MATHAMSUD EEQUADD CONFERENCE 2017

LIST OF TITLES AND ABSTRACTS
DECEMBER 4-7, DIM-CMM UNIVERSITY OF CHILE

Organizers: Felipe Linares, Claudio Muñoz, and Jean-Claude Saut

Schedule MathAmSud Workshop

MathAmSud EEQUADD Workshop 2017, Dec 4-7, FCFM U. Chile					
Planning/Venue	d'Etigny	d'Etigny	d'Etigny	d'Etigny	
Time	Lu 4	Ma 5	Mi 6	Ju 7	Vi 8
9:00 - 9:40	Saut	Linares	Kowalczyk	Molinet	
9:50 - 10:30	Angulo	Miot	Goloschshapova	Van den Bosch	
10:30 - 11:00	Coffee	Coffee	Coffee	Coffee	Holiday
11:00 - 11:40	Chamorro	Alejo	Pilod	Dávila	
11:50 - 12:30	De Laire	Panthee	Farah	Combet	
LUNCH	LUNCH	LUNCH	LUNCH	Closing words	
14:30 - 15:10	Natali	Corcho			
15:20 - 16:00	Panassenko	N. Santos/ Kwak			
16:00 - 16:30	Coffee	Coffee			
16:30 - 17:00	Cavalcante	Palacios			
20:00		DINNER			

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1. Miguel A. Alejo (UFSC)
Nonlinear stability of Gardner breathers

In this talk I will show how to generalize our stability results for mKdV breathers for the case of Gardner breather solutions, by using strongly the integrable character of the PDE and obtaining their variational characterization.

2. Jaime Angulo (USP, Brazil)
The NLS equation with the δ'-interaction: (In)Stability theory of standing waves

In this talk we study the orbital stability of standing waves with discontinuous bump-like profile for the nonlinear Schrödinger model with the *repulsive* δ'-interaction on the line. We consider the model with power non-linearity. In particular, it is showed that such standing waves are unstable in the energy space under some restrictions for parameters. The use of extension theory of symmetric operators is fundamental for estimating the Morse index of specific self-adjoint operators. Moreover, the use of Sturm oscillation theory and analytic perturbation theory is essential in our analysis. The Perron-Frobenius property for the repulsive δ'-interaction is established.

3. Marcio Cavalcante (Alagoas, Brazil)
The Korteweg-de Vries equation on a metric star graph

In this talk we show local well-posedness for the Cauchy problem associated to Korteweg-de Vries equation on a metric star graph with three semi-infinite edges given by one negative half-line and two positives half-lines attached to a common vertex, for two classes of boundary conditions. We discuss the reasons for the choices of the boundary conditions considered. The results are obtained in the low regularity setting by using the approach given by Colliander, Kenig (2002) and Holmer (2006).

4. Diego Chamorro (U. Evry, France)
Local stability of energy estimates for the Navier-Stokes equations

In the local regularity theory of Caffarelli-Kohn-Nirenberg for weak solutions of the Navier-Stokes equations, some control over the pressure is needed. In a recent work we generalized this theory by removing the hypothesis over the pressure and we obtained a new class of solutions of the Navier-Stokes problem called "dissipative solutions". We study now the regularity of the weak limit of a sequence of dissipative solutions to the Navier-Stokes equations when no assumptions is made on the behavior of the pressures.

5. Vianney Combet (U. Lille, France)
Construction of multi-bubble solutions for the critical gKdV equation

In this talk, we show the existence of solutions of the mass critical generalized Korteweg-de Vries equation containing an arbitrary number of blow up bubbles. Due to strong interactions between the bubbles, the construction relies decisively on the sharp properties of the minimal mass blow up solution (single bubble case), proved in a former paper and that we will recall in the first part of the talk. We will also discuss the differences with the corresponding well-known results for the nonlinear Schrdinger equation, for both single and multi-bubble solutions.

This is a joint work with Yvan Martel (École Polytechnique).

6. Adán Corcho (UFRJ, Brazil)
On the blow-up phenomena for Schrödinger - Korteweg de Vries system posed on the half-line.

We consider the short-long wave interactions, modeled by the coupled equations:

$$\begin{cases} iu_t + u_{xx} = \alpha uv + \beta u|u|^2, & (x,t) \in \mathbb{R}^+ \times (0,T), \\ v_t + v_{xxx} + \frac{1}{2}(v^2)_x = \gamma(|u|^2)_x, & (x,t) \in \mathbb{R}^+ \times (0,T), \\ u(x,0) = u_0(x),\ v(x,0) = v_0(x), & x \in \mathbb{R}^+, \\ u(0,t) = f(t),\ v(0,t) = g(t), & t \in (0,T), \end{cases} \tag{1}$$

where $u = u(x,t)$ is a complex valued function, $v = v(x,t)$ is a real valued function and α, β, γ are real constants.

Under homogeneous boundary conditions we prove that local solutions in the energy space can be extended globally in time when $\alpha\gamma > 0$. On the other hand, in the case $\alpha\gamma < 0$, we show formation of singularities in finite time for certain initial data in $H^1 \times H^1$. This phenomena is very interesting since singles one-dimensional cubic nonlinear Schrödinger and Korteweg-de Vries equations are sub-critical for H^1 regularity and they do not have solutions that blow-up in finite time in H^1; however, for the coupled interactions on the half-line with "hyperbolic energy" the formation of singularities appears.

This is a joint work with Márcio Cavalcante (IM - Universidade Federal de Alagoas -UFAL/Brasil).

7. Juan Dávila (DIM-CMM, U. Chile)
Vortex desingularization for the 2D Euler equations

We construct solutions to the 2D Euler equation with highly concentrated vorticity around a finite number of points. Compared to the result of Marchiro and Pulvirenti (1993) we obtain a finer description of the velocity near the vortices. We do this by exploiting a connection with the Liouville equation. This is joint work with Manuel del Pino (U. of Chile), Monica Musso (Catholic University of Chile) and Juncheng Wei (U. of British Columbia).

8. André de Laire (U. Lille)
The Sine-Gordon regime of the Landau-Lifshitz equation with a strong easy-plane anisotropy

It is well-known that the dynamics of biaxial ferromagnets with a strong easy-plane anisotropy is essentially governed by the Sine-Gordon equation. In this talk, we provide a rigorous justification to this observation. More precisely, we show the convergence of the solutions of the Landau-Lifshitz equation for biaxial ferromagnets towards the solutions of the Sine-Gordon equation in the regime of a strong easy-plane anisotropy, and we establish the sharpness of this convergence.

Our result holds for solutions to the Landau-Lifshitz equation in high order Sobolev spaces. We provide an alternative proof for local well-posedness in this setting by introducing high order energy quantities with better symmetrization properties. We then derive the convergence from the consistency of the Landau-Lifshitz and Sine-Gordon equations by using well-tailored energy estimates. As a by-product, we also obtain a further derivation of the free wave regime of the Landau-Lifshitz equation.

This is joint work with Philippe Gravejat (Universit de Cergy-Pontoise).

9. Luiz Gustavo Farah (UFMG, Brazil)
On the supercritical gKdV equation

In this talk we discuss some results for the supercritical gKdV equation, such as well-posedness, existence of maximizers for Airy-Strichartz inequalities, concentration of blow-up solutions and scattering. These results were obtained in collaboration with Ademir Pastor (UNICAMP-Brazil), Brian Pigott (Wofford College-USA), Felipe Linares (IMPA-Brazil), Henrique Versieux (UFMG-Brazil), Nicola Visciglia (UNIPI-Italy). The author was partially supported by CNPq-Brazil and FAPEMIG-Brazil.

10. Nataliia Goloschshapova (USP, Brazil)
NLS with logarithmic nonlinearity and δ-interaction on a star graph. Well-posedness and stability of standing wave solutions.*

Let $\mathcal{G}$ be a star graph, i.e. N half-lines attached to the common vertex $\nu = 0$. We consider the following NLS-log equation with δ-interaction on $\mathcal{G}$

$$i\partial_t \mathbf{U} = -\Delta_\alpha \mathbf{U} - \mathbf{U}\log|\mathbf{U}|^2, \tag{2}$$

where $\mathbf{U}(t,x) = (u_j(t,x))_{j=1}^N : \mathbb{R}\times\mathbb{R} \to \mathbb{C}^N$, and the operator $-\Delta_\alpha$ is defined by

$$-\Delta_\alpha \mathbf{V}(x) = (-v_1''(x), ..., -v_N''(x)), \quad x > 0,$$

$$D(-\Delta_\alpha) = \left\{ \begin{array}{c} \mathbf{V} \in H^2(\mathcal{G}) : v_1(0) = ... = v_N(0), \\ \sum\limits_{j=1}^N v_j'(0) = \alpha v_1(0),\ \alpha \in \mathbb{R}\setminus\{0\} \end{array} \right\}.$$

We will discuss briefly the well-posedness of equation (2) in the energy domain given by the Banach space

$$W(\mathcal{G}) = \left\{\mathbf{V} \in H^1(\mathcal{G}) : v_1(0) = ... = v_N(0),\ |v_j|^2\log|v_j| \in L^1(\mathbb{R}_+)\right\}.$$

Basically the talk will be concerned with an orbital stability of the standing wave solutions $e^{i\omega t}\mathbf{\Phi}(x)$ to equation (2). All the possible profiles $\mathbf{\Phi}(x)$ generate the family of $[\frac{N-1}{2}]+1$ solutions (stationary states) to the stationary equation associated with (2). When an intensity α of the δ-interaction is negative, there is a unique ground state among them (in the sense of constraint minimality of the associated action functional). It is the only solution symmetric modulo rotations of the edges of the graph $\mathcal{G}$. The rest of the stationary states are of different action (they are *excited states*).

An orbital stability of the ground state was shown by A. Ardila. To our knowledge, nothing was known about stability of exited states. Using classical linearization procedure, the theory of extensions of symmetric operators, and the perturbation theory, we prove instability of exited states.

*This is a joint work with J. Angulo Pava (University of São Paulo)

11. Michal Kowalczyk (DIM-CMM U. Chile)
Asymptotic stability for some nonlinear Klein-Gordon equations for odd perturbations in the energy space

Showing asymptotic stability in one dimensional nonlinear Klein-Gordon equations is a notoriously difficult problem. In this talk I will describe an approach based on virial estimates which allows to prove it in case when only odd perturbations are allowed. In particular I will discuss asymptotic stability of the kink in the $\phi 4$ model.

12. Chulkwang Kwak (PUC, Chile)
Probabilistic global well-posedness of generalized KdV equations

In this talk, we consider the Cauchy problem of the generalized Korteweg-de Vries (gKdV) equations:

$$\begin{cases} \partial_t u + \partial_x^3 u + F(u) = 0 \\ u(0,x) = \phi(x) \in H^s, \end{cases}$$

where $F(u) = u^\kappa \partial_x u, \kappa \geq 5$. As well-known, gKdV is ill-posed in H^s, for $s < s_c = \frac{1}{2} - \frac{2}{\kappa}$. In spite of this negative result, by applying the probabilistic idea to this problem, one can prove the local well-posedness of gKdV. Moreover, once we assume probabilistic a priori energy bounds and global well-posedness of the critical gKdV, we can extend the local solution to a global one. In this talk, we mainly discuss the difficulties and its resolutions comparing with previous probabilistic well-posedness results.

13. Felipe Linares (IMPA, Brazil)
The Cauchy Problem for some Dispersive Models in $\mathbb{T}^2$

In this lecture we will discuss recent results regarding well-posedness of the Cauchy problem associated to some third order dispersive models posed on $\mathbb{T}^2$. In particular, we will consider the Zakharov-Kuznetsov equation and prove local well-posedness for initial data in $H^s(\mathbb{T}^2)$, $s > \frac{3}{2}$. The key arguments used are a derivation of a Strichartz estimate in short times and the method introduced by Koch and Tzvetkov and exteded by Kenig and collaborators to study the Benjamin-Ono and KP-I equations, respectively.

Joint work with: M. Panthee (*UNICAMP, Brazil*), Nikolay Tzvetkov (*Cergy, France*).

14. Evelyne Miot (U. Grenoble-Alpes, France)
Uniqueness for the Vlasov-Navier-Stokes system

In this talk I will present a uniqueness result for the 2D Vlasov-Navier-Stokes system, holding for weak solutions with divergence-free velocity fields belonging to the natural energy space and bounded densities satisfying some specific assumptions on the moments. This is joint work with Daniel Han-Kwan, Ayman Moussa and Ivan Moyano.

15. Luc Molinet (U. Tours, France)
A Rigidity result for the Camassa-Holm equation

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 belongs to $\mathcal{M}_+(\mathbb{R})$.

16. Fabio Natali (State U. Maringa, Brazil)
Sufficient conditions for orbital stability of periodic traveling waves

The present talk deals with sufficient conditions for orbital stability of periodic waves of a general class of evolution equations supporting nonlinear dispersive waves. Firstly, our main result do not depend on the parametrization of the periodic wave itself. Secondly, motived by the well known orbital stability criterion for solitary waves, we show that the same criterion holds for periodic waves. In addition, we show that the positiveness of the principal entries of the Hessian matrix related to the "energy surface function" are also sufficient to obtain the stability. Consequently, we can establish the orbital stability of periodic waves for several nonlinear dispersive models. We believe our method can be applied in a wide class of evolution equations and, in particular, it can be extended to regularized dispersive wave equations.

17. José M. Palacios (DIM U. Chile)
Stability of Sine-Gordon 2-solitons in the energy space

In this talk we will prove that three different 2-soliton solutions of the sine-Gordon equation (SG) are orbitally stable in the natural energy space of the problem [4]. We will prove this result without using the inverse scattering technique for the equation nor the steepest descent method, which allows us to work in the very large energy space $H^1(\mathbb{R}) \times L^2(\mathbb{R})$. The three families which we will study are called 2-kink, kink-antikink and breather of SG, described by Lamb [3]. To prove this result we will use a well-chosen Bäcklund transformation which allow us to reduce the stability question of these families to the zero solution case, in the same spirit as the result of Alejo and Muñoz for the case of the modified Kortweg-de Vries equation [1]. However, we will see that SG presents several new difficulties that we will have to solve appropriately. Possible connections to asymptotic stability results will also be discussed. This work is in colaboration with C. Muñoz and improves in several directions the results in [2]. (Partially funded by Nucleo Milenio CAPDE, CMM Fondo Basal, and Fondecyt 1150202.)

References

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18. Grigory Panassenko (U. Saint-Etienne, France and CMM, U. Chile)
Homogenization in nonlinear acoustics

The nonlinear acoustics models are described by a set of dispersive partial derivative equations, such as the well-known Riemann wave equation, Burgers equation, Korteweg–de Vries (KdV) equation, Khokhlov–Zabolotskaya -Kuznetsov (KZK) equation, and others. These models are derived from the linear or nonlinear wave equation for the acoustic pressure, usually, under the hypothesis of small variations of this pressure [1]. However they are applied in some cases when these variations are not small (when it no more corresponds to the physics of the process) and often it is an obstacle for the global existence theorems. For instance the global existence could be proved for the KZK equation only for small data while for great data there is a conjecture of blow up effect [2]. Slight modification of the equation for great values of the unknown function may fix the problem of global existence [3]. Mostly in physics these equations are considered in the case of constant coefficients when analytical solution can be constructed. However the heterogeneity of the medium (stratified ocean or atmosphere) corresponds to varying coefficients and often these coefficients rapidly oscillate at the microscopic scale. So, the homogenization (passage from microscopic scale description to the macroscopic one, see [4-6]) should be applied in these cases. In the present talk we provide a mathematical analysis (well posedness theorems) for several equations of nonlinear acoustics with varying coefficients and pass to the macroscopic description: the KZK type equation [7], the Witham-Rudenko equation (Burgers equation with an integral operator in the right hand side) [8, 9] and the Rudenko-Sukhorukov equation (the eikonal equation coupled with the nonlinear transfer equation along the sound beam) [10].

References

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19. Mahendra Panthee (U. Campinas SP)

Higher-Order Hamiltonian Model for Unidirectional Water Waves

Formally second-order correct, mathematical descriptions of long-crested water waves propagating mainly in one direction are derived. These equations are analogous to the first-order approximations of KdV- or BBM-type. The advantage of these more complex equations is that their solutions corresponding to physically relevant initial perturbations of the rest state may be accurate on a much longer timescale. The initial value problem for the class of equations that emerges from our derivation is then considered. A local well-posedness theory is straightforwardly established by a contraction mapping argument. A subclass of these equations possess a special Hamiltonian structure that implies the local theory can be continued indefinitely.

This is a joint work with J. Bona (UIC), X. Carvajal (UFRJ) and M. Scialom (UNICAMP).

20. Didier Pilod (UFRJ, Brazil)

Well-posedness for low dispersion fractional KdV and KP equations

In this talk we will review some recent results on the well-posedness for some classes of nonlocal dispersive equations in dimensions 1 and 2 at low regularity. Those classes contain in particular the fractional KdV equation

$$\partial_t u + u\partial_x u - D_x^\alpha \partial_x u = 0\,,$$

with low dispersion $0 < \alpha \leq 1$ in dimension 1, and the fractional KP equation

$$\partial_t u + u\partial_x u - D_x^\alpha u_x + \kappa \partial_x^{-1}\partial_y^2 u = 0\,,$$

with low dispersion $0 < \alpha < 2$ in dimension 2, ($\kappa = 1$ corresponding to the fKP-II equation and $\kappa = -1$ to the fKP-I equation).

Here D^α denotes a fractional derivative of order $\alpha \in \mathbb{R}$ and is defined *via* Fourier transform by $D^\alpha f = \big(|\xi|^\alpha \widehat{f}(\xi)\big)^\vee$.

This talk is based on joint works with Felipe Linares (IMPA), Jean-Claude Saut (Université Paris-Saclay), Luc Molinet (Université de Tours) and Stéphane Vento (Université Paris 13).

21. Gleison N. Santos (Universidade Federal do Piauí UFPI)
On a class of solutions to the generalized derivative Schrödinger equation

In this talk we shall discuss about the initial value problem associated to the generalized derivative Schrödinger equation
$$\partial_t u = i\partial_x^2 u + |u|^\alpha \partial_x u, \quad x, t \ \in \mathbb{R}, \ \ 0 < \alpha \leq 1.$$
Following an argument introduced by Cazenave and Naumkin we shall establish the local well-posedness for a class of small data in an appropriate weighted Sobolev space. The other main tools in the proof include the homogeneous and inhomogeneous version of the Kato smoothing effect for the linear Schrödinger equation established by Kenig-Ponce-Vega.

22. Jean-Claude Saut (Orsay, France)
Asymptotic behavior in time of solution to the nonlinear Schrödinger equation with higher order anisotropic dispersion

We consider the asymptotic behavior in time of solutions to the nonlinear Schrödinger equation with fourth order anisotropic dispersion (4NLS) which describes the propagation of ultrashort laser pulses in a medium with anomalous time-dispersion in the presence of fourth-order time-dispersion. We prove existence of a solution to (4NLS) which scatters to a solution of the linearized equation of (4NLS) as $t \to \infty$.

This is a joint work with Jin-ichi Segata (Tohoku University).

23. Hanne Van den Bosch (CMM, U. Chile)
Non-existence of minimizers for the TFDW model

It is a well-known fact in physics that a neutral atom can bind at most one or two additional electrons. But proving such a bound on the maximum positive ionization is still an open problem in many-body quantum mechanics. Recently, we were able to prove such a bound in several approximate models for the full quantum theory: the Thomas-Fermi-Dirac-von Weiszcker density functional and Mllers density matrix functional. In this talk, I will give an overview of the known results and techniques, illustrate our method in a simplified model and give the basic ideas behind the proof.

This talk is based on joint work with R. L. Frank and P. T. Nam (LMU Munich).