Nonlinear Waves 2016 : June Conference

Centre de conférences Marilyn et James Simons

ABSTRACTS

Monday 20 June

10:10 -11:00 **Patrick GERARD**

Interaction of small mass solitons for the half wave equation

I will discuss the construction of solutions for the one dimensional focusing cubic half wave equation based on the interaction of two small mass concentrated solitons, displaying growth of Sobolev norms of high regularity.
I will focus on the study of the modulation system and on the energy estimates.
This is a jointwork with Enno Lenzmann, Oana Pocovnicu and Pierre Raphael.

11:30 -12:20 **Hatem ZAAG**

A pyramid-shaped blow-up set for the 2d semilinear wave equation

We consider the semilinear wave equation with subconformal power nonlinearity in two space dimensions. We construct a finite-time blow-up solution with a pyramid-shaped blow-up surface and an isolated characteristic blow-up point at the origin. Our solution is symmetric with respect to both axes, and anti-symmetric with respect to both bisectrices. The blow-up surface is differentiable outside the bisecrtices. On the bisectrices, it only has directional derivatives.
As for the asymptotic behavior in similariy variables, the solution converges to the classical one-dimensional soliton outside the bisectrices, and to a genuinely two dimensional stationary solution, on the bisectrices, outside the origin. At the origin, it behaves like the sum of 4 solitons localized on the two axes, with opposite signs for neighbors.
This is the first example of a blow-up solution with a characteristic point in higher dimensions, showing a really two dimensional behavior. Moreover, the points of the bisectrices outside the origin give us the first example of non characteristic points where the blow-up surface is non differentiable.

14:00-14:50 **Thomas KAPPELER**

Analytic extensions of frequencies of integrable PDEs and applications

In form of a case study for the mKdV and the KdV2 equation we discuss a novel approach of representing frequencies of integrable PDEs which allows to extend them analytically to spaces of low regularity and to study their asymptotics. Applications include properties of the actions to frequencies
map as well as wellposedness results in spaces of low regularity.
This is joint work with Jan Molnar.

15:30-16:20 **Michal KOWALCZYK**

Kink dynamics in the ϕ^4 model: asymptotic stability for odd perturbations in the energy space

We consider a classical equation $\[\phi_{tt}-\phi_{xx}=\phi-\phi^3, \quad (t,x) \in \RR\times\RR \] known as the ϕ^4 model in one space dimension.
The kink, defined by $H(x)=\tanh(x/{\sqrt{2}})$, is an explicit stationary solution of this model. From a result of Henry, Perez and Wreszinski it is known that the kink is orbitally stable with respect to small perturbations of the initial data in the energy space.
In this paper we show asymptotic stability of the kink for odd perturbations in the energy space. The proof is based on Virial-type estimates partly inspired from previous works of Martel and Merle on asymptotic stability of solitons for the generalized Korteweg-de Vries equations.
However, this approach has to be adapted to additional difficulties, pointed out by Soffer and Weinstein in the case of general nonlinear Klein-Gordon equations with potential: the interactions of the so-called internal oscillation mode with the radiation, and the different rates of decay of these two components of the solution in large time.

Tuesday 21 June

10:10 -11:00 **Cécile HUNEAU**

Stability of Minkowski Space-time with a translation space-like Killing _vector field

In the presence of a translation symmetry, the 3+1 vacuum Einstein equations reduce to the 2+1 Einstein equations with a scalar fi_eld. We work in generalised wave coordinates.
In this gauge Einstein equations can be written as a system of quasilinear quadratic wave equations. The main diffi_culty in proving global existence of solutions for small data is due to the weaker decay of free solutions to the wave equation in 2+1 dimensions, compared to 3+1 dimensions. This weak decay seems to be a deterrent for proving a stability result in the usual wave coordinates. In this talk we will present the construction of a suitable generalized wave gauge in which our system has a "cubic weak null structure", which allows for the proof of global existence.

11:30 -12:20 **Pierre GERMAIN**

Stability of the Couette flow

I will present new results on asymptotic stability of the Couette flow in dimension 3. These results give an estimate for the size of the basin of attraction, depending on the viscosity, in Gevrey and Sobolev topology. This is joint work with J. Bedrossian and N. Masmoudi.

14:00 -14:50 **Mihalis DAFERMOS**

The stability of the Kerr Cauchy horizon and the strong cosmic censorship conjecture in general relativity

I will discuss recent work on black hole interiors for dynamical vacuum spacetimes (without any symmetry) and what this means for the question
of the nature of generic singularities in general relativity and the celebrated strong cosmic censorship of Penrose.
This is joint work with Jonathan Luk.

15:00 - 15:50 **Fabio PUSATERI**
Global regularity for water waves.

We will begin by introducing the water waves equations which are a system of evolution equations modeling the motion of waves (like those in the surface of the ocean), and discuss some of the works done in recent years on the question of long-time regularity.
We will then present a recent result, joint with Deng, Ionescu and Pausader, about global existence of smooth solutions for the 3d gravity-capillary water waves system in infinite depth.
The main difficulties in this problem are the slow decay of linear solutions and the presence of a large set of resonant interactions.

16:20 - 17:10 **Andrea NAHMOD**
Long time dynamics of random data NLS and invariant measures.

In this talk we show how certain well posedness results that are not available using only deterministic techniques (eg. Fourier and harmonic analysis) can be obtained when introducing randomization in the set of initial data and using powerful but still classical tools from probability.
These ideas go back to seminal work by J. Bourgain on the almost sure global well posedness and invariance of Gibbs measures for NLS and other dispersive PDE.
After explaining some of these ideas , we describe in more detail some further ideas in recent probabilistic well posedness results for NLS (joint with G. Staffilani) and new work on the existence and uniqueness of non-equilibrium in variant measures associated to resonant NLS (joint with Z. Hani, J. Mattingly, L. Rey-Bellet and G. Staffilani).

Wednesday 22 June

10:10 - 11:00 **Andrew LAWRIE**
Wave maps on hyperbolic space

The Cauchy problem for wave maps on hyperbolic space exhibits several features of a different nature than the corresponding problem on flat space. In this talk we'll focus on the question of gauge choice and we'll sketch the proof of small data global well-posedness and scattering in high dimensions using the moving frame approach introduced by Shatah and Struwe. In this setting of a curved domain, the argument will rely crucially on the fact that the main dynamic equations in Tao's caloric gauge are scalar, rather than the tensorial equations that arise in say, the Coulomb gauge. This talk is based on joint work with Sung-Jin Oh and Sohrab Shahshahani.

11:30 - 12:20 **Rowan KILLIP**
Mass-subcritical NLS

The talk will address two main topics: (i) Well-posedness in the weak topology on L^2, as well as its role in proving symplectic non-squeezing in this setting. This is joint work with Monica Visan and Xiaoyi Zhang. (ii) New large-data scattering results at critical regularity; this is joint work with Satoshi Masaki, Jason Murphy, and Monica Visan.

14:00 -14:50 **Benjamin SCHLEIN**
Derivation of invariant Gibbs measures for nonlinear Schroedinger equations from many body quantum states.

We prove that Gibbs measures of nonlinear Schroedinger equations of Hartree-type arise as high-temperature limits of appropriately modified thermal states in many-body quantum mechanics. In dimensions d=2,3 these Gibbs measures are supported on singular distributions and Wick ordering of the interaction is necessary. Our proof is based on a perturbative expansion in the interaction, organised in a diagrammatic representation, and on Borel resummation of the resulting series.

15:00 -15:50 **Enno LENZMANN**
Critical Half-Wave Problems

In this talk, I will a give a survey of recent results about the mass-critical nonlinear half-wave equation on the line. Furthermore, I will discuss work in progress on the energy-critical half-wave maps equation, which posesses some intriguing connections to completely integrabe spin chains and the theory of minimal surfaces.

16:20 -17:10 **Chris SOGGE**
Toponogov's theorem and improved Kakeya-Nikodym estimates for eigenfunctions on manifolds of nonpositive curvature

This is joint work with Matthew Blair. Using wave equation techniques and elementary facts from Riemannian geometry, we show that, on negatively curved manifolds, eigenfunctions cannot concentrate near geodesics as measured in L^2. From this we obtain improved L^p estimates which complement the sup-norm bounds in this setting obtained by Berard in the 1970s. Time permitting, we shall also discus related joint work with Y. Xi and C. Zhang on period integrals on Riemannian surfaces of negative curvature.

Thursday 23 June

10:10 -11:00 **Valeria BANICA**
Collision of almost parallel vortex filaments

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.

11:30 –12:20 **Alexandru IONESCU**
On the long-term dynamics of solutions of water wave models

I will discuss some recent work on two main questions: (1) the existence of long-term solutions in certain water wave models, and (2) the dynamical formation of singularities. The talk will be based on recent work with several collaborators, F. Pusateri, B. Pausader, Y. Deng, V. Lie, and C. Fefferman.

14:00-14h:50 **Diego CORDOBA**
Global smooth solutions for the inviscid SQG equations

In this lecture I will discuss some recent work, joint with Angel Castro and Javier Gomez-Serrano, on the existence of a non trivial family of classical global solutions of the inviscid surface quasi-geostrophic equation (SQG).

15:00-15:50 **Vlad VICOL**
On global regularity for the 2D Muskat equations with finite slope

We consider the 2D Muskat equation for the interface between two constant density fluids in an incompressible porous medium, with velocity given by Darcy's law. We establish that as long as the slope of the interface between the two fluids remains bounded and uniformly continuous, the solution remains regular. The proofs exploit the nonlocal nonlinear parabolic nature of the equations through a series of nonlinear lower bounds for nonlocal operators. These are used to deduce that as long as the slope of the interface remains uniformly bounded, the curvature remains bounded. We provide furthermore a global regularity result for small initial data: if the initial slope of the interface is sufficiently small, there exists a unique solution for all time. This is joint work with P. Constantin, F. Gancedo, and R. Shvydkoy.

16 :20-17:10 **Benjamin DODSON**
Cubic nonlinear wave equation

In this talk we will discuss some recent results regarding global well - posedness and scattering for the cubic, radial wave equation in three dimensions. Both type one and type two blowup will be discussed.

Friday 24 June

10 :10-11:00 **Thomas ALAZARD**
Control and stabilization of the incompressible Euler equation with free surface

The incompressible Euler equation with free surface dictates the dynamics of the interface separating the air from a perfect incompressible fluid. This talk is about the controllability and the stabilization of this equation.
The goal is to understand the generation and the absorption of water waves in a wave tank. These two problems are studied by two different methods: microlocal analysis for the controllability, and study of global quantities for the stabilization (multiplier method, Pohozaev identity, hamiltonian formulation, Luke's variational principle, conservation laws…).

11:30-12:20 **David LANNES**

On the dynamics of floating structures

The goal of this talk is to derive some equations describing the interaction of a floating solid structure and the surface of a perfect fluid.
This is a double free boundary problem since in addition to the water waves problem (determining the free boundary of the fluid region), one has to find the evolution of the contact line between the solid and the surface of the water.
The so-called floating body problem has been studied so far as a three-dimensional problem. Our first goal is to reduce it to a two-dimensional problem that takes the form of a coupled compressible-incompressible system.
We will also show that the hydrodynamic forces acting on the solid can be partly put under the form of an added mass-inertia matrix, which turns out to be affected by the dispersive terms of the equations.

14:00-14:50 **Robert JERRARD**

Concentrated vorticity in the Gross-Pitaevskii equations

We will present recent results describing the behavior of certain solutions of the Gross-Pitaevskii equations, in a particular scaling regime, for initial data with concentrated vorticity.

15:30-16:20 **Camillo DE LELLIS**

The h-principle and a conjecture of Onsager in fluid dynamics

I will explain some interesting connections between a well known conjecture of Lars Onsager in the theory of turbulence and a technique pioneered by Nash to produce counterintuitive solutions to (some) systems of PDEs.