small data) and with Sung-Jin Oh (for large data), on global well-posedness for this problem. In particular, I will discuss the paradifferential gauge renormalization that is crucial to all these results.

Keith Rogers (ICMAT, Madrid, Spain),
Global uniqueness for the Calderón problem with Lipschitz conductivities.

Abstract. We will review recent progress for Calderón's inverse problem in which one hopes to determine the conductivity γ of a body $\Omega \subset \mathbb{R}^n$. In order to do this, voltages are placed on the boundary $\partial\Omega$, and the induced currents, perpendicular to $\partial\Omega$, are measured. In other words, we hope to recover the conductivity from the Dirichlet-to-Neumann-map of the associated conductivity equation. With $n \geq 3$, we prove that no two Lipschitz conductivities give rise to the same Dirichlet-to-Neumann-map, extending a recent result of Haberman, who proved uniqueness for conductivities in the larger class $L^\infty \cap W^{1,n}$ with $n = 3$ or 4. Our proof builds on the work of Sylvester and Uhlmann, Brown, and Haberman and Tataru who proved uniqueness for C^1-conductivities and Lipschitz conductivities sufficiently close to the identity (as long as $\|\nabla \log \gamma\|_\infty$ is sufficiently small). We will recall their ideas, before sketching the proof of a Carleman estimate that we use in order to remove the smallness condition. This is joint work with Pedro Caro.

Maarten de Hoop (Purdue University, USA),
Title TBA

Abstract.

Adrian Nachman (University of Toronto, Canada),
Imaging Conductivity from one Internal Current Measurement and Minimal Surfaces.

Abstract. This talk will give an overview of electric conductivity imaging from interior data obtainable using Magnetic Resonance Imagers, and the beautiful underlying Riemannian structure. We show that an anisotropic conductivity in a known conformal class can be determined from measurement of one current using geometric measure theory methods. Further, we show that the associated equipotential surfaces are area minimizing with respect to a Riemannian metric obtained entirely from the physical data. We treat both Dirichlet boundary conditions, as well as those coming from the Complete Electrode Model, which we will descibe.
This describes results obtained in several joint papers with Nicholas Hoell, Robert Jerrard, Amir Moradifam, Alexandru Tamasan and Johann Veras. The experimental results are joint work with Weijing Ma, Nahla Elsaid, Michael Joy and Tim DeMonte.

Session 28, March 27, 2015 in London (King's College London)

Laurent Michel (Université de Nice-Sophia Antipolis),
Tunnel effect for a semiclassical random walk.

We consider a semiclassical random walk associated to a probability density with a finite number of wells. We study the spectrum of the associated Markov operator and give an asymptotics of the highest eigenvalues. The key ingredient in our approach is a general factorization result of pseudodifferential operators, which allows us to use recent results of the Witten Laplacian. This is a joint work with J.-F. Bony and F. Hérau.

Svetlana Jitomirskaya (Isaac Newton Institute, Cambridge, UK and UCI, USA),
Quasiperiodic Operators with Monotone Potentials: Sharp Arithmetic Spectral Transitions and Small Coupling Localization.

It is well known that spectral properties of quasiperiodic operators depend rather delicately on the arithmetics of the parameters involved. Consequently, obtaining results for all parameters often requires considerably more difficult arguments than for a.e. parameter, and does offer a deeper insight. In the first part of the talk we will report the first result of this kind in regard to the spectral decomposition: full description of spectral types of the Maryland model for all (in contrast with a.e., known for 30 years) values of frequency, phase, and coupling with nontrivial dependence on the arithmetics (joint work with W. Liu). In the second part of the talk we show that for (a large class of) bounded monotone potentials there is Anderson localization for all non-zero couplings (joint work with I. Kachkovskiy).

Dimitri Yafaev (Université de Rennes),
Spectral and scattering theory for differential and Hankel operators

We consider a class of Hankel operators H realized in the space $L^2(\mathbb{R}_+)$ as integral operators with kernels $h(t+s)$ where $h(t) = P(\ln t)t^{-1}$ and $P(X) = X^n + p_{n-1}X^{n-1} + \cdots$ is an arbitrary real polynomial of degree n. This class contains the classical Carleman operator when $n = 0$. We show that Hankel operators H in this class can be reduced by an *explicit* unitary transformation (essentially by the Mellin transform) to a differential operator $A = vQ(D)v$ in the space $L^2(\mathbb{R})$. Here $Q(X) = X^n + q_{n-1}X^{n-1} + \cdots$ is a polynomial determined by $P(X)$ and $v(\xi) = \pi^{1/2}\big(\cosh(\pi\xi)\big)^{-1/2}$ is the universal function. Then the operator $A = vQ(D)v$ reduces by the generalized Liouville transform to the standard differential operator $B = D^n + b_{n-1}D^{n-1} + \cdots + b_0(x)$ with the coefficients $b_m(x)$, $m = 0, \ldots, n-1$, decaying sufficiently rapidly as $|x| \to \infty$. This allows us to use the results of spectral theory of differential operators for the study of spectral properties of generalized Carleman operators. In particular, we show that the absolutely continuous spectrum of H is simple and coincides with $\mathbb{R}$ if n is odd, and it has multiplicity 2 and coincides with $[0, \infty)$ if $n \geq 2$ is even. The singular continuous spectrum of H is empty, and its eigenvalues may accumulate to the point 0 only. As a by-product of our considerations, we develop spectral theory of differential operators $A = vQ(D)v$ with sufficiently arbitrary functions $v(\xi)$ decaying at infinity.

Yulia Karpeshina (University of Alabama at Birmingham and Isaac Newton Institute, Cambridge),
Absolutely continuous branch of the spectrum and quantum transport properties of Schrödinger operator with a limit-periodic potential in dimension two

Existence of absolutely continuous branch of the spectrum and ballistic transport for Schrödinger operator with a limit-periodic potential in dimension two is discussed. Considerations are based on the following properties of the operator: the spectrum of the operator contains a semiaxis and there are generalized eigenfunctions being close to plane waves $e^{i\langle\vec{k},\vec{x}\rangle}$ (as $|\vec{k}| \to \infty$) at every point of this semiaxis. The isoenergetic curves in the space of momenta $\vec{k}$ corresponding to these eigenfunctions have a form of slightly distorted circles with holes (Cantor type structure).

Session 27, December 12, 2014 in Paris (Institut Henri-Poincaré)

Tadahiro Oh (The University of Edinburgh),
Invariant Gibbs measures for the nonlinear Schrödinger equations on the circle and the real line.
In this talk, we first go over the construction of invariant Gibbs measures for the nonlinear Schrödinger equations (NLS) on the circle by Bourgain '94. Then, we discuss the situation on the real line by taking larger and larger periods. In particular, we realize the limiting Gibbs measure on the real line as a diffusion process in x and prove its invariance for (sub-)quintic NLS on the real line.

Hajer Bahouri (CNRS, Université Paris-Est),
On nonlinear Schrödinger equations with exponential growth.
We describe the feature of solutions to nonlinear Schrödinger equations with exponential growth, where the Orlicz norm plays a crucial role. Based on profile decompositions, the analysis we conducted in this work emphasizes that the nonlinear effect is only generated by the **1**-oscillating component of the sequence of the Cauchy data. This phenomenon is strikingly different from those observed in scale invariant equations, where all the oscillating components have the same impact on the behavior of the solutions. One of the key arguments of our approach relies on refined Strichartz estimates involved Bourgain spaces.

Jonathan Luk (University of Cambridge),
Singularities in general relativity
I will present some recent developments in constructing stable low-regularity solutions to the Einstein equations without any symmetry assumptions. These in particular include stable spacetimes which contain singularities propagating along null hypersurfaces. I will discuss some applications of these techniques for various problems in general relativity, including understanding the interaction of impulsive gravitational waves, the formation of trapped surfaces and the singularity structure in the interior of black holes. This talk is based on results obtained in collaboration with M. Dafermos

and I. Rodnianski.

Jérémie Szeftel (CNRS, Université Pierre-et-Marie-Curie),
The resolution of the bounded L^2 curvature conjecture in general relativity.
In order to control locally a space-time which satisfies the Einstein equations, what are the minimal assumptions one should make on its curvature tensor? The bounded L^2 curvature conjecture roughly asserts that one should only need L^2 bounds of the curvature tensor on a given space-like hypersurface. This conjecture has its roots in the remarkable developments of the last twenty years centered around the issue of optimal well-posedness for nonlinear wave equations. In this context, a corresponding conjecture for nonlinear wave equations cannot hold, unless the nonlinearity has a very special nonlinear structure. I will present the proof of this conjecture, which sheds light on the specific null structure of the Einstein equations. This is joint work with Sergiu Klainerman and Igor Rodnianski.

Session 26, October 10, 2014 in London (University College London)

Claude-Alain Pillet (Centre de Physique Théorique, Université de Toulon),
The Landauer Principle in quantum statistical mechanics.
In a celebrated 1961 paper, Landauer formulated a fundamental lower bound on the energy dissipated by computation processes. Since then, there has been many attempts to formalize, generalize and contradict Landauer's analysis. The situation became even worse with the advent of quantum computing. In a recent enlightening article, Reeb and Wolf sets the game into the framework of quantum statistical mechanics, and finally gave a precise mathematical formulation of Landauer's bound. I will discuss parts of this analysis and present some extensions of it that were obtained in a joint work with V. Jaksic.

Michiel van den Berg (University of Bristol),
Minimization of Dirichlet eigenvalues.
We discuss the problem of minimizing the k'th eigenvalue of the Dirichlet Laplacian over all open sets which satisfy one or more geometric constraints for example (i) both Lebesgue measure and perimeter bounded from above, or (ii) moment of inertia bounded from above and convexity.

Gérard Besson (Université Joseph Fourier, Grenoble),
On some open 3-manifolds
We describe some open 3-manifolds whose Riemannian Geometry is widely unknown. Most of them are submanifolds of the 3-sphere, complement of Cantor sets or fractals embedded in S3. We will survey some open questions both in analysis and in geometry. Some of these questions may even be thought of as pertaining to Geometric inverse problems.

Kirill Cherednichenko (Cardiff University),
Resolvent estimates for high-contrast elliptic problems with periodic coefficients.
I will discuss the asymptotic behaviour of the resolvents $(\mathcal{A}^\varepsilon + I)^{-1}$ of elliptic second-order differential operators $\mathcal{A}^\varepsilon$ in $\mathbb{R}^d$ with periodic rapidly oscillating coefficients, as the period ε goes to zero. The class of operators covered by the discussion includes both the "classical" case of uniformly elliptic families (where the ellipticity constant does not depend on ε) and the "double-porosity" case of coefficients that take contrasting values of order one and of order ε^2 in different parts of the period cell. I shall describe a construction for the leading order term of the "operator asymptotics" of $(\mathcal{A}^\varepsilon + I)^{-1}$ in the sense of operator-norm convergence and prove order $O(\varepsilon)$ remainder estimates. This is joint work with Shane Cooper.

Session 25, June 20, 2014 in Paris (Institut Henri-Poincaré)

Karine Beauchard (École Polytechnique),
Controllability of degenerate parabolic equations: minimal time and geometric control condition.
We consider degenerate parabolic equations of Grushin type and of Kolmogorov type, on rectangle domains. We study their null controllability in the usual L^2 setting. The control is a source term localized on an open subset of the rectangle. We will see that, depending on the strength of the degeneracy, the form of the control support, and the time allowed, this controllability property holds or does not hold. These fact contrasts with the classical results proved in the uniformly parabolic case (heat equation).

Gui-Qiang G. Chen (Oxford University),
Multidimensional Transonic Shocks and Free Boundary Problems.

In this talk, we shall analyze several longstanding, fundamental multidimensional shock problems in mathematical fluid mechanics and related free boundary problems for nonlinear partial differential equations of mixed elliptic-hyperbolic type. These shock problems include supersonic flow onto a solid wedge (Prandtl-Meyers problem), shock reflection-diffraction by a concave cornered wedge (von Neumann's conjectures), and shock diffraction by a convex cornered wedge (Lighthills problem). Some recent developments and related mathematical challenges in solving these problems will be discussed. Further trends and open problems in this direction will also be addressed.

Eugen Varvaruca (University of Reading),
Singularities of steady free surface water flows under gravity.
We shall present some recent results which provide a characterization, by means of geometric methods, of all possible singularities in two related free-boundary problems in hydrodynamics: that of steady two-dimensional gravity water waves and that of steady three-dimensional axisymmetric water flows under gravity. In the 2D problem, we shall outline a modern proof, using blow-up analysis based on a monotonicity formula and a frequency formula, of the famous Stokes conjecture from 1880, which asserts that at any stagnation point on the free surface of a steady irrotational gravity water wave, the wave profile necessarily has lateral tangents enclosing a symmetric angle of 120 degrees. This result was first proved in the 1980s under some restrictive assumptions and by somewhat ad-hoc methods. The new approach extends to the case when the effects of vorticity in the flow are included. Moreover, we shall explain how the methods can be adapted to the 3D axisymmetric problem, which exhibits a much richer behaviour as far as singularities are concerned, depending on whether one is dealing with a stagnation point, a point on the axis of symmetry, or both (in the case of the origin). For example, in the case of the origin, there are two possible types of singular asymptotic behaviour: one is a conical singularity called "Garabedian corner flow", and the other is a flat degenerate point; while in the case of points on the axis of symmetry different from the origin, cusps are the only possible singularities. These results were obtained in joint works with Georg Weiss (Dusseldorf).

Christophe Cheverry (Université de Rennes 1),
Can one hear whistler waves ?

In this talk, we will present two results. The first provides a new approach allowing to extend in longer times the classical insights on fast rotating fluids. This will be applied to show that a plasma can be confined by a magnetic field. The second is based on a study of oscillatory integrals implying special phases. This will be applied to give a better understanding of whistler-mode chorus emissions in space plasmas. The framework will be relativistic Vlasov-Maxwell equations, with a penalized skew-symmetric term where the inhomogeneity of the magnetic field plays an essential part.

Session 24, March 28, 2014 in London (Queen Mary University)

Yaroslav Kurylev (University College London),
Discrete metric measure approximation and spectral convergence for Riemannian manifolds.
We consider a discrete ε-metric-measure approximation (X, d, μ) to a compact Riemannian manifold (M, g) of bounded sectional curvature and injectivity radius. We define a ρ-Laplacian, $\Delta_{\varepsilon,\rho}$ on X, $\varepsilon \ll \rho \ll 1$, and analyse the spectral convergence of $\Delta_{\varepsilon,\rho}$ to Δ_M. This is a joint work with D. Burago (PennState Univ, USA) and S. Ivanov (PDMI, Russia).

Frank Merle (Université de Cergy-Pontoise & IHES),
Blow up for mass critical KdV and universality properties near the solitary wave.
We shall give a review of old and recent results on mass critical KdV related to blow-up. A classification of all possible dynamics around the solitary wave will be given and some related problems. Joint work with Martel and Raphael.

Didier Robert (Université de Nantes),
On random Hermite series and applications.
In this lecture, we shall present some smoothing properties obtained for Hermite expansions with random coefficients in $L^2(\mathbb{R}^d)$, extending in this case known classical results for Fourier series, like the Paley-Zygmund and Salem-Zygmund theorems. In particular we get a random Strichartz inequality which can be applied to discuss local and global well-posedeness for super-critical non-linear Schrödinger equations, with and without harmonic potentials, for random initial data. We will survey these results obtained in

several joint works with Rafik Imekraz, A. Poiret, and L. Thomann.

Tom Körner (Cambridge University),
Convolution Squares.
When we convolve two functions, the result is sometimes smoother than we expect. The talk investigates the degree to which this can happen.

Session 23, December 13, 2013 in Paris (Institut Henri-Poincaré)

Pascal Auscher (Université Paris Sud),
A new proof of Koch-Tataru result for Navier-Stokes equation with BMO^{-1} data.
This result bears on the boundedness of a bilinear operator on a solution space using parabolic Carleson functions. The space of such functions is a sample of a (parabolic) tent space as defined by Coifman, Meyer, Stein. We shall explain the more systematic use of tent space in our approach of the bilinear operator. In particular, we do not rely on self-adjointness of the Laplacian. This is joint work with Dorothee Frey (ANU).

Charles Batty (University of Oxford),
Rates of decay in Tauberian theorems.
Ingham proved in 1935 that if $f \in L^\infty(0, \infty)$ and its Laplace transform $\hat{f}$ has a holomorphic extension across the imaginary axis, then the improper integral of f over $(0, \infty)$ exists and equals $\hat{f}(0)$. New proofs emerged in the 1980s as parts of elementary proofs of the Prime Number Theorem. This led to a qualitative theorem about decay of smooth orbits of operator semigroups. Recent research into rates of decay of energy in damped wave equations has inspired further investigation of the rates of converegence in these results and to L^p-versions of Ingham's theorem. I will survey these results including recent joint work with Yuri Tomilov, Ralph Chill and Alexander Borichev.

Nicolas Rougerie (CNRS & Université Joseph Fourier),
Classical Coulomb gases beyond mean-field theory.
Classical Coumb systems are fundamental models of matter and have a well-known relevance to the study of random matrices ensembles, the Ginzburg-Landau theory of superconductivity, and the fractional quantum Hall effect.

In this talk, we will consider a large system of N classical charged particles interacting via Coulomb forces in space dimension d=2 or larger, trapped in a confining electrostatic potential. Assuming that the strength of the interaction scales as the inverse of N (mean-field regime), it is well-known that the leading order of the ground state energy is given by a mean-field (continuum) theory. We will be interested in going to the next order and investigate the fluctuations around mean-field theory. We prove that these are described by the minimization of a "renormalized energy" functional that gives the energy per unit volume of infinitely many charged particles interacting with each other and with a constant neutralizing background of opposite charge (infinite jellium). Exploiting coercivity properties of this functional, we deduce estimates on the precision of mean-field theory, both at zero and positive temperature. This is a joint work with Sylvia Serfaty.

Véronique Fischer (Imperial College London),
Pseudo-Differential Operators on nilpotent Lie groups.
The aim of this talk is to present recent developments in pseudo-differential calculi on nilpotent Lie groups as well as some historical motivations. This is a joint work with Professor Michael Ruzhansky (Imperial College London).

Session 22, October 11, 2013 in London (University College)

Dmitry Jakobson (McGill University),
Averaging over Riemannian metrics.
I will survey several recent results related to averaging over different spaces of Riemannian metrics. The first result is joint work with Y. Canzani and J. Toth. We study the moments of propagated perturbed eigenfunctions, evaluated at a fixed point x on a compact manifold, considered as random variables that arise from random perturbations of a metric. The (finite-dimensional) family of Schrödinger operators corresponds to perturbations of the reference Riemannian metrics. Assuming the perturbation family has nontrivial projections onto conformal changes of the metric at x, we establish asymptotics for the odd moments. Assuming the perturbation family has non-degenerate projection onto the space of volume-preserving transformations at x, we establish bounds for the variance. The perturbed eigenfunctions arise in the study of Loschmidt echo effect in physics. If time permits, I will speak about the second result (joint work with Y. Canzani, B. Clarke, N. Kamran, L. Silberman and J. Taylor). We define Gaussian

measures on manifolds of metrics with the fixed volume form. We next prove integrability results for diameter and Laplace eigenvalue functionals of the random Riemannian metric.

Michel Pierre (ENS Cachan, Ker Lann),

An introduction to shape optimization: some mathematical issues.

Shape optimization is a specific part of calculus of variations where the variable is a geometric object, often called “a shape”, which is most of the time a subset of the plane, of the space or of a d-dimensional space. Shape optimization is a very old topic, but recent years have seen renewed interest for its study, due to the countless underlying applications and to the challenging mathematical questions behind. In this survey talk, we will present some mathematical tools and results related to shape optimization. We will address for instance the questions of existence of optimal shapes, of shape differentiation and of regularity of optimal shapes (together with open problems).

Jim Wright (University of Edinburgh),

A calculus for oscillatory integrals ?

Starting with a uniform oscillatory integral bound with a given phase, we ponder the possibility of deducing uniform oscillatory integral estimates for polynomial changes of the phase. Our investigations lead to some elementary considerations of how certain geometric quantities associated to the roots of a polynomial (for example, the diameter of the roots) depend on the coefficients of the polynomial.

Matthieu Léautaud (Université Paris 7),

Damped wave equation on the torus.

We address the decay rates of the energy for the damped wave equation on the torus. When the damping coefficient does not satisfy the Geometric Control Condition (i.e. in the presence of “trapped rays”), the decay is known to fail to be exponential. In such situations, we first prove that the decay is always polynomial and then investigate the optimal polynomial rate. We prove that the relevant feature in this study is the rate at which the damping coefficient vanishes. We finally discuss different situations in which the damping coefficient is invariant in one direction. The methods used include resolvent estimates and second microlocalizations around trapped rays. This is based on joint works with Nalini Anantharaman and Nicolas Lerner.

Session 21, June 28, 2013 in Paris (Institut Henri-Poincaré)

Christian Lubich (Universität Tübingen),
Modulated Fourier expansions for continuous and discrete oscillatory systems.
This talk reviews some of the phenomena and theoretical results on the long-time energy behaviour of continuous and discretized oscillatory systems that can be explained by modulated Fourier expansions: long-time preservation of total and oscillatory energies in oscillatory Hamiltonian systems and their numerical discretisations, near-conservation of energy and angular momentum of symmetric multistep methods for celestial mechanics, metastable energy strata in nonlinear wave equations, and long-time stability of plane wave solutions of nonlinear Schrödinger equations. We describe what modulated Fourier expansions are and what they are good for. Most of the presented work was done in collaboration with Ernst Hairer. Some of the results on modulated Fourier expansions were obtained jointly with David Cohen and Ludwig Gauckler.

Horia Cornean (Aalborg University),
On the steady state correlation functions of open interacting systems.
We address the existence of steady state Green-Keldysh correlation functions of interacting fermions in mesoscopic systems for both the partitioning and partition-free scenarios. Under some spectral assumptions on the non-interacting model and for sufficiently small interaction strength, we show that the system evolves to a NESS which does not depend on the profile of the time-dependent coupling strength/bias. For the partitioned setting we also show that the steady state is independent of the initial state of the inner sample. This is joint work with V. Moldoveanu (Bucharest) and C.-A. Pillet (Toulon).

Annalisa Panati (Université du Sud-Toulon-Var),
Entropic fluctuations in non-equilibrium statistical mechanics for spin-boson systems.
We consider a finite level quantum system interaction with many (bosonic) heat reservoir. Using methods of spectral analysis of Liouvellean opera-

tors, we study fluctuation of the entropy fluxes (central limit theorem, large deviation principle). This is a joint work with V. Jaksic, C.A. Pillet, M. Westrich.

Jean Dolbeault (Université Paris Dauphine, CNRS),
Rigidity results, inequalities and nonlinear flows on compact manifolds.

Session 20, March 22, 2013 in London (Imperial College)

Gunther Uhlmann (University of Washington, Fondation Sciences Mathématiques de Paris),
Multiwave Imaging.
Multi-wave imaging methods, also called hybrid methods, attempt to combine the high resolution of one imaging method with the high contrast capabilities of another through a physical principle. One important medical imaging application is breast cancer detection. Ultrasound provides a high (sub-millimeter) resolution, but suffers from low contrast. On the other hand, many tumors absorb much more energy of electromagnetic waves (in some specific energy bands) than healthy cells. Photoacoustic tomography (PAT) consists of sending relatively harmless optical radiation into tissues that causes heating which results in the generation of propagating ultrasound waves (the photo-acoustic effect). Such ultrasonic waves are readily measurable. The inverse problem then consists of reconstructing the optical properties of the tissue from these measurements. In Thermoacoustic tomography (TAT) low frequency microwaves, with wavelengths on the order of $1m$, are sent into the medium. The rationale for using the latter frequencies is that they are less absorbed than optical frequencies. Transient Elastography (TE) images the propagation of shear waves using ultrasound. Multi-wave imaging methods lead to a rich supply of new mathematical questions that involve elliptic and hyperbolic partial differential equations. We will discuss some of the inverse problems arising in these imaging techniques with emphasis on PAT.

Jonathan R. Partington (University of Leeds),
Near invariance and kernels of Toeplitz operators.
This talk presents a study of kernels of Toeplitz operators on scalar and vector-valued Hardy spaces. The property of near invariance of a kernel

for the backward shift is shown to hold in much greater generality. In the scalar case, and in some vectorial cases, the existence of a minimal kernel containing a given function is established, and a corresponding Toeplitz symbol is determined; thus for rational symbols its dimension can be easily calculated. It is shown that every Toeplitz kernel is the minimal kernel for some function lying in it. This is joint work with Cristina Camara (Lisbon).

Pierre Degond (CNRS, Université Paul Sabatier, Toulouse),
Phase transition, hysteresis and hydrodynamic limit in models of self propelled particles interacting through local alignment.
Systems of self-propelled particles can be observed in nature at a wide variety of scales from swarming bacteria, and collectively moving cells to insect swarms, bird flocks and fish schools. In 1995, Vicsek and co-authors proposed a paradigmatic model for these phenomena, where particles tend to locally align to the average direction of their neighbors. They observed phase transitions from disordered motion to coherent collective motion when the density exceeds a certain threshold. A controversy arose in the physics community about the order of this phase transition. The goal of this talk is to provide a mathematically rigorous perspective to this discussion in a kinetic theory formalism. We prove that, according to the interaction rules, the transition can be either second-order (continuous) or first-order (discontinuous), the latter giving rise to hysteresis phenomena. We then discuss how hydrodynamic-like models for self-propelled particle systems can be constructed and show that these models present specific features that standard hydrodynamic models do not have.

Marco Marletta (Cardiff University),
On the stability of a forward-backward heat equation.
We examine the spectral properties of a family of periodic singular Sturm-Liouville problems which are highly non-self-adjoint but have purely real spectrum. The problem originated from the study of the lubrication approximation of a viscous fluid film in the inner surface of a rotating cylinder and has received substantial attention in recent years. We determine the Schatten class inclusions for the resolvent operator and properties of the associated evolution equation. This is joint work with Lyonell Boulton and David Rule.

Session 19, December 7, 2012 in Paris (Institut Henri-Poincaré)

Francis Nier (Université de Rennes 1 & INRIA),

About the method of characteristics.

While studying the mean field dynamics of a systems of bosons, one is led to solve a transport equation for a probability measure in an infinite dimensional phase-space. Those probability measures are characterized after testing with cylindrical or polynomial observables classes which are not invariant after composing with a nonlinear flow. Thus, the standard method of characteristics for transport equations cannot be extended at once to the infinite dimensional case. A solution comes from techniques developed for optimal transport and a probabilistic interpretation of trajectories. This is extracted from a joint work with Z. Ammari.

Igor Krasovsky (Imperial College London),

Double-scaling asymptotics for Toeplitz determinants.

We will discuss double-scaling asymptotics of Toeplitz determinants that display a "phase-transition". Close to the transition point the asymptotics are given in terms of Painleve functions. A typical example is the 2-spin correlation function in the 2D Ising model at the critical temperature. We will provide this and some other examples. The talk is based in part on the joint work with A.Its and T.Claeys.

Boguslaw Zegarlinski (Imperial College London),

Generalized gradient bounds and applications.

We shall discuss generalized gradient bounds for Markov semigroups and some applications including construction and ergodicity in a finite and infinite dimensional context.

Taoufik Hmidi (Université de Rennes 1),

On the regularity of the rotating vortex patches.

In this talk we discuss some special vortex patches for the two-dimensional incompressible Euler equations which preserve their shape during the motion. The simplest examples are given by Rankine and Kirchhoff vortices which are subjected to a uniform rotation around their centers. We know from the works of Deem-Zabusky and Burbea that there is a general class of rotating vortex patches, called the V-states and bifurcating from the circle at the eigenvalues of a certain linearized operator. We will show that the

V-states are convex and C^∞ close to the circle. The lecture is based on a joint work with Mateu and Verdera.

Session 18, October 5, 2012 in London (University College)

Frédéric Hérau (Université de Nantes),
Subelliptic estimates for the inhomogeneous Boltzmann equation without cut-off.
We provide global subelliptic estimates for the Bolzmann equation without angular cutoff, and show that some global gain in the spatial direction is available although the corresponding operator is not elliptic in this direction. Due to the bad symbolic properties of the operator (in the microlocal sense), the proof uses the so-called Wick quantization and some ideas coming from semi-classical analysis. This is a joint work with W.-X. Li (Wuhan) and R. Alexandre (Shanghai and Brest).

Alexander Strohmaier (Loughborough University),
Semiclassical Analysis for Discontinous Systems and Ray-Splitting Billiards.
Many questions in spectral theory are motivated by Bohr's correspondence principle which states that in the semi-classical limit classical mechanics can be recovered from Quantum mechanics. For spectral theory of the Laplace operator on compact manifolds that means that in the limit of high energy the geodesic flow determines the behaviour of the spectrum and that of eigenfunctions. A precise version of this is Egorov's theorem that links the quantum dynamics explicitly with the geodesic flow via the symbol map for pseudodifferential operators. Another classical theorem is the quantum ergodicity theorem which states that most eigenfunctions become equidistributed for large eigenvalues if the geodesic flow is ergodic. If the manifold has a metric with a jump-like discontinuity across a codimension one hypersurface Egorov's theorem does in general not hold in its classical form and the geodesic flow may not be well defined any more: geodesics hitting the discontinuity may split into reflected and refracted rays. We will prove a quantum ergodicity theorem for such manifolds relating the ergodicity of a ray-splitting dynamics to equidistribution of eigenfunctions. This is a joint work with D. Jakobson and Y. Safarov.

Stéphane Mallat (École Normale Supérieure),

From Fourier to Wavelet Scattering for Signal Classification.
Fourier analysis is powerful to characterize stationary properties and build translation invariant functional representations. Applications to signal and image processing are well known. However, a Fourier transform has high frequency instabilities under the action of diffeomorphisms. It thus becomes inappropriate to analyze the properties of functions that undergo complex deformations. As a result, it fails to characterize signal properties in most signal classification problems. Facing this issue, computer scientists have developed a jungle of new non-linear classification algorithms that go well beyond linear functional analysis. The seminar concentrates on this new area of non-linear functional analysis and its applications.
We prove that Lipschitz continuity to diffeomorphisms is obtained with a scale separation using a wavelet transform. A translation invariant and Lipschitz continuous functional representation results from a scattering decomposition which cascades wavelet transforms and non-linearities. This transform retains strong mathematical similarities with a Fourier integral, but it is Lipschitz continuous to diffeomorphisms. It is computed with a neural network architecture similar to algorithms used for classification. Several applications will be shown for image and audio texture classification, as well as hand-written digits and musical genre recognition.

Ben Green (Cambridge),
Approximate groups and applications.
We will give a survey on the topic of approximate groups. This is an area that has seen a lot of activity recently. Assuming no former knowledge, we will explain what an approximate group is, what is known about them, and some of the applications.

Session 17, June 22, 2012 in Paris (Institut Henri-Poincaré)

Maria Esteban (CNRS & Université Paris Dauphine),
Scenario for a symmetry breaking phenomenon in symmetric functional inequalities.
In this talk, I will present recent analytical and numerical work to understand symmetry breaking phenomena for optimizers in some functional inequalities, like for instance the Caffarelli-Kohn-Nirenberg inequalities. The unexpected symmetry breaking can be explained by a complicated bifurcation pattern for the branches of solutions of the corresponding Euler-

Lagrange equations.

André Martinez (Università di Bologna),
Padé approximants for the cubic oscillator (joint work with V. Grecchi).
We study the cubic oscillator Hamiltonian,

$$H(\beta) = -\frac{d^2}{dx^2} + x^2 + i\sqrt{\beta}x^3,$$

on $L^2(\mathbb{R})$, for β in the cut plane $\mathbb{C}_c$ consisting of all complex numbers that are not negative real numbers. We prove that the spectrum consists of simple eigenvalues only. Moreover, these eigenvalues depend analytically on $\beta \in \mathbb{C}_c$, are labeled by the constant number of nodes of the corresponding eigenfunction, and can be computed as the Stieltjes-Padé sum of their perturbation series at $\beta = 0$. This also gives an alternative proof of the fact that the spectrum of $H(\beta)$ is real when β is a positive number.

Adrian Constantin (King's College London),
Pressure beneath a traveling water wave.
Using harmonic function theory, we investigate the pressure within an irrotational fluid in a periodic, steady, two-dimensional gravity wave above a flat bed. We show that the pressure in the fluid strictly decreases horizontally away from the crest line. Furthermore, the pressure strictly increases with depth. The approach deals with the governing equations (incompressible Euler equations with a free boundary) and does not rely on approximations. In particular, it applies to waves of large amplitude. This is a joint work with W. Strauss.

David Gérard-Varet (Université Denis Diderot Paris 7),
Domain continuity for the Euler and Navier-Stokes equations.
The aim of the talk is to understand the effect of rough walls or rough obstacles on fluid flows. Mathematically, there are two natural ways to model the roughness:

1. by considering fluid domains with non-smooth boundaries.
2. by considering fluid domains with oscillating boundaries, the oscillation being of small amplitude and wavelength.

The first model often raises numerical and mathematical difficulties (like a lack of Cauchy theory), which requires to consider smooth approximations Ω^ε of the irregular domain Ω^0. As regards the second model, denoting by ε the small wavelength or amplitude of the oscillating boundary, one is also led to consider a sequence of domains Ω^ε parametrized by ε.

This leads naturally to questions of domain continuity for fluid models, broadly: if $\Omega\varepsilon$ converges to Ω^0, does the associated fluid velocity u^ε converge to u^0 ? Are the boundary conditions preserved in the limit ?

We shall investigate these questions in the context of the Euler and Navier-Stokes equations.

Session 16, March 23, 2012 in London (Queen Mary University)

D. Vassiliev (University College London),

The spectral function of a first order system.

We consider an elliptic self-adjoint first order pseudodifferential operator acting on columns of m complex-valued half-densities over a connected compact n-dimensional manifold without boundary. The eigenvalues of the principal symbol are assumed to be simple but no assumptions are made on their sign, so the operator is not necessarily semi-bounded. We study the spectral function, i.e. the sum of squares of Euclidean norms of eigenfunctions evaluated at a given point of the manifold, with summation carried out over all eigenvalues between zero and a positive λ. We derive a two-term asymptotic formula for the spectral function as λ tends to plus infinity. In doing this we establish that all previous publications on the subject give incorrect or incomplete formulae for the second asymptotic coefficient. We then restrict our study to the case when $m = 2$, $n = 3$, the operator is differential and has trace-free principal symbol, and address the question: is our operator a massless Dirac operator ? We prove that it is a massless Dirac operator if and only if the following two conditions are satisfied at every point of the manifold: a) the subprincipal symbol is proportional to the identity matrix and b) the second asymptotic coefficient of the spectral function is zero.

S. Nonnenmaher (CEA Saclay),

Chaotic damped waves.

The damped wave equation on a compact Riemannian manifold is a simple, yet rich nonselfadjoint problem. The study of its spectrum (made of complex eigenvalues in a strip below the real axis), in the high frequency/semiclassical limit, leads to a subtle interplay between the geodesic flow and the spatial distribution of the damping. We want to address the following question: which conditions ensure the presence of a spectral gap below the real axis, and hence the exponential decay of the wave energy ? We will mostly focus on cases where the geodesic flow (or at least some part of it) is hyperbolic, for instance if the manifold has negative sectional curvature.

J. Marklof (University of Bristol),

Eigenfunctions of rational polygons.

Consider an orthonormal basis of eigenfunctions of the Dirichlet Laplacian for a rational polygon. The modulus squared of the eigenfunctions defines a sequence of probability measures. I will show that this sequence contains a density-one subsequence that converges to Lebesgue measure. An important open problem is to classify all possible limit measures, and also to understand the corresponding microlocal lifts. The lecture is based on joint work with Zeev Rudnick.

A. Avila (Université Paris 7, IMPA),

Global theory of one-frequency Schrödinger operators.

One-frequency Schrödinger operators give one of the simplest models where fast transport and localization phenomena are possible. From a dynamical perspective, they can be studied in terms of certain one-parameter families of quasiperiodic cocycles, which are similarly distinguished as simplest classes of dynamical systems compatible with both KAM phenomena and nonuniform hyperbolicity (NUH). While being much studied since the 1970's, up to recently the analysis was mostly confined to "local theories" describing detailedly the KAM and the NUH regime. In this talk we will describe some of the main aspects of the global theory that has been developed in the previous few years.

Session 15, December 7, 2011 in Paris (Institut Henri-Poincaré)

Y. Capdeboscq,

Regularity Estimates in High Conductivity Homogenization.

In a recent work with Marc Briane and Luc Nguyen, we considered the case of a periodic micro-structure with highly conducting fibres (i.e. metal rods). Fenchenko and Khruslov showed 30 years ago that for a particular scaling

range, the effective problem includes a non-local term. We show that
(1) From a homogenization corrector result, one can deduce a lower bound on all norms $W^{1,p}_{loc}$ of the solution for $p > 2$, and this bound blows up like $\exp(C/\epsilon^2)$, a given power of the inverse of the radius of the rods.
(2) This is not a surface effect : the blow-up also occurs outside the fibres.
(3) Everywhere but at a distance less than $\epsilon^{1+\delta}$ from the fibres, the solution is uniformly $C^{1,\alpha}$ smooth. The measure of the forbidden domain tends to zero with a given rate in epsilon.
I will then discuss the interpretation of this result for two applications, a resolution problem in imaging, and meta-materials.

J.-Y. Chemin,
Blow-up condition for Navier-Stokes and Besov spaces with negative index.
In this talk, we want of extend the Escauriaza-Segerin-Sverak blow-up criteria in negative Besov spaces. Namely we want to prove that if u is a solution of the 3D incompressible Navier-Stokes equation and has a finite maximal time of existence T, then the norm in the Besov space $B^{-1+\frac{3}{p}}_{p,q}$ blows up near T for some p greater than 3 and for some q less than 2. The method consists in proving self-improving bounds on the solution which bypass the fact that the law of products is not valid for Besov spaces with negative indices.

I. Kachkovskiy,
Some results on almost-commuting operators.
A pair of almost-commuting operators is a pair of bounded self-adjoint operators with a small commutator. We are going to discuss various aspects of approximating such a pair with a pair of commuting operators, including some new results obtained jointly with N. Filonov.

F. Pacard,
Finite energy, sign changing solutions for the stationary non-linear Schrödinger equation.
I will explain how to construct finite energy solitary waves for nonlinear Klein-Gordon or Schrodinger equations. Under natural conditions on the nonlinearity, I will show the existence of finitely many nonradial solutions. In dimension 2, I will also explain how to construct finite energy solutions which have no symmetry at all.

Session 14, October 14, 2011 in London

J. Bennett,

Aspects of multilinear analysis related to Fourier restriction phenomena.

In this talk we will discuss the wide variety of geometric and combinatorial inequalities related to the restriction conjecture for the Fourier transform.

J.- M. Coron,

Controllability and stabilization of nonlinear control systems.

We present methods to study the controllability and the stabilizability of nonlinear control systems. The emphasis is put on specific phenomena due to the nonlinearities. In particular we study cases where the nonlinearities are essential for the controllability or the stabilizability. We illustrate these methods on specific control systems modeled by ordinary differential equations or partial differential equations.

B. Khoruzhenko,

Non-Hermitian Random Matrices.

In this talk I plan to survey statistical patterns in distribution of complex eigenvalues of real and complex random matrices. The emphasis will be on the exactly solvable ensembles, Gaussian and non-Gaussian, where one can derive the joint probability density function of eigenvalues induced by the matrix measure, and, consequently, the eigenvalue densities and higher-order correlations. The latter exhibit remarkable universality when scaled with the mean distance between eigenvalues. Proving such universality for a wide class of matrix distributions remains a challenging open problem.

C. Fermanian-Kammerer,

Coherent states and Nonlinear Schrödinger equation.

In this talk we will discuss the asymptotics of a family of solutions of a semi-classical nonlinear Schrödinger equation associated with initial data which are coherent states. More precisely, we will consider systems of such Schrödinger equations which are coupled by a matrix-valued potential. In this setting, we will describe nonlinear adiabatic theorems obtained recently.

Session 13, June 17, 2011 in Paris

T. Carbery,
The Multilinear Kakeya theorem, factorisation and algebraic topology.
We discuss some developments arising out of Guth's recent proof of the Multilinear Kakeya theorem which concern factorisation of functions, convex optimisation and aspects of algebraic topology.

S. Klainerman,
Rigidity of black holes.

A. Laptev,
Spectral inequalities for Dirichlet and Neumann Laplacians.
We discuss the properties of the eigenvalues of the Dirichlet and Neumann Laplacians on domains in the Euclidean space. In particular, we derive upper bounds on Riesz means that improve the sharp Berezin inequality by a negative second term. This remainder term depends on geometric properties of the boundary of the domain and reflects the correct order of growth in the semi-classical limit.

M. Rumin,
On some distribution-energy inequalities and related entropy bounds.
The talk will deal with some generalizations of inequalities by Li-Yau and Lieb-Thirring, that hold on general spaces and without Markovian or positivity assumption on the energy. They apply equally on functions or mixed states (density operators) and imply uncertainty principles involving various entropies associated to the states.

Session 12, March 4, 2011 in London

J. Robinson,
Numerical verification of regularity for solutions of the 3D Navier-Stokes equations.
I will show that one can (at least in theory) guarantee the "validity" of a numerical approximation of a solution of the 3D Navier-Stokes equations

using an explicit a posteriori test, despite the fact that the existence of a unique solution is not known for arbitrary initial data.
The argument relies on the fact that if a regular solution exists for some given initial condition, a regular solution also exists for nearby initial data ("robustness of regularity"); I will outline the proof of robustness of regularity for initial data in $H^{1/2}$.
I will also show how this can be used to prove that one can verify numerically (at least in theory) the following statement, for any fixed $R > 0$: every initial condition $u_0 \in H^1$ with $\|u\|_{H^1} \leq R$ gives rise to a solution of the unforced equation that remains regular for all $t \geq 0$.
This is based on joint work with Sergei Chernysehnko (Imperial), Peter Constantin (Chicago), Masoumeh Dashti (Warwick), Pedro Marń-Rubio (Seville), Witold Sadowski (Warsaw/Warwick), and Edriss Titi (UC Irvine-Weizmann).

S. Serfaty,
Derivation of a renormalized energy for Ginzburg-Landau vortex lattices.

P. Topping,
Regularity and compactness results for geometric PDE.
I will show how by understanding the geometry behind certain PDE, one can derive much better regularity and compactness properties for solutions than one might have initially expected. At the heart of the theory is the fact that Jacobian determinants have special properties in these regards, as has been exploited by various communities since the 1970s.
There will be no geometry prerequisites for this talk. I will do my best to make the talk appropriate both to experts and novices in the theory of PDE and harmonic analysis. Joint work with Ben Sharp.

M. Zworski,
Solitons in external fields.

Session 11, December 10, 2010 in Paris

M. Hillairet,

On a variational method to compute the forces exerted by a viscous incompressible fluid on a rigid body.
We consider a system coupling ODEs and Navier Stokes equations and modeling the motion of rigid bodies inside a viscous fluid. The Cauchy problem for this system is well-posed up to contact between two bodies or between one body and the boundary of the cavity (see [E. Feireisl, J. evol. equ. '03] and references therein). The 'contact problem' has been tackled by J.L. Vazquez and E. Zuazua (introducing a 1D toy-model), and by V.N. Starovoitov and T.I. Hesla independently. In a series of papers, we provide a new method for attacking this problem and give evidence that, when considering bodies with smooth boundaries, no contact is expectable in the 2D case, whereas it can occur in very specific 3D configurations. In this talk, I will explain this method and discuss its applications to numerical simulations and its extension to models including roughness of the rigid boundaries.

G. Koch,
Profile Decompositions and Navier-Stokes, (joint work with I. Gallagher and F. Planchon).
We use the dispersive method of "critical elements" established by Kenig and Merle to give an alternative proof of a well-known Navier-Stokes regularity criterion due to Escauriaza, Seregin and Sverak. The key tool is a decomposition into profiles of bounded sequences in critical spaces.

E. Shargorodsky,
Bernoulli free-boundary problems.
A Bernoulli free-boundary problem is one of finding domains in the plane on which a harmonic function simultaneously satisfies the homogeneous Dirichlet and a prescribed inhomogeneous Neumann boundary conditions. The boundary of such a domain is called a free boundary because it is not known a priori. The classical Stokes waves provide an important example of a Bernoulli free-boundary problem. Existence, multiplicity or uniqueness, and smoothness of free boundaries are important questions and their solutions lead to nonlinear problems.
The talk, based on a joint work with J.F. Toland, will examine an equivalence between these free-boundary problems and a class of nonlinear pseudo-differential equations for real-valued functions of one real variable, which have the gradient structure of an Euler-Lagrange equation and can be formulated in terms of the Riemann-Hilbert theory. The equivalence is global

in the sense that it involves no restriction on the amplitudes of solutions, nor on their smoothness.
Non-existence and regularity results will be described and some important unresolved questions about how irregular a Bernoulli free boundary can be will be formulated.

C.-J. Xu,
Well-posedness and qualitative properties for Boltzmann equation without angular cutoff.
It is known that the singularity in the non-cutoff cross-section of the Boltzmann collision operator leads to the gain of regularity in the velocity variable. By defining and analyzing a new non-isotropic norm which precisely captures the dissipation in the linearized collision operator, we first give a precise coercive estimate for general physical cross-sections. Then the Cauchy problem for the Boltzmann equation is considered in the framework of small perturbation of an equilibrium state where the global existence of classical solution is established in a general setting. With some essential estimates on the collision operators, the proof is based on the energy method through macro-micro decomposition.
Furthermore, we study the qualitative properties of solutions, precisely, the full regularization in all variables, uniqueness, non-negativity and convergence rate to the equilibrium. The key step to obtain the regularizing effect is a generalized version of the uncertainty principle together with a theory of pseudo-differential calculus on non-linear collision operators.
In summary, the above results lead to a satisfactory mathematical theory for the space inhomogeneous Boltzmann equation without angular cutoff. The results of this talk are from a series of joint works with R. Alexandre, Y. Morimoto, S. Ukai and T. Yang.

Session 10, October 8, 2010 in London

P. Gérard,
Action-angle variables for the cubic Szegő equation.
The cubic Szegő equation is an evolution equation on the Hardy space of the circle, which is a toy model for infinite dimensional Hamiltonian systems without dispersion. It turns out that this system admits a Lax pair. In this

talk I will show how to use this Lax pair structure to construct explicitly the action-angle variables for generic data, and discuss some applications to stability theory of special solutions. This is a joint work with Sandrine Grellier (Orléans).

M. Hairer,
Spatially Rough (S)PDEs.
We consider a class of $1+1$-dimensional Burgers-type equations driven by space-time white noise. These equations arise naturally in some path sampling problems. Their main features are that the nonlinearity is not a total derivative and that the solutions are spatially quite rough. As a consequence, the standard weak formulation breaks down and it is not clear what the right concept of solution should be. We propose a solution concept based on the theory of rough paths, which allows to understand very clearly in which sense the equations are ill-posed and how different approximations can converge to different solutions.

A. Pushnitski,
Scattering matrix and the spectral theory of discontinuous functions of self-adjoint operators.
Let A and B be self-adjoint operators in a Hilbert space such that the scattering matrix for the pair A, B is well defined. I will discuss the Fredholm index of the pair of spectral projections $P(A), P(B)$, corresponding to the interval $(-\infty, E)$. It turns out that that this index is related to the eigenvalue counting function of the scattering matrix $S(E)$ for the pair A, B. The formula which expresses this relationship can be interpreted as an integer valued version of the Birman-Krein formula.

A. Shirikyan,
Exponential stabilisation to a non-stationary solution for Navier-Stokes equations and applications.
The problem of controllability and stabilisation for Navier-Stokes equations in a bounded domain was intensively studied in the last twenty years. In particular, it was proved that the Navier-Stokes system is exactly controllable in any finite time by an external force localised in space, and any stationary point of the flow can be stabilised by a finite-dimensional feedback control. This talk is devoted to the problem of stabilisation to a non-stationary so-

lution of Navier-Stokes equations. We show that it can be achieved by a finite-dimensional force localised in space and time. We also discuss two applications of this result: construction of a feedback control stabilising a given smooth solution and exponential mixing of the flow for $2D$ Navier-Stokes equations perturbed by a space-time localised noise. The results presented in this talk are obtained in collaboration with V. Barbu, S. Rodrigues, and L. Xu.

Session 9, May 31, 2010, in Paris

R. Danchin,
A global existence result for the compressible Navier-Stokes equations in the critical L^p framework.
This talk is dedicated to the global well-posedness issue for the barotropic compressible Navier-Stokes system in the whole space. We aim at using a "critical functional framework" which is not related to the energy space. For small perturbations of a stable equilibrium state in the sense of suitable L^p-type Besov norms, we establish global existence. As a consequence, like for incompressible flows, one may exhibit a class of large highly oscillating initial velocity fields for which global existence and uniqueness hold true. The proof is based on new estimates for the linearized and the paralinearized system. This is a joint work with F. Charve.

P. Markowich,
Bohmian measures and their classical limit,
(based on joint work with Thierry Paul and Christoph Sparber). We consider a class of phase space measures, which naturally arise in the Bohmian interpretation of quantum mechanics (when written in a Lagrangian form). We study the so-called classical limit of these Bohmian measures, in dependence on the scale of oscillations and concentrations of the sequence of wave functions under consideration. The obtained results are consequently compared to those derived via semi-classical Wigner measures. To this end, we shall also give a connection to the theory of Young measures and prove several new results on Wigner measures themselves. We believe that our analysis sheds new light on the classical limit of Bohmian quantum mechanics and gives further insight on oscillation and concentration effects of semi-classical wave functions.

G. Seregin,
How does L^3-norm approach potential blowup of the Navier-Stokes equations?.
In the talk, we are going to discuss behavior of L^3-norm approaching potential blowup of the Navier-Stokes equations. Although the full answer is still unknown, some partial results will be presented.

S. Vu Ngoc,
Symplectic and spectral theory of semitoric integrable systems.
Semitoric systems form a class of completely integrable systems with two degrees of freedom that naturally generalizes completely integrable hamiltonian torus actions. I will report on recent results obtained with Alvaro Pelayo on the symplectic classification of such systems. Then the quantum analogue of these systems will be presented, together with results and conjectures concerning their spectral theory, in the semiclassical limit.

Session 8, March 19, 2010, in London

Y. Guivarc'h,
A renewal theorem for products of random matrices and some applications to stochastic recursions.
We consider a product of i.i.d random matrices A_k, and we investigate the asymptotics of the length of colum vectors for the product, under natural hypotheses on the law of A_k. We establish a renewal theorem, extending the classical one for sums of i.i.d real random variables as well as Kesten's results for positive matrices. An important role in the corresponding analysis is played by certain spectral properties of group actions on projective spaces and associated operators. We describe some consequences:
(a) Asymptotics of the tails of stationary laws for multidimensional stochastic recursions.
(b) Properties of the solutions of a matrix stochastic equation of Mandelbrot type.
(c) Convergence towards stable laws for the sum of increments associated with multidimensional stochastic recursions.

B. Helffer,

On spectral problems related to a time dependent model in superconductivity with electric current.

This lecture is mainly inspired by a paper of Y. Almog which appeared last year in the *Siam J. Math. Anal.* Our goal here is first to discuss in detail the simplest models which we think are enlightening for understanding the role of the pseudospectra in this question and secondly to present proofs which will have some general character and will for example apply in a more physical model, for which we have obtained recently results together with Y. Almog and X. Pan.

S. Kuksin,

Perturbed KdV.

I consider perturbations of the KdV equation under periodic boundary conditions which may include a random force. For any perturbation I heuristically derive an effective equation which describes the behaviour of solutions for the perturbed equation on long time-intervals. These new equations do not contain the small parameter and are often well-posed. For some classes of perturbations with randomness I prove that, indeed, the effective equation correctly describes the long time dynamics of solutions. I will discuss the relations of these results with the classical finite-dimensional averaging as well as with the Whitham averaging.

B. Niethammer,

Self-similar rupture of thin films with slip.

We consider a simple model for line rupture of thin fluid films in which Trouton viscosity and van-der-Waals forces balance. For this model there exists a one-parameter family of second kind self-similar solutions describing the evolution towards the point of rupture. We establish necessary and sufficient conditions for convergence to those self-similar solutions that lie in a certain parameter regime and present results of numerical simulations that support a conjecture on the domains of attraction of all self-similar solutions.

Session 7, December 4, 2009, in Paris

M. Dafermos,

TBA.

D. Dos Santos Ferreira,

Stability estimates for anisotropic inverse problems.

We are interested in the following inverse problem for evolution equations: in a compact Riemannian manifold with boundary, find the potential or the conformal factor of the metric from the knowledge of the dynamical Dirichlet-to-Neumann map. For instance, for the wave equation the question of identifiability has been settled by Belishev and Kurylev using the boundary control method, introduced by Belishev. This method however doesn't seem to provide suitable stability estimates.

Following ideas of Stefanov and Uhlmann on the wave equation, and inspired by a recent paper of DSF, Kenig, Salo and Uhlmann (concerned with the anisotropic Calderón problem), we derive stability estimates in simple geometries for potentials and close conformal factors from the Dirichlet-to-Neumann map associated to the dynamical Schrödinger equation. This a joint work with Mourad Bellassoued (Faculté des Sciences de Bizerte).

H. Isozaki,

Spectral deviations for the damped wave equation.

We consider an inverse problem associated with some 2-dimensional non-compact manifolds, or strictly speaking, orbifolds. Our motivating example is a Riemann surface $\mathcal{M} = \Gamma\backslash\mathbf{H}^2$ associated with the Fuchsian group of 1st kind Γ containing parabolic elements. $\mathcal{M}$ is non-compact, and has a finite number of cusps and elliptic singular points. It is then regarded as a hyperbolic orbifold. We introduce a class of Riemannian orbifolds whose metric is asymptotically equal to that of this Riemann surface at the cusp, and by observing solutions of the Helmholtz equation at the cusp, define a generalized S-matrix. We then show that this generalized S-matrix determines the Riemannian metric.

C. Mouhot,

On Landau damping.

Landau damping is a collisionless stability result of considerable importance in plasma physics, as well as in galactic dynamics. Our recent work on the subject provides a first mathematical ground for this effect in the nonlinear regime, and qualitatively explains its robustness over extremely long time scales. This is a joint work with C. Villani.

Session 6, October 2, 2009, in London

N. Anantharaman,
Spectral deviations for the damped wave equation.
We prove a Weyl-type fractal upper bound for the spectrum of the damped wave equation, on a negatively curved compact manifold. It is known that most of the eigenvalues have an imaginary part close to the average of the damping function. We count the number of eigenvalues in a given horizontal strip deviating from this typical behaviour; the exponent that appears naturally is the "entropy" that gives the deviation rate from the Birkhoff ergodic theorem for the geodesic flow. A Weyl-type lower bound is still far from reach; but in the particular case of arithmetic surfaces, and for a strong enough damping, we can use the trace formula to prove a result going in this direction.

J. Ball,
Interfaces, surface energy and solid phase transformations.
Phase transformations in solids lead to interfaces between different variants of the product phase. In some materials these are atomistically sharp, while in others the interface thickness extends over a number of atomic spacings. The talk will discuss different variational models for describing such interfaces and their analysis. This is joint work with Elaine Crooks (Swansea) and with Carlos Mora-Corral (Bilbao).

T. Duyckaerts,
Non-generic blowup solutions to cubic focusing inhomogeneous nonlinear Schrödinger equations in two dimensions.
The nonlinear Schrödinger equations with a focusing cubic nonlinearity admits an explicit blowup solution based on the ground state of the equation, which has minimal mass among the blowup solutions and an unstable blowup behavior. In this talk I will construct similar unstable blowup solutions in

the presence of an external potential and when the nonlinearity is inhomogeneous. This construction is based on properties of the linearized operator around the ground state, and on a full use of the invariances of the homogeneous cubic equation, via time-dependent modulations. This is a joint work with Valeria Banica (Evry) and Rémi Carles (Montpellier).

J. Langley,

Zeros of derivatives in the plane and off the real line.

It follows from the classical Polya shire theorem that if the function f is meromorphic with at least two distinct poles in the plane then for all sufficiently large k the kth derivative $f^{(k)}$ has at least one zero. It was conjectured by Gol'dberg that the frequency of distinct poles of f is in fact controlled by the frequency of zeros of $f^{(k)}$ as soon as $k \geq 2$. This is known to be true if all poles of f have multiplicity at most $k-1$ (Frank-Weissenborn). It is also known that if two derivatives $f^{(m)}$ and $f^{(n)}$ have finitely many zeros, where $0 \leq m \leq n-2$, then f has finitely many poles (Frank, JKL). A recent result shows that if f grows not too fast, and if $f^{(k)}$ has finitely many zeros for some $k \geq 2$, then again f has finitely many poles. On the other hand, simple examples make it clear that no result along the lines of Gol'dberg's conjecture holds for $k = 1$.

The second main theme concerns non-real zeros of derivatives of real entire functions and results by several authors (Levin, Ostrovskii, Hellerstein, Williamson, Sheil-Small, Edwards, Bergweiler, Eremenko, JKL) arising from a conjecture of Wiman around 1911. Let f be an entire function, real on the real axis, with only real zeros. If $f^{(k)}$ has only real zeros for some $k \geq 2$, then f belongs to the Laguerre-Polya class LP of locally uniform limits of real polynomials with real zeros, and all derivatives of f have only real zeros. On the other hand if f does not belong to LP then the number of non-real zeros of $f^{(k)}$ tends to infinity with k.

The last part of the talk involves non-real zeros of the derivatives of meromorphic functions. Here much less is known than in the entire case, but some recent results suggest that at least some progress is possible.

Session 5, June 4, 2009, in Paris

N. Bournaveas,

Kinetic models of chemotaxis.

Chemotaxis is the directed motion of cells towards higher concentrations of chemoattractants. At the microscopic level it is modeled by a nonlinear kinetic transport equation with a quadratic nonlinearity. We'll discuss global existence results obtained using dispersion and Strichartz estimates, as well as some blow up results (joint work with Vincent Calvez, Susana Gutierrez and Benoît Perthame).

D. Lannes,

The stabilizing role of gravity for Rayleigh-Taylor instabilities in internal waves.

The internal waves problem consists in studying the motion of the interface between two perfect fluids of different densities (the water waves problem is thus the particular case of an upper fluid of density zero). Even if the heavier fluid is below, it is known that in absence of surface tension, these equations are always ill-posed in absence of surface tension, due to the formation of Rayleigh-Taylor/Kelvin-Helmoltz instabilities. However, these results do not "fit" with in situ observations that show the propagation of very large internal waves over very long distances in situations where the surface tension is very small. By a careful analysis of the role played by gravity, we are able to give a lower bound for the appearance of such instabilities, and thus get a mathematical result closer to the physical observations.

T. Paul,

Quantum normal forms and long time semiclassical approximation.

A "non-symbolic" operator theoretic derivation of the quantum Birkhoff canonical form near a periodic trajectory is presented, and provides an explicit recipe for expressing this "quantum" form from the usual (symbolic) construction (work in collaboration with Victor Guillemin). This construction can be used in the study of the long time (diverging as the Planck constant vanishes) semiclassical evolution, for which several results are presented, with an emphasis on the cases where the classical paradigm is not recovered at the (semi)classical limit.

N. Tzvetkov,

Transverse instability of the water solitary waves.

We present a recent joint work with F. Rousset. We prove the instability of the water line solitary waves constructed by Amick-Kirchgassner with respect to transverse perturbations. For that purpose we construct a family of solutions of the water waves equations which are initially arbitrary close to the line solitary waves, but for later (long) times they separate from the solitary wave (and its spatial translates) at some fixed distance, the distance being measured in some natural norms for the considered problem.

Session 4, March 20, 2009, in London

K. Ball,
From Monotone Transportation to Probability.
The talk will explain an elementary construction of the monotone transportation map of Brenier and how the map can be used to prove a deviation inequality of Marton and Talagrand and to understand entropy growth for sums of random variables.

F. Germinet,
Poisson Statistics for Eigenvalues of Continuum Random Schrödinger Operators.
We show the absence of energy levels repulsion for the eigenvalues of random Schrödinger operators in the continuum. We prove that, in the localization region at the bottom of the spectrum, the properly rescaled eigenvalues of a continuum Anderson Hamiltonian are distributed as a Poisson point process with intensity measure given by the density of states. We also obtain simplicity of the eigenvalues. We derive a Minami estimate for continuum Anderson Hamiltonians. We also give a simple and transparent proof of Minami's estimate for the (discrete) Anderson model. (Joint work with Abel Klein and Jean-Michel Combes)

J. Keating,
Quantum chaotic resonance eigenfunctions.
I will review some rather interesting conjectures concerning the distribution of resonances in quantum chaotic scattering systems. I will then describe some recent results concerning the morphology of the associated resonance

eigenfunctions for a particular class of open maps.

M. Lewin,
Spectral pollution and how to avoid it.
Spectral pollution is a very common phenomenon occurring when the spectrum of a self-adjoint operator is approximated using increasing finite-dimensional subspaces. Spurious eigenvalues can appear in gaps of its essential spectrum. In this work we precisely localize the spurious spectrum when some constraints are imposed on the basis (for instance if it is chosen in accordance with a decomposition of the underlying Hilbert space into a direct sum of two subspaces). This is followed by applications to Dirac and periodic Schrödinger operators. Joint work with Eric Séré (Paris Dauphine).

Session 3, December 1rst, 2008, in Paris

C. Guillarmou,
Analysis of the bottom of the spectrum for Schrödinger operators and some applications to Riesz transforms.
We will explain how to study the resolvent (or the spectral measure) near 0 for short range Schrödinger type operators on asymptotically Euclidean metric (or more generally asymptotically conic). Then we shall give some applications to boundedness of Riesz transforms on L^p and other problems coming from harmonic analysis.

K. Pravda-Starov,
Spectra and semigroup smoothing for non-elliptic quadratic operators.
We study non-elliptic quadratic differential operators. Quadratic differential operators are non-selfadjoint operators defined in the Weyl quantization by complex-valued quadratic symbols. When the real part of their Weyl symbols is a non-positive quadratic form, we point out the existence of a particular linear subspace in the phase space intrinsically associated to their Weyl symbols, called a singular space, such that when the singular space has a symplectic structure, the associated heat semigroup is smoothing in every direction of its symplectic orthogonal space. When the Weyl symbol

of such an operator is elliptic on the singular space, this space is always symplectic and we prove that the spectrum of the operator is discrete and can be described as in the case of global ellipticity. We also describe the large time behavior of contraction semigroups generated by these operators.

H.H. Rugh,
Cones and gauges in complex spaces.
We introduce the notion of a complex cone and its associated projective gauge. This generalises a real cone with its Hilbert metric (introduced by Birkhoff in 1957). We prove various spectral gap theorems for operators contracting a complex cone. In particular we prove a Perron-Frobenius like Theorem for a certain class of complex matrices.

J. Wright,
Isoperimetric(-type) inequalities in harmonic analysis.
Many inequalities in harmonic analysis can be viewed in the same framework as the Loomis-Whitney inequality (which immediately implies the classical isoperimetric inequality). In this talk we will develop this point of view.

Session 2, October 3rd, 2008, in London

E.B. Davies,
Spectrum of a rotating fluid film.
A few years ago some non-rigorous and partly numerical calculations suggested that a certain highly non-self-adjoint and non-elliptic second order ordinary differential operator arising in fluid mechanics had real spectrum. In this lecture I will explain results of John Weir and myself that eventually proved that this was indeed the case. The implications for the original fluid evolution equation are spelt out.

J. Dolbeault,
Fast diffusions and generalized entropies.
The first part of the talk corresponds to a joint work with B. Nazaret and G. Savaré. It will be devoted to inequalities which interpolate between

logarithmic Sobolev and Poincaré inequalities and give rates for equations involving an Ornstein-Uhlenbeck operator. The method is based on a non-local Bakry- Emery criterion and can be adapted to nonlinear diffusions of porous medium type. The second part of the talk is concerned with intermediate asymptotics of nonlinear diffusions (porous medium and fast diffusion). It is based on two papers written with A. Blanchet, M. Bonforte, G. Grillo and J.L. Vázquez. In self-similar variables, by linearizing the entropy and entropy-production functionals, it is shown that getting optimal rates amounts to find optimal constants in some Hardy-Poincaré inequalities.

I. Gallagher,
Spectral asymptotics for a skew-symmetric perturbation of the harmonic oscillator.
The aim of this lecture is to discuss spectral and pseudospectral properties of a perturbed harmonic oscillator. Motivated by a problem in Fluid Mechanics, we are particularly interested in the asymptotics of the infimum of the real part of the spectrum, as the parameter goes to zero. This is a joint work with Thierry Gallay and Francis Nier.

M. Ruzhansky,
Pseudo-differential operators and symmetries.
The theory of pseudo-differential operators on manifolds usually relies on local representations of operators in local coordinates, thus often ignoring global geometric and algebraic information that is often available. We will present a new approach to pseudo-differential operators exploring global symmetries of the underlying space and yielding a globally defined full symbol. The talk will be based on the joint work with Ville Turunen (Helsinki).

First session of the Paris London Analysis Seminar, May 16, 2008, in Paris

R. Carles,
Loss of regularity for supercritical nonlinear Schrödinger equations.
We consider the nonlinear Schrödinger equation with defocusing, smooth,

nonlinearity. Below the critical Sobolev regularity, it is known that the Cauchy problem is ill-posed. We show that this is even worse, namely that there is a loss of regularity, in the spirit of the result due to G. Lebeau in the case of the wave equation. As a consequence, the Cauchy problem for energy-supercritical equations is not well-posed in the sense of Hadamard. We reduce the problem to a supercritical WKB analysis. The proof of the main result relies on the introduction of a modulated energy functional à la Brenier. This is a joint work with T. Alazard.

A. Its,
Global asymptotic analysis of the Painlevé transcendents.
In this talk we will review some of the global asymptotic results obtained during the last two decades in the theory of the classical Painlevé equations with the help of the Isomonodromy - Riemann-Hilbert method. The results include the explicit derivation of the asymptotic connection formulæ, the explicit description of linear and nonlinear Stokes phenomenon and the explicit evaluation of the distribution of poles. We will also discuss some of the most recent results emerging due to the appearance of Painlevé equations in random matrix theory. The Riemann-Hilbert method will be outlined as well.

S. Olla,
Diffusion (and superdiffusion) of energy in a system of oscillators.
We consider a system of coupled oscillators whose Hamiltonian dynamics is perturbed by stochastic terms that conserve energy (and eventually momentum). We study the macroscopic thermal conductivity and the diffusion of energy in the kinetic limit. The corresponding Wigner distribution of the energy converges to a linear phonon Boltzmann equation. In the one dimensional unpinned case (with conservation of momentum and energy) this Boltzmann equation generates a superdiffusion governed by a Levy process, i.e. a fractional heat equation governs the macroscopic evolution of the energy.

L. Parnovski,
Spectral properties of periodic pseudo-differential operators.
I will discuss some recent results in the spectral theory of self-adjoint periodic elliptic problems (joint papers with G.Barbatis, R.Shterenberg and

A.Sobolev). One type of results I will present is the proof of the Bethe-Sommerfeld conjecture (the finiteness of the number of spectral gaps) for a large class of pseudo-differential operators which include, in particular, magnetic Schrödinger operators. The conditions under which the conjecture is shown to hold are very close to the optimal ones. The second result is a complete asymptotic expansion for the integrated density of states of a two-dimensional electric Schrödinger operator.