Monday, June 25

9:00-9:50 **Registration and coffee**.

9:50-10:00 **Opening and practical info**.

10:00-10:40 **W. Strauss**, *Brown University*, *USA*.

Title: **Steady states of rotating stars and galaxies**.

Abstract: Consider a continuum of particles attracted to each other by gravity but subject to no other forces. When it rotates, it flattens at the poles and expands at the equator. This is a simple classical model of a rotating star or planet. It can also model a rotating galaxy with its billions of stars. There are several possible mathematical formulations: Euler-Poisson, Vlasov-Poisson, etc. Yilun (Allen) Wu and I construct a connected set of slowly and rapidly rotating steady states. We fix the mass and use a global implicit function theorem based on degree to construct both slow and fast rotations.

10:50-11:30 **C. Sulem**, *University of Toronto*, *Canada*.

Title: **Bloch theory and spectral gaps for linearized water waves**.

Abstract: We examine the effect of a periodic bottom on the free surface of a fluid linearized near the stationary state develop a Bloch theory for the linearized water wave system. This analysis takes the form of a spectral problem for the Dirichlet-Neumann operator of the fluid domain with periodic bottom. We find that, generically, the presence of the bottom results in the splitting of double eigenvalues creating a spectral gap. This is a joint work with W. Craig, M. Gazeau, C. Lacave.

11:30-13:00 **Lunch at Finn Inn**.

13:00-13:40 **D. Lannes**, *Université de Bordeaux*, *France*.

Title: **The shoreline problem for the nonlinear shallow water and Green-Naghdi equations**.

Abstract: The nonlinear shallow water equations and the Green-Naghdi equations are the most commonly used models to describe coastal flows. A natural question is therefore to investigate their behavior at the shoreline, i.e. when the water depth vanishes. For the nonlinear shallow water equations, this problem is closely related to the vacuum problem for compressible Euler equations, recently solved by Jang-Masmoudi and Coutand-Shkoller. For the Green-Naghdi equation, the analysis is of a different nature due to the presence of linear and nonlinear dispersive terms. We will show in this talk how to address this problem. This is a joint work with G. Métivier.

13:50-14:30 **M. Haragus**, *Université Bourgogne Franche-Comté*, *France*.

Title: **Existence of grain boundaries for the Bénard-Rayleigh problem**.

Abstract: We study the existence of grain boundaries for the stationary Bénard-Rayleigh system. The analysis relies upon a spatial dynamics formulation of the existence problem and a centre-manifold reduction. In this setting, the grain boundaries are found as heteroclinic orbits of a reduced system of ODEs. A normal form transformation allows us to identify a leading-order approximation, which is then shown to persist using transversality arguments.

14:30-14:50 **Coffee break**.

14:50-15:30 **V. Kozlov**, *Linköping University*, *Sweden*.

Title: **A comparison theorem for $\mathbf{\Delta u + f(u) = 0}$ and its application to water waves with vorticity**.

Abstract: A comparison theorem is proved for a pair of solutions that satisfy opposite nonlinear differential inequalities in a weak sense. The nonlinearity is of the form $f(u)$ with f belonging to the class L^p_{loc}, $p > 1$, and the solutions are assumed to have non-vanishing gradients in the domain, where the inequalities are considered. The proof of this assertion uses a local partial hodograph transformation and a new strong maximum principle for linear equations. The comparison theorem is applied to the problem describing steady, periodic water waves with vorticity in the case of arbitrary free surface profiles including overhanging ones. Bounds for these profiles as well as streamfunctions and admissible values of the total head are obtained. Comparison of these estimates with previously known will be given. This work is based on the results obtained in the following papers

○ Kozlov, V., Kuznetsov, N. Bounds for solutions to the problem of steady water waves with vorticity. *Quart. J. Mech. Appl. Math.* 70 (2017), no. 4, 497–518.

○ V. Kozlov, N. Kuznetsov, A comparison theorem for super- and subsolutions of $\mathbf{\nabla^2 u + f(u) = 0}$ and its application to water waves with vorticity, *Algebra and Analysis*, v.30, (2018), 3, 112-128.

○ V. Kozlov, A. Nazarov, A comparison theorem for $\mathbf{\Delta u + f(u) = 0}$ with $\mathbf{f \in L^p}$, $\mathbf{p > 1}$. In preparation.

Tuesday, June 26

9:00-9:40 **D. Cordoba**, *Instituto de Ciencias Matemáticas (ICMAT)*, *Spain*.

Title: **On global in time solutions for two-fluid interfaces**.

Abstract: I will discuss some recent results on global existence for the Muskat equation and on stationary solutions with a splash singularity for the two-fluid Euler equations.

9:40-10:00 **Coffee break**.

10:00-10:40 **F. Rousset**, *Université Paris-Sud*, *France*.

Title: **Linear inviscid damping and enhanced viscous dissipation of shear flows by the conjugate operator method**.

Abstract: We will show how we can use the classical Mourre commutator method to study the asymptotic behavior of the linearized incompressible Euler and Navier-Stokes at small viscosity equations about shear flows. We will focus on the case of the mixing layer. Joint work with E. Grenier, T. Nguyen and A. Soffer.

10:50-11:30 **D. Tataru**, *University of California, Berkeley*, *USA*.

Title: **Morawetz estimates for water waves**.

Abstract: The classical Morawetz, or local energy decay estimates, have proved their usefulness in the study of a wide range of nonlinear pde's. The aim of this talk will be to present a family of Morawetz estimates for the full water wave equations. This is joint work with Thomas Alazard and Mihaela Ifrim.

11:30-13:00 **Lunch at Finn Inn**.

13:00-13:40 **M. Groves**, *Universität des Saarlandes*, *Germany*.

Title: **Small-amplitude static periodic patterns at a fluid-ferrofluid interface**.

Abstract: We establish the existence of static doubly periodic patterns (in particular rolls, squares and hexagons) on the free surface of a ferrofluid near onset of the Rosensweig instability, assuming a general (nonlinear) magnetisation law. A novel formulation of the ferrohydrostatic equations in terms of Dirichlet-Neumann operators for nonlinear elliptic boundary-value problems is presented. We demonstrate the analyticity of these operators in suitable function spaces and solve the ferrohydrostatic problem using an analytic version of Crandall-Rabinowitz local bifurcation theory. Criteria are derived for the bifurcations to be sub-, super- or transcritical with respect to a dimensionless physical parameter.

13:50-14:30 **A. Enciso**, *Instituto de Ciencias Matemáticas (ICMAT)*, *Spain*.

Title: **Applications of Beltrami fields to the analysis of the Euler and Navier-Stokes equations**.

Abstract: We will consider two geometric problems on fluid mechanics in whose solution Beltrami fields have played a key role. The first problem, which goes back to Lord Kelvin in 1875, concerns the existence of stationary solutions to the 3D Euler equations with vortex lines and vortex tubes of arbitrary topology. The second problem addresses the phenomenon of vortex reconnection, that is, the fact that vortex lines and vortex tubes can change their topology in the 3D Navier-Stokes equations while the solution remains smooth. The talk is based on joint work with R. Lucà and D. Peralta-Salas.

14:30-14:50 **Coffee break**.

14:50-15:30 **B. Buffoni**, *École Polytechnique Fédérale de Lausanne (EPFL)*, *Switzerland*.

Title: **Perturbative and variational solutions to the three-dimensional steady Euler equation**.

Abstract: We consider stationary flows of an inviscid and incompressible fluid of constant density in the region $D = (0, L) \times S$, where $S \neq \emptyset$ is either a bounded open connected subset of $\mathbb{R}^2$, or $S = \mathbb{R}^2$ with periodicity conditions in the second and third variables. Moreover the flows have prescribed flux through each point of ∂D. The value of the Bernoulli function $H = \frac{1}{2}|v|^2 + p$ is also prescribed on $\{0, L\} \times S \subset \partial D$ (where v is the velocity field and p the pressure). When $S = \mathbb{R}^2$, solutions near a constant solution can be obtained by a Nash-Moser iteration and, when S is bounded, generalized variational solutions can be obtained by an adaptation of Brenier's minimization approach.

Wednesday, June 27

9:00-9:40 **L. Molinet**, *Université de Tours*, *France*.

Title: **A rigidity result with application to asymptotic stability for the Camassa-Holm equation**.

Abstract: The Camassa-Holm equation possesses peaked solitary waves called peakons. We prove a Liouville property for uniformly almost localized (up to translations) H^1-global solutions of the Camassa-Holm equation with a momentum density that is a non negative finite measure. More precisely, we show that such solution has to be a peakon. As a consequence, we prove that peakons are asymptotically stable in the class of H^1-functions with a momentum density that is a non negative finite measure.

9:40-10:00 **Coffee break**.

10:00-10:40 **J. Lenells**, *KTH Royal Institute of Technology*, *Sweden*.

Title: **Long-time asymptotics for the Boussinesq equation**.

Abstract: I will discuss the solution of the initial-value problem for the Boussinesq equation via inverse scattering techniques and present asymptotic formulas for the long-time behavior of the solution in certain cases.

10:50-11:30 **J.-C. Saut**, *Université Paris-Sud*, *France*.

Title: **Boussinesq-Full Dispersion: old and new results on Boussinesq type systems**.

Abstract: The "classical" Boussinesq systems are (two-way) asymptotic models for surface water waves in the Boussinesq (KdV) regime. Variant and (more nonlinear) extensions appear also in the modeling of internal waves, for instance the two-way counterparts of the Benjamin-Ono or of the Intermediate Long Wave equations. The talk will survey old and new results on those systems, comprising long time existence and asymptotic behavior of solutions to the Cauchy problem and existence of solitary wave solutions. We will also mention a few challenging open problems.

11:30-13:00 **Lunch at Finn Inn**.

13:00-19:00 **Excursion to the Island of Ven**.

Excursion to the Island of Ven. Departure 13.00 from outside the Math building. Ferry departs 13.45 there. Guided tour 15.30-16.30. Ferry departs 17.45 back. Arrival back to the city centre at 19.00.

19:30-22:30 **Dinner at Grand Hotel**.

Thursday, June 28

9:00-9:40 **A. Geyer**, *Delft University of Technology*, *Netherlands*.

Title: **Stability of periodic waves in the reduced Ostrovsky equation**.

Abstract: In this talk I will discuss the stability of smooth and peaked periodic travelling wave solutions of the reduced Ostrovsky equation, which is a model for internal waves in a rotating fluid. I will show that all smooth periodic travelling waves are spectrally stable, independent of the nonlinearity power. In the second part of the talk I will discuss our recent result on the peaked periodic waves. This is joint work with D. Pelinovsky.

9:40-10:00 **Coffee break**.

10:00-10:40 **M. Johnson**, *University of Kansas*, *USA*.

Title: **Existence of Generalized Solitary Waves in a Gravity-Capillary Whitham Equation**.

Abstract: We consider the unidirectional Whitham equation with gravity and capillary effects taken into account. For large surface tension, this equation is known to admit small amplitude solitary wave solutions of depression, while for zero surface tension it admits solitary waves of elevation. In this talk, we consider the case of "weak" surface tension and prove that there exists small amplitude solutions that consist of a localized core, which is nearly the KdV soliton, and which is asymptotic to very small periodic oscillations at spatial infinity. This is joint work with J. Douglas Wright (Drexel).

10:50-11:30 **H. Kalisch**, *University of Bergen*, *Norway*.

Title: **Approximate Conservation Laws for the KdV Equation**.

Abstract: Dispersive long wave models, such as the KdV equation and a variety of Boussinesq and Green-Naghdi systems can be shown to accurately describe wave motion at the surface of a homogeneous fluid if the waves have small amplitude and are sufficiently long. All of these model equations feature constants of motion in the form of time-invariant integrals. Some approximate models, such as the KdV equation admit an infinite number of conserved integrals, but the physical meaning of these integrals is relatively poorly understood. In this lecture, we look at how energy conservation and other balance laws of the Euler equations may be represented in the context of these approximate models, and how they are connected to the invariant integrals of the model equations. Joint work with: Alfatih Ali, Samer Israwi, Zahra Khorsand.

11:30-13:00 **Lunch at Finn Inn**.

13:00-13:40 **S. Walsh**, *University of Missouri*, *USA*.

Title: **Capillary-gravity water waves with exponentially localized vorticity**.

Abstract: In this talk, we discuss recent success in establishing the existence of solutions to the water wave problem with exponentially decaying vorticity. These are two-dimensional stationary waves in a finite-depth body of water beneath vacuum. An external gravitational force acts in the bulk, and the effects of surface tension are felt on the air-sea interface. Our approach involves modeling the corresponding stream function as a spike layer solution to a singularly perturbed elliptic PDE. This is joint work with Mats Ehrnström (NTNU) and Chongchun Zeng (Georgia Tech).

13:50-14:30 **M. Wheeler**, *Universität Wien*, *Austria*.

Title: **Spatial asymptotics for solitary waves in deep water**.

Abstract: We consider the behavior near spatial infinity of localized traveling waves on the surface of an infinitely deep fluid. In a variety of settings and under suitable decay assumptions, we show that the leading order term in these asymptotics is of "dipole type". This has many implications for the wave, particularly in the simpler settings where the dipole moment in the expansion is given explicitly in terms of the kinetic energy. As an application, we provide detailed asymptotics for the waves with compactly supported vorticity constructed in [Shatah–Walsh–Zeng 2013]. This is joint work with Sam Walsh and Ming Chen.

14:30-14:50 **Coffee Break**.

14:50-15:30 **E. Varvaruca**, *Universitatea Alexandru Ioan Cuza*, *Romania*.

Title: **Large-amplitude steady gravity water waves with constant vorticity**.

Abstract: We consider the problem of two-dimensional traveling water waves propagating under the influence of gravity in a flow of constant vorticity over a flat bed. By using a conformal mapping from a strip onto the fluid domain, the governing equations are recasted as a one-dimensional pseudodifferential equation that generalizes Babenko's equation for irrotational waves of infinite depth. We explain how an application of the theory of global bifurcation in the real-analytic setting leads to the existence of families of waves of large amplitude that may have critical layers and/or overhanging profiles. Some new a priori bounds and geometric properties of the solutions on the global bifurcating branches will also be presented. This is joint work with Adrian Constantin (University of Vienna, Austria) and Walter Strauss (Brown University, USA).

15:30-16:00 **Break**.

16:00-18:00 **Poster session and reception**.

Friday, June 29

9:00-9:40 **G. Brüll**, *Karlsruhe Institute of Technology*, *Germany*.

Title: **A singular limit problem for compressible fluids**.

Abstract: We consider a singular limit problem for the compressible Euler system in the low Mach and strong stratification regime. Surprisingly, the limit problem is not unique but depends on the initial data. We identify the limit problem - the anelastic Euler system - in the case of well prepared initial data close to an isentropic static state. The result holds in the large class of dissipative measure-valued solutions of the primitive system. This is a joint work with E. Feireisl.

9:40-10:00 **Coffee break**.

10:00-10:40 **M. Ifrim**, *University of Wisconsin–Madison*, *USA*.

Title: **Well-posedness and dispersive decay of small data solutions for the Benjamin-Ono equation**.

Abstract: This article represents a first step toward understanding the long time dynamics of solutions for the Benjamin-Ono equation. While this problem is known to be both completely integrable and globally well-posed in L^2, much less seems to be known concerning its long time dynamics. Here, we prove that for small localized data the solutions have (nearly) dispersive dynamics almost globally in time. An additional objective is to revisit the L^2 theory for the Benjamin-Ono equation and provide a simpler, self-contained approach.

10:50-11:30 **V. Duchêne**, *Université de Rennes 1*, *France*.

Title: **On the Favrie-Gavrilyuk approximation to the Serre-Green-Naghdi system**.

Abstract: The Serre-Green-Naghdi system is a fully nonlinear and weakly dispersive model for the propagation of surface gravity waves. Recently, N. Favrie and S. Gavrilyuk proposed a strategy for producing approximate solutions with the aim of removing the numerical difficulties due to high-order differential operators. They introduced an "augmented" first-order quasilinear system with source terms, using additional unknows and a free parameter. The claim is that in the singular limit when the parameter goes to infinity, solutions of the augmented system approach solutions of the Green-Naghdi system. We will discuss a rigorous analysis.

11:30-13:00 **Lunch at Finn Inn**.

13:00-13:40 **D. Pilod**, *University of Bergen*, *Norway*.

Title: **Construction of a minimal mass blow up solution of the modified Benjamin-Ono equation**.

Abstract: We construct a minimal mass blow up solution of the modified Benjamin-Ono equation (mBO), which is a classical one dimensional nonlinear dispersive model. Let $Q \in H^{\frac{1}{2}}$, $Q > 0$, be the unique ground state solution associated to mBO. We show the existence of a solution S of mBO satisfying $\|S\|_{L^2} = \|Q\|_{L^2}$ and

$$S(t) - \frac{1}{\lambda^{\frac{1}{2}}(t)} Q\left(\frac{\cdot - x(t)}{\lambda(t)}\right) \to 0 \quad \text{in} \quad H^{\frac{1}{2}}(\mathbb{R}) \text{ as } \; t \downarrow 0,$$

where

$$\lambda(t) \sim t, \quad x(t) \sim -|\ln t| \quad \text{and} \quad \|S(t)\|_{\dot{H}^{\frac{1}{2}}} \sim t^{-\frac{1}{2}} \|Q\|_{\dot{H}^{\frac{1}{2}}} \quad \text{as } t \downarrow 0.$$

This existence result is analogous to the one obtained by Martel, Merle and Raphaël (J. Eur. Math. Soc., 17 (2015)) for the mass critical generalized Korteweg-de Vries equation (gKdV). However, in contrast with the gKdV equation, for which the blow up problem is now well-understood in a neighborhood of the ground state, S is the first example of blow up solution for mBO. The proof involves the construction of a blow up profile, energy estimates as well as refined localization arguments, developed in the context of Benjamin-Ono type equations by Kenig, Martel and Robbiano (Ann. Inst. H. Poincaré, Anal. Non Lin., 28 (2011)). Due to the lack of information on the mBO flow around the ground state, the energy estimates have to be considerably sharpened here. This talk is based on a joint work with Yvan Martel (École Polytechnique).

13:50-14:30 **E. Lokharu**, *Lund University*, *Sweden*.

Title: **Local bifurcation of three-dimensional doubly-periodic steady water waves with vorticity**.

Abstract: We investigate the propagation of three-dimensional steady water waves with vorticity on water of finite depth under the action of gravity and surface tension. Assuming the corresponding relative velocity fields are represented by Beltrami vector fields, we prove existence of small-amplitude doubly-periodic waves. Our argument is based on local bifurcation theory with multi-dimensional kernels. This is a joint work with E. Wahlén and D. Svensson Seth (Lund University).