Waves and Nonlinear Phenomena

28.-30. September 2022
Trondheim

1 Program

	Wednesday	Thursday	Friday
8:45-9:00	Opening		
9:00-9:40	Luc Molinet	Matteo Bonforte	Rinaldo M. Colombo
9:50-10:30	Gabriele Brüll	Alessio Porretta	Nils Henrik Risebro
10:30-11:00	Coffee	Coffee	Coffee
11:00-11:40	Anna Geyer	Erik Lindgren	Pierre Cardaliaguet
11:40-14:00	Lunch	Lunch	Lunch
14:00-14:40	Kenneth H. Karlsen	Felix del Teso	Piotr Gwiazda
14:40-15:20	Coffee	Coffee	Closing
15:20-16:00	Didier Pilod	Vincent Duchêne	
19:00-		Dinner	

2 Abstracts

Matteo Bonforte
Title: Stability in Gagliardo–Nirenberg–Sobolev inequalities: nonlinear flows, regularity and the entropy method
Abstract: We discuss stability results in Gagliardo–Nirenberg–Sobolev inequalities, a joint project with J. Dolbeault, B. Nazaret and N. Simonov. We have developped a new quantitative and costructive "flow method", based on entropy methods and sharp regularity estimates for solutions to the fast diffusion equation (FDE). This allows to study refined versions of the Gagliardo–Nirenberg–Sobolev inequalities that are nothing but explicit stability estimates. Using the quantitative regularity estimates, we go beyond the variational results and provide fully constructive estimates, to the price of a small restriction of the functional space which is inherent to the method.

Gabriele Brüll
Title: On traveling waves for the fractional KP–I equation
Abstract: In this talk, I will discuss some recent results and ongoing work concerning traveling waves for the fractional KP–I equation

$$(u_t + uu_x - D^\alpha u_x)_x - u_{yy} = 0. \tag{1}$$

For $\alpha = 2$ one recovers the classical KP–I equation, which was introduced by Kadomtsev & Petviashvili as a weakly two-dimensional extension of the Korteweg— de Vries (KdV) equation. Similarly as in the classical case, the fractional KP–I equation is a two-dimensional extension of the fractional KdV equation. Trivially, any solitary solution of the fractional KdV equation is a solution of the fractional KP–I equation – called the line solitary solution. It is known that the line solitary solution for the classical KP–I equation is transversely linear and nonlinear unstable (Zakharov '73; Alexander, Pego, Sachs '97; Rousset, Tzvetkov '09, Rousset, Tzvetkov '07). Relying on a simple criterion posed by Rousset & Tzvetkov in 2013, we extend the result on transverse linear instability for the fractional KP-I equation. Numerical experiments support the instability result for the fractional KP–I equation and suggest transverse stability for the fractional KP–II equation (which is given by (1) when replacing $-u_{yy}$ by $+u_{yy}$. Furthermore, we discuss the existence and properties of fully localized solitary solutions for the fractional KP–I equation. The results are based on joint works with H. Borluk (Istanbul) and D. Nilsson (Saarbrücken).

Pierre Cardaliaguet
Title: Microscopic derivation of a traffic flow model with a bifurcation
Abstract: In this joint work with N. Forcadel (Rouen), we derive rigorously a macroscopic traffic flow model with a bifurcation or a local perturbation from a microscopic one. The microscopic model is a simple follow-the-leader with random parameters. The random parameters are used as a statistical description of the road taken by a vehicle and its law of motion. The limit model is a deterministic and scalar Hamilton-Jacobi on a network with a flux limiter, the flux-limiter describing how much the bifurcation or the local perturbation slows down the vehicles. The proof of the existence of this flux limiter—the first one in the context of stochastic homogenization—relies on a concentration inequality and on a delicate derivation of a superadditive inequality.

Rinaldo M. Colombo
Title: Recent Results on Conservation Laws and their Applications
Abstract: The present talk aims at fostering discussions on recent results related to Conservation Laws and their applications. Epidemiological models and the analytical questions they pose are the starting point. Then, the relations between Hamilton–Jacobi Equation and Conservation Laws are considered. Finally, if time permits, a simple existence and uniqueness theorem on the Nash

equilibrium in a traffic network is presented.

Vincent Duchêne
Title: Rectifying a deep water model for water waves
Abstract: We will discuss the so-called "WW2" model obtained when disregarding higher-than-quadratic nonlinearities on the water waves system under the Zakharov/Craig-Sulem formulation. We will first argue that the initial-value problem is (most certainly) ill-posed in finite-regularity functional spaces, and precisely point out the underlying instability mechanism. Based on this analysis, we will propose a non-invasive regularization procedure which allows to recover all desired properties from the modelling point of view. The discussion will be based on a joint work with Benjamin Melinand.

Anna Geyer
Title: Stability of periodic traveling waves in the Camassa–Holm and Degasperis–Procesi equation
Abstract: I will present two recent results on the spectral stability of periodic waves in the Camassa–Holm (CH) and Degasperis–Procesi (DP) equations. I will derive a precise energy stability criterion for each equation, which is then verified numerically and shown analytically near the boundaries of the existence region. Monotonicity properties of the period function with respect to two parameters are used to obtain an existence curve for the family of smooth periodic waves with fixed period. Moreover, it allows us to classify the number of negative eigenvalues of an associated Hessian operator, which plays a crucial role in the stability analysis. For the DP equation, the number of eigenvalues changes within the existence region. For the CH equation the analysis is more elegant: we find that the periodic waves can be characterized by an alternative Hamiltonian structure for which the period function is always monotone, and hence the Hessian operator has only one simple negative eigenvalue in the entire existence region. This is joint work with Dmitry Pelinovsky.

Piotr Gwiazda
Title: Relative entropy methods for measure-valued solutions for various systems of mathematical physics
Abstract: In this talk I will present several results on so called weak-strong uniqueness result. It means that weak (measure-valued) solution and the strong solution emanating from the same initial data coincide. The physical systems discussed in the talk arise from fluid mechanics (compressible and incompressible, MHD) as well as from elasticity theory. Particularly intresting in this context seems to be the Euler-Poison system.

Kenneth H. Karlsen
Title: A singular limit problem for stochastic conservation laws
Abstract: We investigate a singular limit problem for stochastic conservation laws with discontinuous flux, perturbed by vanishing diffusion—dynamic capillarity terms. Our convergence arguments use kinetic formulations, H-measures and velocity averaging for stochastic transport equations, and a.s. representations of random variables in quasi-Polish spaces. This talk is based on joint work M. Kunzinger and D. Mitrovic.

Erik Lindgren
Title: Extremals for for some Poincaré–Sobolev inequality
Abstract: A classical result in the theory of Sobolev spaces is that for a bounded domain $\Omega \subset \mathbb{R}^n$ and $q \leq p^*$, there is $c > 0$ such that

$$c\|u\|_{L^q(\Omega)} \leq \|Du\|_{L^p(\Omega)}, \quad u \in W_0^{1,p}(\Omega).$$

Interestingly enough, the equality case of this inequality has not been thoroughly investigated when $p < q < p^*$. I will discuss uniqueness properties of extremals of this inequality. In particular, I will present some recent results for q near p and for $q = \infty$. The talk is based on results obtained with Lorenzo Brasco and Ryan Hynd.

Luc Molinet
Title: Improved bilinear Strichartz estimates with application to the well-posedness of periodic generalized KdV type equations
Abstract: We prove the unconditional LWP in Sobolev spaces of the Cauchy problem for periodic one-dimensional non linear equation of KdV type. Our result is in particular optimal in the case of the generalized KdV equation for which we obtained the unconditional LWP in H^s for $s > 1/2$.

Our main new ingredient is the introduction of improved bilinear estimates in the spirit of the improved Strichartz estimates introduced by Koch–Tzvetkov. Finally note that this enables us to derive some global existence results for sufficiently dispersive equations. This is a joined work with Tomoyuki Tanaka.

Didier Pilod
Title: Finite point blowup for the critical generalized Korteweg–de Vries equation
Abstract: In the last twenty years, there have been significant advances in the study of the blow-up phenomenon for the critical generalized Korteweg–de Vries (gKdV) equation, including the determination of sufficient conditions for blowup, the stability of blowup in a refined topology and the classification of minimal mass blowup. Exotic blow-up solutions with a continuum of blow-up rates and multi-point blow-up solutions were also constructed. However, all

these results, as well as numerical simulations, involve the bubbling of a solitary wave going at infinity at the blow-up time, which means that the blow-up dynamics and the residue are eventually uncoupled. Even at the formal level, there was no indication whether blowup at a finite point could occur for this equation.

After reviewing the theory of blow-up for the critical gKdV equation in the first part of the talk, we will answer this question by constructing solutions that blow up in finite time under the form of a single-bubble concentrating the ground state at a finite point with an unforeseen blow-up rate. Finding a blow-up rate intermediate between the self-similar rate and other rates previously known also reopens the question of which blow-up rates are actually possible for this equation. This talk is based on a joint work with Yvan Martel (École Polytechnique, France).

Alessio Porretta
Title: Long time decay rates of Fokker–Planck equations with confining drift
Abstract: The convergence to equilibrium of Fokker–Planck equations with confining drift is a classical issue, starting with the basic model of the Ornstein–Uhlenbeck process. I will discuss a new approach to obtain estimates on the time decay rate, which applies to both local and nonlocal diffusions. This is based on duality arguments and oscillation estimates for transport-diffusion equations, which are reminiscent of coupling methods used in probabilistic approaches. The motivation and application of these results stem from the study of long time behavior and turnpike properties of solutions in mean field game theory.

Nils Henrik Risebro
Title: TBA
Abstract: TBA

Felix del Teso
Title: Evolution driven by the infinity fractional Laplacian
Abstract: We consider the evolution problem associated to the following infinity fractional Laplacian operator introduced by Bjorland, Caffarelli and Figalli as the infinitesimal generator of a non-Brownian tug-of-war game:

$$\Delta_\infty^s \phi(x) = \sup_{|y|=1} \inf_{|\tilde{y}|=1} \int_0^\infty \left(\phi(x+\eta y) + \phi(x-\eta\tilde{y}) - 2\phi(x)\right) \frac{\mathrm{d}\eta}{\eta^{1+2s}}.$$

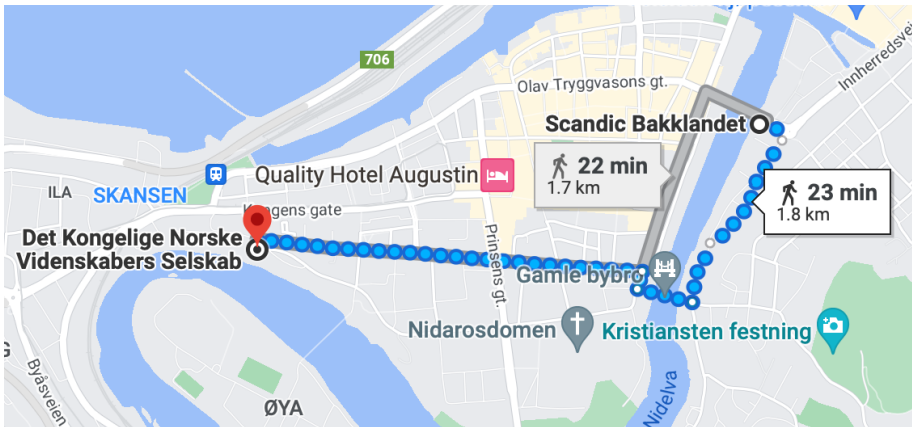
We first construct a class of viscosity solutions of the initial-value problem for bounded and uniformly continuous data. An important result is the equivalence of the nonlinear operator in higher dimensions with the one-dimensional fractional Laplacian when it is applied to radially symmetric and monotone functions. Thanks to this and a comparison theorem between classical and vis-

cosity solutions, we are able to establish a global Harnack inequality that, in particular, explains the long-time behavior of the solutions. Finally, we propose a fully discrete and monotone finite-difference scheme, and support our theoretical results with numerical evidence.

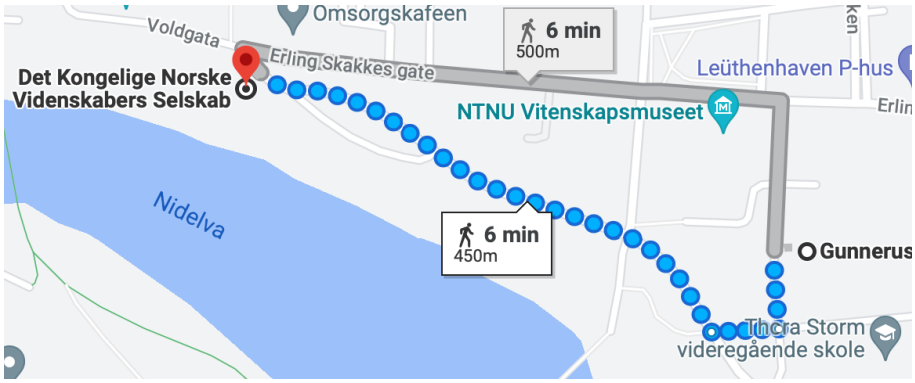
3 Practical Information

Hotel:
Scandic Bakklandet, Nedre Bakklandet 60, 7014 Trondheim
From the airport: Take the airport bus Værnes-Ekspressen til the bus stop Bakkegata. The hotel is opposite the bus stop.

Talks:
Will be at Royal Norwegian Society of Sciences and Letters (in Norwegian: Det Kongelige Norske Videnskabers Selskab), Elvegata 17, 7012 Trondheim.
From the hotel: It is a 25 min walk.



Lunch:
Will be served at Sit Kafe Kalvskinnet (Gunnerus gate 1, 7012 Trondheim). It is a 5 min walk.



Dinner:
Thursday 19:00 at Jossa Mat og Drikke, Ladeveien 9, 7066 Trondheim.
From the hotel: Either take bus number 2 in the direction Strindheim from Søndre gate to Ladeveien at 18:37.
Alternatively it is a 25 min walk from your hotel.