First Joint Meeting Brazil Italy of Mathematics
Book of abstracts

Rio de Janeiro, August 29 - September 02, 2016

Contents

1 Introduction

The first Joint Meeting Brazil Italy in Mathematics will take place in August 29 through September 02, 2016 at IMPA, the Instituto Nacional de Matemtica Pura e Aplicada, located near the Botanical Gardens in the city of Rio de Janeiro. The Joint Meeting aims:

(1) To promote acquaintance and scientific collaborations between Brazilian and Italian mathematicians;

(2) To explore opportunities to build partnerships among Brazilian and Italian academic and scientific institutions.

The program of the Joint Meeting will include both plenary lectures and special sessions (symposia), in any field of current research in Mathematics and its applications. It is anticipated that about 300 researchers from both countries will attend the Joint Meeting. The participation of young mathematicians (post-docs and students in the final stage of the PhD) is particularly welcome.

2 Venue and local informations

2.1 Instituto Nacional de Matemtica Pura e Aplicada-IMPA

The first Joint Meeting Brazil-Italy in Mathematics will take place at IMPA, the Instituto Nacional de Matemtica Pura e Aplicada, located at Estrada Dona Castorina, 110, Jardim Botnico, Horto, on the skirts of the Tijuca Forest, neighbor of the Botanical Garden, close to the most famous beaches and other post cards of Rio de Janeiro.

See the map at http://www.impa.br/opencms/en/institucional/localizacao.html

2.2 General informations

⋆ Visa Information

The first step, before even thinking of packing your suitcases, is to find out from the nearest Brazilian Consulate which documents are necessary for your authorized entry into Brazil. See more information.

⋆ Currency

The Brazilian monetary unit is the Real. The exchange rate available to visitors is published daily in the newspapers. Cash and traveler checks, specially US$ dollars, can be exchanged at most banks or exchange houses as well as the major hotels. All major credit cards are accepted in Brazil, and some stores even accept foreign currency.

⋆ Climate

The climate in Rio de Janeiro is predominantly tropical with average temperatures varying between 20 C (72 F) to 30C (82 F) in this part of the year. A light jacket for the evening is suggested, as temperatures can drop slightly.

⋆ Electrical Appliances

Electrical appliances in Rio de Janeiro, operate on 105-120 volts. The frequency is 60 cycles (Hz) and most of the sockets are two-pin sockets. Time

Rio is 3 hours of GMT

⋆ Business Hours

Most offices and stores are open from 9:00 am to 6:30 pm, Monday through Friday. Stores are also open on Saturday from 9:00 am to 1:00 pm while most of the large shopping centers open Monday to Saturday from 10:00 am to 10:00 pm. Banks are open from Monday through Friday from 10:00 am to 4:00 pm. Some shops inside the malls open also on Sundays, after 2:00pm.

⋆ Communications

The International Direct Dial (IDD) code for Brazil is 55

⋆ Language

The official language is Portuguese. Some English is spoken, particularly in the main cities, but the nearest thing to a second language is Spanish, with which you will generally be able to make yourself understood.

⋆ Brazilian Food and Drink

Brazilian Food is rich in flavors that please the most demanding sense of taste. Fruits are everywhere and one will find excellent fruit juices including several vitamin-rich fruits never heard of. Coffee is served everywhere. The *caipirinha* is the most famous liquor drink and anyone coming from abroad has to try it, at least once.

⋆ Buses and Cabs

There are two bus lines running near the Institute: line 409 (Tijuca-Jardim Botnico) and line 416 (Tijuca-Jardim Botnico, via Rebouas Tunel). Pay as you enter, using the front door to get on and the rear door to get off the bus. The current bus fare is R$ 3,80 and the maximum change given is for a R$20,00 bill.

3 Scientific and Organizing Committees

3.1 Scientific Committee

(⋆) Liliane Basso Barichello (UFRGS, Porto Alegre, lbaric@mat.ufrgs.br)

(⋆) Piermarco Cannarsa (Universitá di Roma Tor Vergata, Roma,cannarsa@axp.mat.uniroma2.it)

(⋆) Ciro Ciliberto (Universitá di Roma Tor Vergata, Roma, cilibert@axp.mat.uniroma2.it) - co-chair

(⋆) Giorgio Fotia (Universitá di Cagliari, Giorgio.Fotia@crs4.it)

(⋆) Claudio Landim (IMPA, Rio de Janeiro, landim@impa.br)

(⋆) Maria José Pacifico (Universidade Federal do Rio de Janeiro, pacifico@im.ufrj.br)

(⋆) Paolo Piccione (Universidade de So Paulo, piccione.p@gmail.com)

(⋆) Mario Primicerio (Universitá di Firenze, mario.primicerio@math.unifi.it)

(⋆) Giovanni Russo (Universitá di Catania, russo@dmi.unict.it)

(⋆) Geraldo Nunes Silva (UNESP, São José do Rio Preto, gsilva@ibilce.unesp.br)

(⋆) Aron Simis (Universidade Federal de Pernambuco, Recife, aron@dmat.ufpe.br)-co-chair

(⋆) Carlo Toffalori (Universitá di Camerino, carlo.toffalori@unicam.it)

3.2 Local Organizing Committee

⋆ Maria José Pacifico (Chair)

⋆ Isaia Nisoli (Universidade Federal do Rio de Janeiro)

⋆ Antonio Nigro (Universidade Federal Fluminense)

⋆ Daniele Sepe (Universidade Federal Fluminense)

⋆ Carolina Araujo (IMPA-Rio de Janeiro)

⋆ Felipe Linares (IMPA-Rio de Janeiro)

⋆ Henrique Bursztyn (IMPA-Rio de Janeiro)

4 Plenary Speakers

- Carlangelo Liverani (Univ. Roma Vergata)
- Eduardo Teixeira (Univ. Federal do Ceará)
- Jorge Vitório Pereira (IMPA)
- José Alberto Cuminato (Univ. of São Paulo
- June Huh (Princeton University)
- Luca Formaggia (Milano, Industrial Mathematics)
- Lucia Caporaso (University of Roma Tre)
- Luigi Preziosi (Politecnico Torino)
- Maria Eullia Vares (Univ. Federal of Rio de Janeiro)
- Nicola Fusco (Univ. Napoli)

5 Special Sessions

Session 1: Group Theory

Organizers: P. Shumyatsky (University of Brasilia), Ilir Snopche (Federal University of Rio de Janeiro), P. Longobardi and M. Maj (University of Salerno, Italy)

Session 2: PDE methods in mean field games and dynamics optimization

Organizers: E. Pimentel (Federal University of So Carlos), A. Porretta (University of Roma 2)

Session 3: Recent Progress in Fluid Dynamics

Organizers:H. J. N. Lopes (Federal University of Rio de Janeiro), H. B. da Veiga (University of Pisa), M. Sammartino (Universit di Palermo), M. C. Lopes (Federal University of Rio de Janeiro)

Session 4: Mathematical Logic

Organizers: P. D?Aquino, (University of Napoli 2), S. G. da Silva and C. Russo (Federal University of Bahia)

Session 5: Algebraic Geometry over Finite Fields and its Applications to Coding Theory

Organizers: M. Giulietti (University of Perugia), C. Carvalho (Federal University of Uberlandia)

Session 6: Commutative Algebra and its Interactions

Organizers: M.E. Rossi (University of Genova), H. Hassanzadeh (Federal University of Rio de Janeiro)

Session 7: Optimal Control

Organizers: M. S. Aronna (Fundação Getúlio Vargas, Rio de Janeiro), Piermarco Cannarsa (University of Roma Tor Vergata), G. N. Silva (University of São Paulo-S. J. do Rio Preto)

Session 8: Classification of Projective Varieties and Related Topics

Organizers: G. Borrelli (Federal University Fluminense-Niterói), E. Esteves (Instituto de Matemática Pura e Aplicada), F. Polizzi (University of Calabria), A. Rapagnetta (University of Roma Tor Vergata)

Session 9: Topological and impulsive methods for the qualitative analysis of differential equations, differential inclusions and difference equations

Organizers: P. Benevieri (University of São Paulo), J. G. Mesquita (University of Braslia), M. Spadini (University of Firenze)

Session 10: Inverse Problems for PDEs

Organizers: M. Di Cristo (Politecnico di Milano), A. Leitao (Federal University of Santa Catarina)

Session 11: Variational and Geometric Methods

Organizers: M. Gross (University of Roma La Sapienza), B. Ruf (Universty of Milano), D. de Figueiredo (State University of Campinas), E. dos Santos (University of So Paulo-So Carlos), J. M. do (Federal University of Paraiba), C. Tomei (Catolic University of Rio de Janeiro)

Session 12: (Non)Local Models and Applications

Organizers: A. Fiscella (State University of Campinas), G. Molica Bisci (Mediterranea University of Reggio Calabria)

Session 13: Population Dynamics and Evolution

Organizers: A. G. M. Neves (Federal University of Minas Gerais) , G. Gaeta (Universty of Milano)

Session 14: Stochastic processes in random environment and applications

Organizers: F. Zucca (Politecnico di Milano), P. M. Rodriguez and F. P. Machado (University of São Paulo- São Carlos)

Session 15: Probability and Statistical Mechanics

Organizers: A. De Masi (University of Aquila), L. R. Fontes (University of So Paulo), E. Presutti (University of Aquila), M. E. Vares (Federal University of Rio de Janeiro)

Session 16: Algebraic Geometry

Organizers: M. Jardim (State University of Campinas), S. Marchesi (State University of Campinas), G. Ottaviani (University of Firenze)

Session 17: Geometric Topology and Dynamics

Organizers: D. L. Goncalves (University of São Paulo), C. Petronio (University of Pisa), S. Francaviglia (University of Bologna), S. Martins (University of São Paulo), Isaia Nisoli (Federal University of Rio de Janeiro)

Session 18: Geometric Analysis

Organizers: B. Nelli, (University of Aquila), M. F. Elbert (Federal University of Rio de Janeiro)

Session 19: Control and Asymptotics of Nonlinear PDE Dynamics

Organizers: F. Bucci (University of Firenze), A. N. de Carvalho (University of São Paulo), E. Rocca (Universitá di Pavia)

Session 20: Variational Methods and PDE in Imaging

Organizers: A. Leaci (University of Salento), E. Teixeira (Federal University of Ceará)

Session 21: Analytical and Numerical Aspects in Modeling Biological Systems

Organizers: M. Amar (University of Roma La Sapienza), G. Pontrelli (Istituto per le Applicazioni del Calcolo?CNR-Roma) and J. A. Cuminato (University of São Paulo-São Carlos)

Session 22: Dynamical Systems and Ergodic Theory —

Organizers: L. J. Díaz (Catholic University of Rio de Janeiro), S. Luzzatto (International Center for Theoretical Physics Abdus Salam)

Session 23: Ring Theory and its Applications

Organizers: I. Shestako (University of So Paulo), P. Koshlukov (State University of Campinas), F. C. P. Milies (University of So Paulo), and A. Giambruno (University of Palermo)

Session 24: Geometric Variational and Evolution Problems.

Organizers: S. Nardulli (Federal University of Rio de Janeiro), G. Orlandi (University of Verona)

Session 25: New developments in nonlinear evolutionary PDEs

Organizers: F. Dell?Oro (Institute of Mathematics of the Academy Sciences of the Czech Republic), J. Rivera (Federal University of Rio de Janeiro), M. G. Naso (University of Brescia), J. Pimentel (University of São Paulo-São Carlos)

Session 26: Geometric Structures, Lie Theory and Applications

Organizers: Anna Fino (University of Torino), Simon Chiossi (Federal University Fluminense-Niterói)

Session 27: Elliptic partial differential equations

Organizers: F. Leoni (University of Roma La Sapienza), B. Sirakov (Catolic University of Rio de Janeiro), A. Vitolo (University of Salerno)

6 Mini course

Mini course: Continuous solutions of the Euler Equations constructed via convex integration - *Camillo De Lellis*(University of Zurich)

7 Special Presentation

Projeto Portinari: Ciência e Tecnologia Promovem Arte e Cultura. *João Cândido Portinari* (Catholic University of Rio de Janeiro)

8 Global Schedule - Rooms/Capacity - Sessions

Table 1: Schedule - Rooms/Sessions

R/C	29/Mo	29/Af	30/Mo	30/Af	31/Mo	31/Af	01/Mo	01/Af	02/Mo	02/Af
224/82	S 9		S 9		S 9		S 21	S 21	S 21	
228/68	S 5	S 5	S 5	S 16	S 16	S 16	S 20	S 20		
232/64	S 6	S 6	S 6	S 18	S 18	S 18	S 23	S 23	S 23	
236/67	S 2	S 2	S 2	S 11	S 11	S 11	S 26		S 26	S 26
333/26							S 25			
345/29	S 13		S 13		S 13		S 24	S 24	S 24	
347/33	S 1	S 1	S 1	S 4	S 4	S 4	S 4			
349/38	S 8	S 8	S 8		S 10		S 12	S 12		
Aud1/100	S 14	S 14	S 14	S 15	S 15	S 15	S 22	S 22	S 22	
Aud2/169	S 3	S 3	S 3	S 17	S 17	S 17	S 27	S 27	S 27	
Aud3/100	S 7	S 7	S 19	S 19	S 19	S 19	S 7			

Rooms 224,228, 232, 236, Aud1, Aud2 and Aud3 are at second floor.
Rooms 333, 345, 347 and 349 are at third floor.
The plenary talks will be at Aud2.

Table 2: Schedule - Time/Sessions

Hour/Date	29/08	30/08	31/08	01/09	02/09
09:00-12:00	Block A	Block C	Block E	Block F	Block H
12:00-13:45	Lunch	Lunch	Lunch	Lunch	Lunch
13:45-14:30	P 1- Liverani	P 4- Lunardi	P 7- Fusco	P 9- Cuminato	Break
14:45-15:30	P 2- Teixeira	P 5- Formaggia	Portinari	P 10- Caporaso	S 26
15:30-15:45	Break	Break	Break	Break	Break
15:45-16:30	P 3- Vares	P 6- Pereira	P 9- Huh	P 11- Preziosi	S 26
16:40-17:25	Block B	MinC	MinC	MinC	MinC
17:30-19:30	Block B	Block D	Block D	Block G	S 26

Block A: Sessions 1, 2, 3, 5, 6, 7, 8, 9, 13, 14
Block B: Sessions 1, 3, 5, 6, 7, 8, 14
Block C: Sessions 1, 2, 3, 5, 6, 8, 9, 13, 14
Block D: Sessions 4, 11, 15, 16, 17, 18, 19
Block E: Sessions 4, 9, 10, 11, 13, 15, 16, 17, 18, 19
Block F: Sessions 4, 7, 12, 20, 21, 22, 23, 24, 25, 26, 27
Block G: Sessions 7, 12, 20, 21, 22, 23, 24, 25, 26, 27
Block H: Sessions 20, 21, 22, 23, 24, 25, 26, 27

9 Plenary Talks

9.1 Strong statistical properties for some partially hyperbolic systems. Carlangelo Liverani.

Abstract: Partially hyperbolic systems are a widely studied subject in dynamical systems. Most of the effort has been put in the study of their qualitative properties both from the topological and ergodic point of view. On the contrary, not much is known concerning their quantitative statistical properties (such as detailed description of the SRB measure, decay of correaltions, precise limit theorems ...). In this talk I will briefly describe some attempts to make progresses in such a direction.

9.2 Geometric estimates for nonlinear diffusive models. Eduardo Teixeira.

Abstract: Diffusive phenomena appear naturally in the mathematical formulation of a number of models in pure and applied sciences, and understanding their intrinsic regularity effects has been a major subject of investigation since the foundation of the modern theory of PDEs, back in the 19th century. In this talk, I will present a panoramic view of the PDE theory developed to treat diffusive models and will discuss regularity properties of solutions of such equations by means of new geometric approaches.

9.3 Layered Ising systems. Maria Eulália Vares

Abstract: In this talk, I would like to review and discuss results about phase transitions for a class of Ising spin systems on $\mathbb{Z}^2$. The spins are subject to anisotropic ferromagnetic interactions: Along each horizontal layer the interaction is given by a Kac potential, while the vertical interaction is of nearest neighbor type. We shall focus on the spontaneous magnetization at the mean field critical temperature, varying the strength of the short range interaction. This is mostly based on joint work in collaboration with L. R. Fontes, D. Marchetti, I. Merola, and E. Presutti.

9.4 Surface measures in infinite dimension. Alessandra Lunardi.

Abstract: Let X be a Banach space endowed with a probability measure m. I will describe different approaches for the construction of surfaces measures associated to m, and related integration by parts formulae on smooth enough subsets of X.

The available literature deals mainly with non-degenerate Gaussian measures in separable Banach spaces. In that case, integration by parts formulae are similar (as far as

possible) to the finite dimensional case. They may be extended to Sobolev functions since a trace theory for Sobolev functions on smooth surfaces is available. For non Gaussian measures the theory is still at its very beginning, and several basic questions remain open.

9.5 Some numerical challenges of numerical simulation of subsurface flow.

***L. Formaggia*, A. Scotti and A. Fumagalli.**

Abstract: Subsurface flow in sedimentary basins or in geothermal/oil reservoir present high variation of the governing parameters, like permeability, and the presence of preferential path, like fracture or faults.

We present here some recent results of the computational geosciences group of the MOX laboratory of Politecnico di Milano on the numerical simulation of these type of problems.

9.6 Foliations with trivial canonical class.

Jorge Vitório Pereira.

Abstract: Projective manifolds with trivial canonical class have a distinguished place in the birational classification of algebraic varieties. Much of their structure is unveiled by Beauville-Bogomolov Theorem which says that they can be decomposed, after a finite tale covering, as a product of Abelian varieties, Hyperkahler manifolds, and Calabi-Yau manifolds. This talk will review some analogues of Beauville-Bogomolov Theorem in the context of singular holomorphic foliations most of them obtained in collaboration with Loray and Touzet.

9.7 Stability and minimality for a nonlocal variational problem.

Emilio Acerbi, *Nicola Fusco* & Massimiliano Morini

Abstract: We discuss the local minimality of certain configurations for a nonlocal isoperimetric problem used to model microphase separation in diblock copolymer melts. We show that critical configurations with positive second variation are local minimizers of the nonlocal area functional and, in fact, satisfy a quantitative isoperimetric inequality with respect to sets that are L^1-close. The link with local minimizers for the diffuse-interface Ohta-Kawasaki energy is also discussed. As a byproduct of the quantitative estimate, we get new results concerning periodic local minimizers of the area functional and a proof, via second variation, of the sharp quantitative isoperimetric inequality in the standard Euclidean case. As a further application, we address the global and local minimality of certain lamellar configurations.

9.8 Hard Lefschetz theorems and Hodge-Riemann relations in geometry, algebra, and combinatorics. June Huh

Abstract: I will give a broad overview of Hard Lefschetz theorems and Hodge-Riemann relations in the theory of polytopes, complex manifolds, Coxeter groups, algebraic and tropical varieties. The focus will be given to tropical varieties, and it will be shown that some of the main results of Hodge theory continue to hold in a combinatorial realm that goes beyond that of algebraic and analytic geometry. This provides strong restrictions on some numerical invariants of graphs, vector configurations, and related combinatorial objects. The talk is based on joint work with Karim Adiprasito and Eric Katz.

9.9 Numerical Simulation of Non-Newtonian Free surface Flows. *José Alberto Cuminato*, Rafael Alves de Figueiredo and Cassio M. Oishi.

Abstract: In this talk a new two-phase flow method will be presented, for the simulation of highly elastic flows of viscoelastic fluids. The proposed technique is based on a combination of classical Volume-of-Fluid and Continuum Surface Force methods, along with a generic kernel-conformation tensor transformation to represent the rheological characteristics of the (multi)-fluid phases. Benchmark test problems are solved in order to assess the numerical accuracy of distinct levels of physical complexities, such as the interface representation, the influence of advection schemes, the influence of surface tension and the role of fluid rheology. In order to demonstrate the new features and capabilities of the solver in the simulation of complex fluids in transient regime, we have performed a set of simulations for the problem of a rotating rod inserted into a container with a viscoelastic fluid, known as the Weissenberg or Rod-Climbing effect. Firstly, our results are compared with numerical and experimental data from the literature for low angular velocities. Secondly, results obtained for high angular velocities (high elasticity) using the Oldroyd-B model which displayed very elevated climbing heights, are also presented. Furthermore, above a critical value for the angular velocity, it was observed the onset of elastic instabilities driven by the combination of elastic stresses, interfacial curvature and secondary flows, that seems to have not been reported in the literature.

9.10 An overview of mathematical models for cell migration. Luigi Preziosi

Abstract: Cell-extracellular matrix interaction and the mechanical properties of cell nucleus have been demonstrated to play a fundamental role in cell movement across fibre networks and micro-channels. From the point of view of application understanding this process is important on the one hand to describe the spread of cancer metastases and on the other hand to optimize medical scaffolds that can be used to cure chronic wounds. From

the point of view of mathematics, the problem can be addressed using different methods. In fact, in the talk, I will describe several mathematical models developed to deal with such a phenomenon, starting from modelling cell adhesion mechanics to the inclusion of influence of nucleus stiffness in the motion of cells, through continuum mechanics, kinetic models and individual cell-based models. In particular, an energetic approach is used in order to obtain a necessary condition for which cells enter cylindrical structures. The nucleus of the cell is treated either (i) as an elastic membrane surrounding a liquid droplet or (ii) as an incompressible elastic material with Neo-Hookean constitutive equation. The results obtained highlight the importance of the interplay between mechanical deformability of the nucleus and the capability of the cell to establish adhesive bonds.

9.11 Tropical methods in the moduli theory of algebraic curves. Lucia Caporaso

Abstract: In recent years a series of remarkable advances in tropical geometry and in non-Archimedean geometry have brought new insights to the moduli theory of algebraic curves and their Jacobians. The goal of this talk is to present some of the results in this area.

10 Projeto Portinari: Ciência e Tecnologia Promovem Arte e Cultura.
João Cândido Portinari

Resumo: A palestra se desdobra em três partes: a vida e obra de Portinari, o trabalho do Projeto Portinari, e sua mais recente iniciativa, o ?Projeto Guerra e Paz?.

A coruscante trajetória artstica de Portinari começa em um humilde povoado perdido nas imensas plantações de café do Estado de São Paulo. Após legar ao País um retrato emocionado e grandioso, em mais de 5 mil obras, do povo, da vida e da alma brasileira, ela vai atingir o seu ápice nos monumentais painéis *Guerra e Paz*, presente do Brasil à Organização das Nações Unidas.

De fato Portinari pode bem ilustrar a famosa reflexão do escritor russo Tolstoi ?se queres ser universal, começa por pintar a tua aldeia?...

Se Portinari retratou abundantemente os meninos e meninas de Brodowski, ao final pinta crianas universais, como no coral de crianas de todas as raças, que se destaca no mural *Paz*. Se antes suas *Pietás*, da clássica imagística católica, as mães com o filho morto ao colo são retirantes nordestinas, no mural *Guerra* elas se transformam em mães universais.

Na segunda parte apresentamos o trabalho de mais de 37 anos do Projeto Portinari, empenhado no levantamento, catalogação, pesquisa e disponibilização da obra e vida do pintor, para cuja execuo foi fundamental a estreita colaborao com os departamentos de $C\&T$ da Universidade, onde este trabalho representou uma ponte entre as atividades de$C\&T$ e as de Arte&Cultura.

A última parte focaliza a sua iniciativa mais recente. Após obter da ONU a guarda dos originais *Guerra e Paz* durante o período 2010-2015, o Projeto Portinari trouxe a obra prima do pintor para restauro e exposição no Brasil, e em Paris, reinaugurando-os depois no grande plenário da Assembleia Geral das Nações Unidas, em 8 de setembro último, com o discurso inaugural proferido pelo Secretário Geral da Organização das Nações Unidas, Ban-Ki-Moon, no grande plenário da Assembléia Geral da ONU:

https://vimeo.com/142678776

11 Special Sessions

11.1 Session 1-Group Theory

Organizers:P. Shumyatsky (University of Brasilia), Ilir Snopche (UFRJ), P. Longobardi and M. Maj (University of Salerno, Italy)

Program

Monday	**29/08**	**(morning session)**
09:00 - 09:40	Patrizia Longobardi	
09:45 - 10:25	Said Sidki	
10:35 - 11:15	Dessislava Kochloukova	
11:20 - 12:00	Francesco Matucci	
Monday	**29/08**	**(afternoon session)**
17:00 - 17:35	Martino Garonzi	
17:40 - 18:15	Michele Triestino	
18:20 - 18:55	Slobodan Tanushevski	
19:00 - 19:30	Ilir Snopche	
Tuesday	**30/08**	**(morning session)**
09:00 - 09:35	Mariagrazia Bianchi	
09:40 - 10:15	Emanuele Pacifici	
10:20 - 10:55	Lucio Centrone	
11:00 - 11:35	Nicola Sambonet	
11:40 - 12:15	Claudio Quadrelli	

Abstracts

(1) **Orderable groups and Additive number theory. *Patrizia Longobardi*, Mercede Maj**

textbfAbstract: Let G denote an arbitrary group.

If S is a subset of G, we define its square S^2 by $S^2 = \{x_1x_2 \mid x_1, x_2 \in S\}$.

We are concerned with the following general problem:

let S be a finite subset with k elements of a group G, determine the structure of S, if $|S^2|$ satisfies the following inequality: $|S^2| \leq \alpha|S| + \beta$ for some small $\alpha \geq 1$ and small $|\beta|$.

Problems of this kind are called *inverse problems of small doubling type*. They have been first investigated by G.A. Freiman in the additive group of the integers; many

authors are now extending the classical Freiman's inverse theorems (see [1]) to non-abelian groups.

In this talk we will survey some recent results, contained in [2]-[7], concerning the structure of finite subsets S of an orderable group satisfying the small doubling property with $\alpha = 3$ and small $|\beta|$'s.

References:

[1] G.A. Freiman, *Foundations of a structural theory of set addition*, Translations of mathematical monographs, **37**, Amer. Math. Soc., Providence, Rhode Island, 1973.

[2] G.A. Freiman, M. Herzog, P. L., M. M., *Small doubling in ordered groups*, J. Australian Math. Soc., **96** (2014), 316-325.

[3] G.A. Freiman, M. Herzog, P. L., M. M., Y.V. Stanchescu, *Direct and inverse problems in Additive Number Theory and in non-abelian group theory*, European J. Combin., **40** (2014), 42-54.

[4] G.A. Freiman, M. Herzog, P. L., M. M., Y.V. Stanchescu, *A small doubling structure theorem in a Baumslag-Solitar group*, European J. Combin., **44** (2015), 106-124.

[5] G.A. Freiman, M. Herzog, P. L., M. M., A. Plagne, D.J.S. Robinson, Y.V. Stanchescu, *On the structure of subsets of an orderable group, with some small doubling properties*, J. Algebra, **445** (2016), 307-326.

[6] G.A. Freiman, M. Herzog, P. L., M. M., A. Plagne, Y.V. Stanchescu, *Small doubling in ordered groups: generators and structures*, submitted.

[7] G.A. Freiman, M. Herzog, P. L., M. M., Y.V. Stanchescu, *Small doubling in ordered nilpotent group of class 2*, submitted.

(2) **Orthogonal Groups over Laurent Polynomials. Said Sidki**

Abstract. Based on the classical presentation of Carmichael

$$\begin{aligned} Alt(m+2) &= < a_1, a_2, ..., a_m |\ a_k^3 = e\ \ (1 \leq k \leq m)\,, \\ (a_k a_l)^2 &= e\ \ (1 \leq k < l \leq m) > , \end{aligned}$$

of the alternating groups with generating set its 3-cycles $a_i = (12i)$, we introduced in 1982 the class of groups defined by the symmetric presentation

$$\begin{aligned} Y(m,n) &= < a_1, a_2, ..., a_m |\ a_k^n = e\ \ (1 \leq k \leq m)\,, \\ \left(a_k^i a_l^i\right)^2 &= e\ \left(1 \leq k < l \leq m,\, 1 \leq i \leq \frac{n}{2}\right) > \end{aligned}$$

which we conjectured then to be always finite. Morevover, we showed for $m \geq 3$ and $n \geq 5$ odd, that these groups mapped onto orthogonal groups in characteristic 2 . We

will discuss recent work on the generalization of this class to groups $Y(m)$, excluding the torsion condition $a_k^n = e$, and about their representations as orthogonal groups over Laurent polynomial rings in characteristic 2.

(3) **Weak commutativity of groups. Dessislava Kochloukova**

Abstract: Let G be a group and $\psi : G \to G^\psi$ be an isomorphism of groups. We will discuss some joint results (with S. Sidki) on the homological and homotopical finiteness properties FP_m and F_m of the group $\chi(G)$ defined by S. Sidki in J. Algebra, 1980 as $\chi(G) = G * G^\psi/N$ where N is the normal closure of $\{[g, g^\psi]\}_{g\in G}$. If the time permits we will discuss some related constructions and discuss the case of pro-p groups too.

(4) **Irredundant covers of finite groups. Andrea Lucchini, *Martino Garonzi*.**

Abstract: A cover of a finite group G is a family C of proper subgroups of G whose union is G. A cover C of G is called irredundant if no proper subfamily of C is a cover of G. In a recent paper with A. Lucchini we classified the finite groups G for which all irredundant covers have the same cardinality. In this talk we present this result and we illustrate the main ideas of its proof.

(5) **Groups of real-analytic circle diffeomorphisms. Michele Triestino**

Abstract: With original motivation coming from the dynamical study of codimension one foliations, we describe what finitely generated groups of real-analytic diffeomorphisms (should) look like, up to topological semi-conjugacy.

Groups that are non-locally discrete are very close to Lie groups (works of Shcherbakov-Nakai-Loray-Rebelo...).

Groups that are locally discrete are conjecturally of Fuchsian type or virtually-free. In the latter case, they are understood using Markov partitions that reflect the tree-product structure. This combinatorial description has several interesting consequences that we shall present during the talk. For instance, we discover the first known examples of such groups that are free but not of Fuchsian type; on the other side, we prove that groups isomorphic to $Z_2 * Z_3$ may only be Fuchsian.

Joint project with S. Alvarez (IMPA), P. G. Barrientos (UFF), D. Filimonov (HSE, Moscow), V. Kleptsyn (CNRS & Rennes 1), D. Malicet (UERJ), C. Meniño (UFF), A. Navas (USACH).

(6) **Test elements in pro-p groups. Slobodan Tanushevski**

Abstract: Let G be a group. An element $g \in G$ is called a test element of G if for every endomorphism $\phi : G \to G$, $\phi(g) = g$ implies that ϕ is an automorphism. I will discuss test elements in pro-p groups and applications to discrete groups. This is a joint work with Ilir Snopche.

(7) **Distribution of test elements in free groups and surface groups. Ilir Snopche**

Abstract: An element g of a group G is called a test element if for any endomorphism φ of G , $\varphi(g) = g$ implies that φ is an automorphism. The first non-trivial example of a test element was given by Nielsen in 1918, when he proved that every endomorphism of a free group of rank 2 that fixes the commutator $[x_1, x_2]$ of a pair of generators must be an automorphism.

In this talk I will discuss the distribution of test elements in free groups and surface groups. This is a joint work with Slobodan Tanushevski.

(8) **Conjugacy class sizes in finite groups. Mariagrazia Bianchi**

Abstract: Let G be a finite group. One of the key tools for studying G is the set $cs(G)$, whose elements are the sizes of the conjugacy classes of G. Of course $cs(G)$ is a finite set of positive integers including 1. There are several questions arising in this context; for example, if $cs(G)$ is known, what can be said about the structure of G ? In order to study these questions, it is useful to introduce two kind of graphs that are attached to $cs(G)$: the prime graph and the common divisor graph. In this talk we will outline the major results about these graphs in particular concerning completeness and regularity.

(9) **On the character degree graphs of finite groups. Emanuele Pacifici**

Abstract: Given a finite group G let $Irr(G)$ denote the set of irreducible complex characters of G, and $cd(G)$ the set of degrees of the characters in $Irr(G)$. As many results in the literature show, there is a deep interplay between the group structure of G and the arithmetical structure of $cd(G)$, and a useful tool in this context is to attach some particular graphs to the set $cd(G)$. The aim of this talk is to present some new results concerning this subject; in particular, we will focus on finite solvable groups and on some feature of their prime character degree graphs.

(10) **On the growth of graded identities. Lucio Centrone**

Abstract: Let A be a C-algebra and G be a finite abelian group. Then a G-graded algebra is simply a G-algebra and viceversa because of the fact that G and its group of characters $\hat{G}$ are isomorphic. This fact is no longer true if we substitute G by infinite or non-abelian groups. In this paper we obtain similar results for a special class of abelian monoids, i.e., the bounded semilattices. Moreover, if S is such a monoid, we are going to investigate the role of S and its Pontryagin dual $\hat{S}$ on the algebra A, in the case A is S-graded.

(11) **The unitary cover of a finite group. Nicola Sambonet**

Abstract: The unitary cover of a finite group is a particular central extension of minimal exponent satisfying the projective lifting property, in analogy with the Schur covers which are of minimal order. This construction presents the right modular property, namely, that the exponent factorizes over any subnormal series of the underlying group. In turn, it provides new bounds for the exponent of the Schur multiplier in terms of the group invariants.

(12) Finite morphic p-groups. Andrea Caranti, *Carlo M Scoppola*

Abstract: According to Li, Nicholson and Zan, and in agreement with an analogous definition for modules, a group G is said to be morphic if, for every pair N_1, N_2 of normal subgroups, each of the conditions $G/N_1 \cong N_2$ and $G/N_2 \cong N_1$ implies the other. Finite, homocyclic p-groups are morphic, and so is the nonabelian group of order p^3 and exponent p, for p an odd prime. In this talk we settle an old conjecture, showing that these are the only examples of finite, morphic p-groups, and we compare our result with those of An, Ding and Zhang on the more general class of s-self dual p-groups.

(13) Koszul pro-p groups. Claudio Quadrelli

Abstract: In recent years Koszulity properties have attracted much attention. Originally this notion was introduced by S. Priddy for (non-negatively) graded associative algebras of finite type. In the talk we will show how one may extend this notion for pro-p groups, via the Zassenhaus filtration. Actually, many prominent examples of pro-p groups – e.g., free pro-p groups, uniformly powerful pro-p groups, Demushkin groups, the pro-p completion of right-angled Artin groups, etc. – are in fact Koszul pro-p groups, with interesting conseguences in Galois theory. Besides recent results for this class of pro-p groups (obtained jointly with J. Mináč and Th. Weigel), we will also discuss some open problem, which are related to the elementary type conjecture formulated by I. Efrat, and a conjecture recently formulated by L. Positselski.

11.2 Session 2-PDE methods in mean field games and dynamics optimization

Organizers: E. Pimentel (Federal University of São Carlos), A. Porretta (University of Roma 2)

Program

Monday	**29/08**	**(morning session)**
10.30 - 10:35	Welcome and opening	
10.35 - 11.05	Alain Bensoussan	
11.10 - 11.40	Diogo Gomes	
Monday	**29/08**	**(afternoon session)**
17.30 -18:00	Piermarco Cannarsa	
18.05 -18.35	Daniela Tonon	
18.40 -19.10	Vardan Voskanyan	
19.15 -19.45	Edgard Pimentel	
Tuesday	**30/08**	**(morning session)**
09:00 - 09.30	Yves Achdou	
09.35 - 10.05	Rafael Rigão	
10.10 - 10.40	Marco Cirant	
10.40 - 10.55	Coffebreak	
10.55 - 11.25	Marie-Therese Wolfram	
11.30 - 12.00	Alessio Porretta	

Abstracts

(1) **Master equation in mean field control theory. Alain Bensoussan.**

Abstract: Mean field games were introduced in 2006, independently by Lasry-Lions and Huang-Caines-Malhamé. Since then, this domain has attracted a considerable interest worldwide.

One of the most fundamental mathematical challenges in mean field control theory concerns solving a system of Hamilton-Jacobi-Bellman and Fokker Planck equations. A new concept, the Master Equation, has been introduced by P.L. Lions, in a heuristic way. In fact this equation encapsulates the system of HJB-FP equations in a single one, by driving a decoupling argument. There is, however, a drawback. It is a partial differential equation on a space of infinite dimensions, the space of probability measures on $\mathbb{R}^n$. Recently, P.L. Lions introduced the idea that one could write the Master Equation using for the space of arguments the Hilbert space of square integrable random variables. This introduces a remarkable simplification – the infinite

dimensional space is a Hilbert space – while nevertheless the properties of probability measures are kept. So, it becomes very interesting to explore this approach. More importantly, it leads naturally to new control problems in Hilbert space.

We will discuss all the concepts related to Mean Field Games, Mean Field type Control, their relation with the Master equation and the new control problems in Hilbert space.

(2) **Stationary mean-field games and variational inequalities. Diogo Gomes.**

Abstract: We consider stationary monotone mean-field games (MFGs) and study the existence of weak solutions. We introduce a regularized problem that preserves the monotonicity and prove the existence of solutions to the regularized problem. Next, using Minty's method, we establish the existence of solutions for the original MFGs. Finally, we examine the properties of these weak solutions in several examples.

(3) **Mean Field Games with state constraints. Piermarco Cannarsa.**

Abstract: We are interested in MFG problems with state constraints in $\overline{\Omega}$, where Ω is an open bounded subset of $\mathbb{R}^d$. Heuristically this game with infinitely many players runs as follows. The repartition of the player at initial time $t = 0$ is m_0 where $m_0 \in \mathcal{P}(\overline{\Omega})$, the space of probability measures on $\overline{\Omega}$. Let $t \to m(t)$ be a measurable trajectory from $[0, T]$ to $\mathcal{P}(\overline{\Omega})$. Any player starting from $x \in \overline{\Omega}$ solves an optimal control problem of the form

$$u(0,x) := \inf_{\gamma,\ \gamma(0)=x} \int_0^T L(\gamma(t), \dot{\gamma}(t)) + F(\gamma(t), m(t))\ dt + G(\gamma(T), m(T)),$$

where the infimum is restricted to the state constraint $\gamma(t) \in \overline{\Omega}$ for all t. Let $\overline{\gamma}^x$ be an optimal solution starting from x. An equilibrium configuration should satisfy $m(t) = \overline{\gamma}^{\cdot}(t)\sharp m_0$ for all $t \in [0, T]$. Unlike the unconstrained case, the problem with this formulation is that there might be several optimal solutions to the optimal control problem for a large set of initial conditions. We will show how to relax the problem to prove the existence of an equilibrium. Then we'll discuss the uniqueness and regularity issues.

(4) **Multi-population mean field games. Daniela Tonon.**

Abstract: We consider the behavior of more than one population consisting of a very large number of indistinguishable rational agents, aiming at minimizing some long-time average criterion. In this case, each population can be seen as satisfying an ergodic MFG system. When the populations are "xenophobic", i.e. the cost paid by an individual is increasing with respect to the distribution of the individuals of the other populations at his position, we expect the populations to partition the domain creating segregated configurations. We show the existence of a solution to the MFG system and the formation of segregated configurations at the singular limit.

(5) **Short time regularity of Mean-Field games with congestion. Vardan Voskanyan.**

Abstract: We consider time-dependent mean-field games with congestion that are given by a system of a Hamilton-Jacobi equation coupled with a Fokker-Planck equation. These models are motivated by crowd dynamics where agents have difficulty moving in high-density areas. The congestion effects make the Hamilton-Jacobi equation singular. The existence of classical solutions to this problem, was only known in very special cases - stationary problems with quadratic Hamiltonians and some time-dependent explicit examples. Here, we prove short-time existence of smooth solutions in the case of sub-quadratic Hamiltonians.

(6) **Fully nonlinear mean field games. Edgard A. Pimentel.**

Abstract: In this talk, we examine a mean-field games system driven by fully nonlinear elliptic operators of the form $F : \mathcal{S}(d) \to \mathbb{R}$. By means of geometric-tangential techniques, we investigate gains of a priori regularity for the solutions in Sobolev spaces. In addition, by combining methods from the realm of Γ-convergence with improved compactness yielded by the tangencial path, we study the existence of minimizers for the associated variational problem.

(7) **Ergodic theory, thermodynamic formalism and transport theory applied to some cooperative and non-cooperative games. Rafael Rigão de Souza.**

Abstract: Let $T : X \to X$ and $S : Y \to Y$ be continuous maps defined on compact sets. Let

$$\varphi_i(\mu, \nu) = \int_{X \times Y} A_i(x, y) d\mu(x) d\nu(y) \text{ for } i = 1, 2,$$

where μ is a T-invariant measure and ν is a S-invariant measure, be *pay-off functions* for a game (in the usual sense of game theory) between players that have the set of probability invariant measures for T (player 1) and S (player 2) as possible *strategies*. Our goal here is to establish the notion of Nash equilibrium point for the game defined by this pay-offs and strategies. The main tools came from ergodic optimization (as we are optimizing over the set of invariant measures) or thermodynamic formalism (when we add to the integrals above the entropy of measures in order to define a second case to be explored). Both cases are ergodic versions of non-cooperative games. We show the existence of Nash equilibrium points with two independent arguments. We also present examples and briefly discuss uniqueness (or lack of uniqueness). In the end we present a different example where players are allowed to collaborate. This final example show connections between cooperative games and ergodic transport, a recent area of research where one wants to transport, at minimal cost, a fixed measure into a measure which is invariant for some dynamical system.

(8) **Some results on focusing Mean Field Games. Marco Cirant.**

Abstract: In this talk we consider stationary Mean Field Games systems in the case of local and decrasing coupling. In this setting, a typical agent is attracted by regions

where his own population is highly distributed. The goal is to understand whether or not smooth solutions exist. Depending on the rate at infinity of the cost function, we observe two different situations: existence of solutions in a "subcritical" case, and non-existence in a "supercritical" case (at least if the problem is set in the whole euclidean space). This scenario is in analogy with focusing nonlinear Schrodinger equations, where the boundary between existence and non-existence of solutions is the critical Sobolev exponent. We show how blow-up techniques and Pohozaev identities apply in the MFG setting. Finally, even if in our case multiple solutions have to be expected in general (the crucial condition of Lasry-Lions is violated), we point out that in very particular situations one obtains that Nash equilibria are unique.On optimal control approaches in pedestrian dynamics.

(9) **On optimal control approaches in pedestrian dynamics. Marie-Therese Wolfram (Warwick)**

Abstract: The complex behavior of large pedestrian groups has always fascinated researchers from various scientific fields. There is an extensive literature on mathematical models describing the individual dynamics on different scales. In optimal control approaches individuals find the optimal path to their goal by minimizing a certain cost functional. In this talk we discuss different choices of cost functionals moddelling fast exit scenarios and the connection of optimal control approaches to the Hughes model for pedes- trian flow. Furthermore we present a space-time method to solve the corresponding optimal control problems efficiently and illustrate the crowd dynamics with numerical simulations.

(10) **Mean field games with congestion. Alessio Porretta (Roma)**

Abstract: A class of mean field games models were introduced by J.M. Lasry and P.L. Lions to describe congestion and aversion effects in dynamics optimization of large populations. In this case the equilibria are solutions of forward-backward systems where Bellman and Fokker-Planck equations are strongly coupled and the Hamiltonian degenerates as the density of the agents becomes large. Moreover, in this model the mean-field games system loses the variational character which is typical of a mean-field control formulation and some of the methods previously used cannot apply. In a joint work with Y. Achdou we prove existence and uniqueness results for this kind of mean field games systems under general assumptions.

11.3 Session 3-Recent Progress in Fluid Dynamics

Organizers: H. J. N. Lopes (Federal University of Rio de Janeiro), H. B. da Veiga (University of Pisa), M. Sammartino (Universit di Palermo), M. C. Lopes (Federal University of Rio de Janeiro)

Schedule

Monday,	**August 29th, morning session**
09:00 - 09:30	André Nachbin
09:30 - 10:00	Luigi Berselli
10:00 - 10:30	Maicon Benvenutti
10:30 - 11:00	Break
11:00 - 11:30	Tommaso Ruggeri
11:30 - 12:00	Cesar Niche
Monday,	**August 29th, afternoon session session**
17:30 - 18:00	Marco Sammartino
18:00 - 18:30	Gabriela Planas
18:30 - 19:00	Stefano Spirito
19:00 - 19:30	Milton Lopes Filho
Tuesday,	**August 30th, morning session**
09:00 - 09:30	Alexei Mailybaev
09:30 - 10:00	Francesco Gargano
10:00 - 10:30	Anne Bronzi
10:30 - 11:00	Break
11:00 - 11:30	Paolo Secchi
11:30 - 12:00	Ricardo Rosa

Abstracts

(1) **The uncertain trajectory of a pilot-wave. André Nachbin**

Abstract: This is a recent problem addressing a new dynamical system for a wave-particle pair. Yves Couder (Paris 7) and coworkers reported on walking droplets on the surface of a vibrating bath and discussed their properties previously thought to be peculiar to the microscopic, quantum realm. John Bush (MIT) and coworkers have also produced laboratory experiments which were compared to theoretical predictions. In this presentation I will briefly review some of their work and introduce our recent hydrodynamic pilot-wave model. Our model considers a wave equation coupled to a trajectory equation for the walking droplet/particle. The wave dynamics starts from rest while the fluid domain is vibrated according to the Faraday theory.

The dynamical properties of this wave-particle pair depends on a memory parameter. When the pilot-wave is confined to bounded domains in the high memory regime interesting random dynamics arise. Examples will be presented from both laboratory experiments as well as numerical simulations. This work is in collaboration with John Bush (MIT/Math), Paul Milewski (Univ. Bath/Math) and Carlos Galeano Rios (IMPA).

(2) **On the construction of suitable Weak Solutions. Luigi C. Berselli**

Abstract: In this talk I will discuss the problem of approximations to the Navier-Stokes equations producing solutions, which are *suitable* in the sense of Scheffer and Caffarelli-Kohn-Nirenberg. This notion of solution is very relevant for partial regularity results, but also the local behavior of energy seems a natural request for numerical methods. I will present a recent result obtained with S. Spirito, showing that solutions obtained by means of the Navier-Voigt model, the finite differences in time, and artificial compressibility are suitable (even when studied in a bounded domain).

(3) **Existence and stability of global large strong solutions for the Hall-MHD system. *Maicon J. Benvenutti* and Lucas C. F. Ferreira**

Abstract: We consider the 3D incompressible Hall-MHD system and prove a stability theorem for global large solutions under a suitable integrable hypothesis in which one of the parcels is linked to the Hall term. As a byproduct, a class of global strong solutions is obtained with large velocities and small initial magnetic fields. Moreover, we prove the local-in-time well-posedness of H^2-strong solutions which improves previous regularity conditions on initial data.

(4) **Non-linear maximum entropy principle for a polyatomic gas subject to the dynamic pressure. Tommaso Ruggeri**

Abstract: We establish Extended Thermodynamics (ET) of rarefied polyatomic gases with six independent fields, i.e., the mass density, the velocity, the temperature and the dynamic pressure, without adopting the near-equilibrium approximation. The closure is accomplished by the Maximum Entropy Principle (MEP) adopting a distribution function that takes into account the internal degrees of freedom of a molecule. The distribution function is not necessarily near equilibrium. To my knowledge, this is the first example of molecular extended thermodynamics with a non-linear closure. The integrability condition of the moments requires that the dynamical pressure should be bounded from below and from above. The model obtained is the simplest example of non-linear dissipative fluid after the ideal case of Euler. The system is symmetric hyperbolic with the convex entropy density and the K-condition is satisfied. Therefore, in contrast with the Euler case, there exist global smooth solutions provided that the initial data are sufficiently smooth.

(5) **A survey of recent results on the characterization of decay of solutions to dissipative equations. César J. Niche**

Abstract: Solutions to many dissipative equations in Fluid Mechanics, like the Navier-Stokes, quasi-geostrophic and Navier-Stokes-Voigt equations, obey energy inequalities that imply that their L^2 or Sobolev norms decay in time. In the late 80?s M.E. Schonbek developed the Fourier Splitting method, which has been widely used to establish decay rates for these and many other systems of equations.

(6) **Vortex Layers of small thickness.**
R.Caflisch, M.C.Lombardo and *M.Sammartino*

Abstract: In this talk we shall consider a 2D incompressible non viscous flow with an initial datum with vorticity concentrated close to a curve $y = \phi_0(x)$ and exponentially decaying away from it. We shall suppose the vorticity intensity to be $O(\epsilon^{-1})$ while the exponential decay occurs on a scale $O(\epsilon)$. We shall prove that, if the initial data are analytic, the solution of the above problem will preserve the vortex layer structure for a time that does not depend on ϵ. Moreover the dynamics of the layer is well approximated by the motion predicted by the Birkhoff-Rott equation for a vortex sheet of equivalent vorticity intensity.

(7) **On the α-Navier-Stokes-Vlasov Equations. *Gabriela Planas* and Cristyan C. V. Pinheiro**

Abstract: We consider the α-Navier-Stokes equations coupled with a Vlasov type equation to model the flow of an incompressible fluid containing small particles. We prove the global existence of weak solutions to the coupled system subject to periodic boundary conditions. The convergence of its solutions to that of the Navier-Stokes-Vlasov equations when α tends to zero is also established.

(8) **Finite Energy Weak Solutions of the Quantum Navier-Stokes equations. *Stefano Spirito* and Paolo Antonelli**

Abstract: In this talk we focus on a new compactness result about finite energy weak solutions of the quantum Navier-Stokes equations. The novelty of the result is that we are able to consider the vacuum in the definition of weak solutions. The main tool is a new formulation of the equations which allows us to get an additional a priori estimate to prove compactness. Some remarks concerning the choice of the approximation system to get global existence will be made. This is a joint work with Paolo Antonelli (GSSI - Gran Sasso Science Institute)

(9) **Vanishing viscosity limit for incompressible flows with symmetry. Milton C. Lopes Filho**

Abstract: In this talk, we describe results on the vanishing viscosity limit and the boundary layer behavior of incompressible flows between two parallel plates or inside a straight circular cylinder, under certain symmetry assumptions. The objective is

to understand the vorticity produced by the interaction of the incompressible fluid and the solid wall, as illustrations of the behavior expected in the general problem and as test cases for numerical methods.

(10) **Dynamics after blowup: spontaneously stochastic solutions. Alexei A. Mailybaev (IMPA, Rio de Janeiro)**

Abstract: We present spontaneously stochastic solutions for inviscid non-local con- servation laws, which appear immediately after the blowup. Starting with the Burgers equation and continuing with the Sabra shell model of turbulence (as well as its continu- ous 1D representation), I will show how the model can be mapped into a dynamical system in renormalized coordinates and time. The renormalized system has a solution in the form of a traveling wave, which describes a nite-time blowup. This wave is deterministic for the Burgers equation, while it becomes stochastic for the Sabra model. One of the limiting states of such stochastic wave corresponds to a deterministic solution at blowup time, while the other limiting state describes the developed turbulent state

(11) **Singularity analysis for the regularized Euler- motion of a vortex sheet. *Francesco Gargano*, Marco Sammartino and Vincenzo Sciacca.**

Abstract: We preset in this talk a numerical analysis concerning the regularization of a vortex sheet motion governed by Birkho -Rott (BR) equation for a ow induced by an in nite array of planar vortex sheets. The Euler- regularization applied to the BR equa- tion is considered, and its solutions is compared with the dynamics of the non regularized vortex sheet by means of the analysis of the complex singularities of the solutions through the singularity tracking method. We show that the regularized solution has several com- plex singularities that approach the real axis, and we relate their presence to the formation of high-curvature points in the vortex sheet during the roll-up phenomenon. The motion of the sheet in the Euler- regularization is shown to be compatible also with the the motion of a viscous layer of non-uniform vorticity governed by the Navier-Stokes equation in the zero viscosity limit. A numerical analysis of the complex singularities of the curve supporting the vortex layer is carried out and results are compared with those obtained from the same analysis for the Euler- vortex sheet case. This is a joint work with Marco Sammartino and Vincenzo Sciacca (Dept. Math., Univ. Palermo)

(12) **On the blow-up scenario for the Euler equations. *Anne Bronzi* and Roman Shvydkoy**

Abstract: In this talk we will survey some results regarding the possibility of a self-similar blow-up for the Euler equations and present some new exclusion results. Furthermore, we will present some studies on the fractal dimension of the energy measure, which roughly speaking is the limit of the measures on the space induced by the velocity squared as time approaches the time of the singularity. We will

explore the relation between the fractal dimension of the energy measure and the growth of the velocity as time approaches the time of the singularity.

The Fourier Splitting method is based on the idea that "long time behavior of solutions is determined by small frequencies?? and for it to provide uniform decay rates, it is necessary to restrict initial data to subsets of L^2 (say, $L^p \cap L^2, 1 \leq p < 2$, or data for which the linear part of the equations has certain decay). The question that then naturally arises is whether it is possible to establish decay for *any* initial data in L^2.

In this talk we will survey recent work in which the decay rates are characterized, for *any* initial data, for solutions to many families of dissipative equations. This description is based on the *decay character* $r^* = r^*(u_0)$ associated to the initial datum u_0. This number is, rougly speaking, the order of u_0 at the origin in frequency space and can be used to give explicit upper (and sometimes lower) bounds for the decay rates. As a consequence of this, we show how the same initial datum can produce quantitatively and qualitatively different behavior for solutions to very similar equations.

The results described in this talk have been obtained by Lorenzo Brandolese, Maria E. Schonbek and myself through joint and individual work.

(13) **On the approximate current-vortex sheets near the onset of instability. Paolo Secchi**

Abstract: We consider the free boundary problem for 2D current-vortex sheets in ideal incompressible magneto-hydrodynamics near the transition point between the linearized stability and instability. In order to study the dynamics of the discontinuity near the onset of the instability, Hunter and Thoo have introduced an asymptotic quadratically nonlinear integro-differential equation for the amplitude of small perturbations of the planar discontinuity.

In this talk we present our results about the well-posedness of the problem in the sense of Hadamard, under a suitable stability condition, that is the local-in-time existence in Sobolev spaces and uniqueness of smooth solutions to the Cauchy problem, and the strong continuous dependence on the data in the same topology.

The results are obtained in a series of joint papers with A. Morando and P. Trebeschi (Brescia).

(9) **Asymptotic Analysis of the Primitive Equations. I. Kukavica, M.C. Lombardo, M. Sammartino**

Abstract: Primitive equations provide a fundamental model to describe global circulation dynamics. They are obtained from the full Boussinesq system under the hydrostatic approximation where the equation for the motion of the third component of the velocity is replaced by the hydrostatic equation for the pressure. This approximation is natural when comparing the sizes of different terms in the momentum equation for physical data. The resulting equations are however challenging

mathematically due to the loss of a derivative compared to the original Boussinesq model or with the Navier-Stokes equations. The mathematical theory of primitive equations was initiated in (Lions et al. 1992) where the authors gave the appropriate mathematical setting for the study of the PE, while in (Cao and Titi 2007) and (Kukavica and Ziane 2007) the proof of the existence of global strong solution was achieved. More problematic is the theory of Hydrostatic equations, for which existence has been shown in the case of analytic data (Kukavica et al. 2011), while the finite-time blow-up has been recently shown (Cao et al. 2015). The aim of this talk is to discuss the relationship between the solution of the PE and the solutions of the Hydrostatic equations in the limit of infinite Reynolds number. We will see that for the PE in a channel with Dirichlet boundary conditions at the bottom boundary and Neumann at the top, the Hydrostatic solution approximates the PE solution away from the boundary. To avoid possible instability in the Hydrostatic solution we shall consider the initial data to be analytic.

(11) **On the approximate current-vortex sheets near the onset of instability. Paolo Secchi**

Abstract: We consider the free boundary problem for 2D current-vortex sheets in ideal incompressible magneto-hydrodynamics near the transition point between the linearized stability and instability. In order to study the dynamics of the discontinuity near the onset of the instability, Hunter and Thoo have introduced an asymptotic quadratically nonlinear integro-differential equation for the amplitude of small perturbations of the planar discontinuity.

In this talk we present our results about the well-posedness of the problem in the sense of Hadamard, under a suitable stability condition, that is the local-in-time existence in Sobolev spaces and uniqueness of smooth solutions to the Cauchy problem, and the strong continuous dependence on the data in the same topology.

The results are obtained in a series of joint papers with A. Morando and P. Trebeschi (Brescia).

11.4 Session 4-Mathematical Logic

Organizers: P. D'Aquino, (University of Napoli 2), S. G. da Silva and C. Russo (Federal University of Bahia)

Program

Tuesday 30/08 (afternoon session)

17:30 - 18:00 Marcelo Coniglio
18:05 - 18:35 Hércules Feitosa
18:40 - 19:10 Hugo Mariano
19:15 - 19:45 Ricardo Bianconi

Wednesday 31/08 (morning session)

09:00 - 09:35 Valeria De Paiva
09:35 - 10:05 Matteo Viale
10:10 - 10:40 Andrey Bovykin
10:45 - 11:15 Vinicius Cifu
11:20 - 12:00 Elaine Pimentel

Wednesday 31/08 (afternoon session)

17:30 - 18:00 Lúcia Junqueira
18:05 - 18:35 Santi Spadaro
18:40 - 19:10 Giorgio Venturi

Thursday 01/09 (morning session)

09:00 - 09:35 Vieri Benci
09:35 - 10:05 Alf Onshuus
10:10 - 10:40 Antongiulio Fornasiero
10:45 - 11:15 Carlo Toffalori

Abstracts

(1) **Towards Non-deterministic algebraic semantics. Marcelo E. Coniglio**

Abstract: Non-deterministic algebras (a.k.a hyperstructures, hyperalgebras, or multialgebras) are algebraic structures having at least one multivalued operation (that is, a function which assigns to any tuple of its domain a nonempty set of possible values); such multivalued operations are called hyperoperations. Multialgebras constitute an useful tool in Computer Science, apt to deal with non-deterministic processes such as non-deterministic automaton. From the perspective of Abstract Algebra, the study of hyperstructures was initiated by F. Marty in 1934, when he proposed the notion of hypergroups. Afterwards, several algebraic hyperstructures

have been studied in the literature besides hypergroups: hyperlattices, hyperrings, hyperfields, and hyperalgebras in general.

A Non-deterministic matrix, or Nmatrix, is a multialgebra together with a set of designated values of its domain. Nmatrices constitute the natural application of multialgebras to Logic. They were introduced in 1962 by N. Rescher under the name of quasi-truth-functional systems. This notion was independently rediscovered by J. Kearns in 1981 and by Y. Ivlev in 1988, as a way to overcome Dugundji's results on modal logic by means of an alternative to Kripke semantics. The Nmatrix semantics was reintroduced once again (together with the terminology "non-deterministic matrices" and "Nmatrices") by A. Avron and I. Lev in 2001, and afterwards intensively developed, from the point of view of applications, by A. Avron and his collaborators. In particular, they shown that several paraconsistent logics in the hierarchy known as Logics of Formal Inconsistency (LFIs), which cannot be characterized by a single finite matrix (that is, systems under the scope of a Dugundji-like theorem), can be characterized by a single finite Nmatrix. Avron's results were recently generalized by W. Carnielli and M. Coniglio by means of the concept of swap structures, which are multiagebras defined over 3-fold products of Boolean algebras. This structures are related, and generalize in some sense, the well-known Fidel-Vakarelov twist structures.

In this talk, new completeness results by means of swap structures will be presented for some LFIs and non-normal modal logics, by introducing the notion of Lindenbaum-Tarski multialgebras. The techniques introduced here open the possibilities of defining a new notion of algebraizability of logics based on classes of multialgebras. This method could be appliable to logics which cannot be agebraizable by means of traditional tools, including the very general theory of Blok-Pigozzi.

This is a joint work with Ana Claudia Golzio.

(2) **A quantificational logic for deducibility. Hércules de Araujo Feitosa.**

Abstract: The extended logics permit the mathematical analysis of different types of structures. In this talk, we discuss the Tarski spaces associated to deduction systems and introduce an extended logic associated to the Tarski spaces.

The logical quantifiers universal $\forall$ and existential $\exists$ are important and present at the Logic history since Antiquity. The traditional use of quantifiers shows beautiful and relevant relations between these quantifiers and others defined from them since ancient times.

These logical quantifiers are essentials in the development of Logic, however there are quantifiers that can not be defined in some natural way from these logical quantifiers. For example, quantifiers as many (few) and almost all (almost none). These new quantifiers are named non logical quantifiers.

Mostowski (1957) pointed the existence of many non logical quantifiers, or generalized quantifiers as named by Mostowski, mathematically interesting but non defined from

the classical ones. We consider that this paper is this tradition.

On the other hand, in the context of linguist, the quantifiers appeared as fundamental concept to be formalized, as we can see in Barwise e Cooper (1981). This tradition named the new quantifiers as natural quantifiers, for they occur in natural languages.

Considering these investigations on non logical quantifiers, Grácio (1999) introduced a family of logics, the modulated logics, such that each member try to formalize aspects of some natural quantifier.

Motivated by these papers and the definition of Tarski consequence operator, we implement the concept of deduction in a first-order logic extended by a new quantifier that interprets the notion of deductibility.

We present the definition of Tarski space, modulated logics and so we introduce this extended logic of deductibility, for whose we give theorems of soundness and completeness, and try to evolve this logic in the environment of modulated logics.

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(3) **Abstract aspects of quadratic forms. Hugo Luiz Mariano.**

Abstract: The relationship between Galois groups of fields with orderings and quadratic forms, established by the works of Artin-Schreier (1920's) and Witt (late 1930's) are reinforced by a seminal paper of John Milnor (1971) through the definition of a (mod 2) k-theory graded ring that "interpolates" the graded Witt ring and the cohomology ring of fields: the three graded rings constructions determine functors

from the category of fields where 2 is invertible that, almost tree decades later, are proved to be naturally isomorphic by the work of Voevodsky with co-authors.

Since the 1980's, have appeared many abstract approaches to the algebraic theory of quadratic forms over fields that are essentially equivalent (or dually equivalent): between them we emphasize the (first-order) theory of special groups developed by Dickmann-Miraglia.

In the present work we consider tree categories which are endowed with a underlying functor into the category of "pointed" groups of exponent 2: the category of pre-special groups, a category formed by certain pointed graded rings and a category given by some pairs of profinite 2-groups and a clopen subgroup of index at most 2 and with arrows the continuous homomorphisms compatible with this additional data. We establish precise (and canonical) functorial relationship between them and explore some of its model-theoretical aspects.

(4) **Some Model Theory of Automorphic Forms. Ricardo Bianconi.**

Abstract: We prove definability and model completeness results about automorphic forms on adelic rings and also on the real and complex fields. We base our work on results of Derakhshan, Macintyre, Peterzil, and Starchenko.

(5) **Bounded Dialectica Interpretation: categorically. Valeria de Paiva.**

Abstract: Recently Ferreira and Oliva introduced the Bounded Functional Interpretation (BFI) as a way of continuing Kohlenbach's programme of shifting attention from the obtaining of precise witnesses to the obtaining of bounds for these witnesses, when proof mining. One of the main advantages of working with bounds, as opposed to witnesses, is that the non-computable mathematical objects whose existence is claimed by various ineffective principles can sometimes be bounded by computable ones. In this talk we present first steps towards a categorical version of BFI, along the lines of de Paiva's version of Gödel's Dialectica interpretation, the Dialectica Categories. The previous categorical constructions seem to extend smoothly to the new ordered setting.

(6) **Using forcing to prove theorems: an example around Schanuel's conjecture. Matteo Viale (Università di Torino, Italy)**

Abstract: Schanuel's conjecture $\mathsf{SC}(\mathbb{Q},\mathbb{C})$ is the following number theory conjecture:

Given complex numbers $a_1,\dots,a_n$

$$\mathsf{trdg}_{\mathbb{Q}}(a_1,\dots,a_n,\exp(a_1),\dots,\exp(a_n)) \geq \mathsf{ldim}_{\mathbb{Q}}(a_1,\dots,a_n).$$

Where trdg_K denotes the transcendence degree and ldim_K the linear dimension of the relevant tuple over the field K. If true, $\mathsf{SC}(\mathbb{Q},\mathbb{C})$ would imply the algebraic independence of π over e. $\mathsf{SC}(\mathbb{Q},\mathbb{C})$ has connections with logic as outlined by the following results (among many others):

(A) Zilber showed that there is a natural and categorical theory for algebraic closed fields of characteristic 0 with an exponential map, and this theory satisfies Schanuel's conjecture.

(B) Bays, Kirby and Wilkie showed that there is K a countable subfield of the complex numbers such that $\mathsf{SC}(K, \mathbb{C})$.

We give a new proof of **(B)** using forcing.

Shoenfield's absoluteness for Σ^1_2-statements says that if a Σ^1_2-statement can be forced, then it holds true (observe that **(B)** is a Σ^1_2-statement).

We prove that $\mathsf{SC}(\mathbb{C}^V, \mathbb{C}^{V[G]})$ holds in $V[G]$ if G is a V-generic filter for a complete boolean algebra B.

(B) will follow applying Shoenfield's absoluteness to the above result for a boolean algebra collapsing the continuum to become countable.

(7) **One more step. Andrey Bovykin.**

Abstract: We know from Simpson's monograph, and, perhaps, from elsewhere, that ATR_0 allows to produce a good theory of V-countable ordinals, transitive sets and imitate the cummulative hierarchy of sets well (resembling apparent V-hereditarily countable sets).

In this set-up, appropriately encoded, we can develop the theory of rudimentary functions, the definability predicate, Gödel's L and elements of the fine structure theory. It is also possible in some very special models of second-order arithmetic, while constructing their L, that formerly V-countable ordinals lose their countability and become L-uncountable cardinals. (We get ZFC minus Powerset.) (Imagine that the bijection with omega stayed outside L.)

I am planning to show a few new tricks (by adding some finite amount of L-indiscernibility with small parameters), to make these L-cardinals into large cardinals below $0\#$, and thus produce a factory of rough versions of Harvey Friedman's most difficult and technically impressive discovery — the unprovability proofs ("reversals") at the levels of n-SRP and $0\#$.

The power-set axiom, the L-indiscernibility and the appropriate large cardinal properties will follow from a certain second-order arithmetical "homogeneity" principle, like in Ramsey theory.

All previous existing proofs of these "reversals" by Harvey Friedman are longer than 100 pages, so my new proof-elements or tricks provide a shortening of the best metamathematical arguments of nowadays. We pay for that by apparent ugliness of our (ZFC + large cardinals) – unprovable statements and, usually, by absence of Friedman's universality (fixed large dimension n of n-SRP).

20% of this study comes from learning the Manchester ways of doing model theory, another 40% comes from studying Harvey Friedman's manuscripts available on his homepage, 10% comes from studying Devlin's book, the rest is original.

If time allows, I will also mention the recent developments on n-baby measurable cardinals, a joint research with Zachiri McKenzie. These cardinals (between Victoria Gitman's super-Ramsey cardinals and measurable cardinals) have neat combinatorial and embedding properties and characterise the strengths of NFUM and KMU and their fragments, answering open questions of R. Holmes from 1990. These cardinals are the next candidates after n-Mahlo and n-SRP to be subjected to Friedman-style arithmetical model-theoretic analysis (this time not compatible with $V = L$).

It became common among metamathematicians to think that the essence of all respectable unprovability proofs nowadays comes from the mantra dating to Paris-Harrington style (and subsequent) proofs, most of them forgotten, ("the witness of induction (least element), collection, replacement or comprehension always comes before the next indiscernible").

I, in this talk, tentatively agreeing with this philosophy as much as current practice allows me to, will concentrate on other aspects of unprovability. However this mantra has to be mentioned as something I am not going to discuss.

The talk will demand as pre-requestives, the knowledge of some modern metamathematics (first-order and second-order), a bit of model theory of PA and ZFC, and the knowledge of the definition of L.

I shall not talk about the crucial notions of Ignorabimus or Arithmetical Splitting this time, although they, of course, are the main motivations and main goals of logic and metamathematics in the next few decades, and the main motivations of my own research.

(8) **Gale–Shapley–Roth algorithms and a course enrollment problem. Vinicius Cifu Lopes.**

Abstract: We review the Gale–Shapley–Roth algorithm for stable marriages and college admission, which has many uses and variants and was worth the 2012 Nobel prize in economics. Its outcome is a pairing between two sets of agents such that, if X, A belong to each set and are not matched to each other, then either X prefers his partner to A, or A prefers her partner to X. We propose an iterated version to produce college course rosters, which must satisfy several constraints on available slots, time conflicts, student scores and preferences.

This is a joint work with Aline Gubitoso.

(9) **On modalities and multi-modalities. Elaine Pimentel.**

Abstract: It is well known that context dependent logical rules can be hard to both, implement and reason about. This is one of the reasons for the quest for better behaved logical systems. In the case of modalities, local rules can be, in general, described using generalizations of sequent calculus systems. Locality in linear logic (LL) can be achieved, for instance, by using deep inference or 2-sequents.

In this work, we propose a general framework for describing systems based on multiplicative additive LL (MALL) plus simply dependent multimodalities. This class of systems includes linear logic with subexponentials (SELL) and hybrid linear logics. The chosen approach is linear nested sequents (LNS), a reformulation of 2-sequents. It turns out that LNS systems can be adequately encoded into (plain) linear logic, showing that LL is, in fact an "universal framework" for the specification of logical systems.

From the theoretical point of view, our results show that (1) logics such as SELL, that were thought to be more expressive than LL, are, in fact, equally expressive; and (2) it is possible to give an uniform presentation to linear logics featuring different axioms of modalities. From the practical point of view, our results: (3) lead to a generic way of building theorem provers for different logics, all of them based on the same grounds; and (4) allow for the use of the same logical framework for reasoning about all such logical systems.

This is a joint work with Björn Lellmann and Carlos Olarte

(10) **Reflecting topological properties. Lúcia R. Junqueira.**

Abstract: We will discuss reflection of topological properties, looking in particular at reflection in continuous images of small weight. A topological property $\mathcal{P}$ is reflected in continuous images of weight at most ω_1 if a space X has $\mathcal{P}$ whenever every continuous image of X of weight at most ω_1 has $\mathcal{P}$. We will present some recente results.

This is a joint work with Ofelia T. Alas and Richard G. Wilson.

(11) **Topological Games and Chain Conditions. Santi Spadaro.**

Abstract: We apply topological games to obtain partial ZFC solutions to a few old problems in topology. For example, we show that every linearly ordered space satisfying the game-theoretic version of the countable chain condition is separable (which is related to Suslin's Problem) and that in every compact space satisfying the game-theoretic version of the weak Lindelof property, every cover by G_δ sets has a continuum-sized subcollection with a G_δ-dense union (which is related to an old still open question of Arhangel'skii).

(12) **Modal and set theoretical tools for the study of the multiverse. Giorgio Venturi.**

Abstract: This talk deals with logical tools devised to study different multiverses: collections of models of ZFC resulting from relative consistency proofs. The talk is divided in two parts, the first one on modal logic and the second one on set theory, that are intended to elucidate on the one hand the meta-theoretical use of consistency in independence proofs and on the other hand the notion of genericity, that is fundamental in forcing constructions.

The modal logic part deals with the modal interpretation of the $\circ$-operator (i.e. the consistency operator of the Logics of Formal Inconsistency) in the context of a classical negation. The resulting systems consist of modal logics that are rendered insensitive to the presence or absence of reflexivity in the accessibility relation by a suitable modification of the standard semantics. These logics where firstly introduced independently in [5] and in [3]. For this part I will present a joint work with David Gilbert (University of Illinois at Urbana-Champaign) where we show how to associate a normal modal logic L with its reflexive insensitive counterpart, which we call L°, and give a general theorem describing the conditions under which characterization results for L° follow from the analogs for L (see [1]). In the end I will hint at applications of these logics to the study of the multiverse, in the lines of [2].

The set theory part deals with the mathematical study of the generic multiverse of a countable transitive model M of ZFC. I will define, following [6], $\mathbb{M}_M^{\Gamma}$ (i.e. the Γ generic multiverse of M) as the partial order whose elements consist of generic extension of M by means of forcings belonging to Γ and equipped with the order induced by the relation of generic extension. I will present a study the Γ generic multiverse of M, when Γ consists of the trivial and the Cohen forcing and when Γ consists of all possible forcing notions. The main result I will present deal with the possibility of building, by forcing, a truly generic model: a model built from the generic filter of $\mathbb{M}_M^{\Gamma}$ that is not a generic extension of M.

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(13) **Euclidean numbers. Vieri Benci**

Abstract: We present a class of hyperreal numbers $\mathbb{E}$ which we call Euclidean numbers. Their main property is that, for any accessible ordinal number α, any α-sequence of Euclidean number converges (in a suitable way) to an Euclidean number. This property gives them a very rich structure which allows to prove many other properties; in particular:

- the accessible ordinal numbers can be embedded in $\mathbb{E}$ in such a way that the natural operations are preserved
- they are isomorphic to a field of Hahn series (and hence they can be compared with the surreal numbers).
- they arise in a natural way from a Eucliedan theory of numerosity (and this explains their name).

This work is in collaboration with Marco Forti.

(14) **Real Lie groups and groups definable in o-minimal expansions of the real field. Alf Onshuus.**

Abstract: We will characterize torsion free groups definable in o-minimal structures, using the concept of "supersolvability". Using this, we will analyze the relation between real Lie groups and groups definable in o-minimal expansions of the real field. We prove for example that every connected simply connected supersolvable real Lie group is Lie isomorphic to a group definable in the real exponential field.

(15) **Groups definable in d-minimal structures. Antongiulio Fornasiero.**

Abstract: D-minimal structures are a generalization of o-minimal ones. We study groups and rings definable in d-minimal expansions of ordered fields.

We generalize to such objects some known results from o-minimality. In particular, we can endow a definable group with a definable topology making it a topological group. Moreover, a definable ring of dimension at least 1 and without zero-divisors is a skew field.

11.5 Session 5-Algebraic Geometry over Finite Fields and its Applications to Coding Theory

Organizers: M. Giulietti (University of Perugia), C. Carvalho (Federal University of Uberlandia)

Program

Monday 29/08 (morning session)

09:00 - 09:25	Gábor Korchmros
09:30 - 09:55	Herivelto Borges
10:00 - 10:25	Guilherme Tizziotti
10:30 - 10:55	Pietro Speziali
11:00 - 11:25	Nazar Arakelian

Monday 29/08 (afternoon session)

17:00 - 17:25	Massimo Giulietti
17:30 - 17:55	Cícero Carvalho
18:00 - 18:25	Giovanni Zini
18:30 - 18:55	Victor Neumann

Tuesday 30/08 (morning session)

09:00 - 09:25	Fernando Torres
09:30 - 09:55	Alonso Sepulveda
10:00 - 10:25	Beatriz Motta
10:30 - 10:55	Maria Montanucci
11:00 - 11:25	Grégory Duran

Abstracts

(1) **Automorphism Groups of Curves with Even Genus in Positive Characteristic. Gábor Korchmáros.**

Abstract: For an (algebraic, projective, absolutely irreducible) curve $\mathcal{X}$ defined over an algebraically closed field K of positive characteristic p, let $\mathrm{Aut}(\mathcal{X})$ be the group of all automorphisms of $\mathcal{X}$ fixing K element-wise. By a classical result, $\mathrm{Aut}(\mathcal{X})$ is finite if the genus $\mathfrak{g}$ of $\mathcal{X}$ is at least two.

The p-rank of $\mathcal{X}$ (also called the Hasse-Witt invariant) is the integer γ so that the Jacobian of $\mathcal{X}$ has p^γ points of order p. It is known that $0 \le \gamma \le \mathfrak{g}$.

In this survey we focus on the following issues concerning a subgroup G of $\mathrm{Aut}(\mathcal{X})$:

(i) Upper bounds on the size of G depending on $\mathfrak{g}$, the case where G is a solvable group.

(ii) Lower bounds on the size of G depending on $\mathfrak{g}$ which yield $\gamma = 0$.

(iii) The structure of G when $\mathfrak{g}$ is even.

The study of the automorphism group of an algebraic curve is mostly carried out by using Galois Theory, via the fundamental group of the curve. Here, we adopt a different approach in order to exploit the potential of Finite Group Theory.

Joint work with Massimo Giulietti.

(2) **Slices of Fermat Surfaces over Finite Fields. Herivelto Borges.**

Abstract: In this talk, we consider curves arising from plane sections of Fermat surfaces of degree d, over the finite field of q=2d+1 elements. We will show that, in some sense, all such curves attain the Stohr-Voloch bound.

(3) **Weierstrass semigroup and Automorphism group of the curves $X_{n,r}$. H. Borges, A. Sepúlveda and *G. Tizziotti* .**

Abstract: In this talk, we determine the Weierstrass semigroup $H(P_\infty)$ and the full automorphism group of a certain family of curves $X_{n,r}$, which was recently introduced by H. Borges and R. Conceição.

(4) **Frobenius nonclassicality of Fermat curves with respect to cubics. Nazar Arakelian.**

Abstract: For Fermat curves $\mathcal{F} : aX^n + bY^n = Z^n$ defined over $\mathbb{F}_q$, we establish necessary and sufficient conditions for $\mathcal{F}$ to be $\mathbb{F}_q$-Frobenius nonclassical with respect to the linear system of plane cubics. In the new $\mathbb{F}_q$-Frobenius nonclassical cases, we determine explicit formulas for the number $N_q(\mathcal{F})$ of $\mathbb{F}_q$-rational points on $\mathcal{F}$. For the remaining Fermat curves, nice upper bounds for $N_q(\mathcal{F})$ are immediately given by the Stöhr-Voloch Theory.

This talk is based in a joint work with Herivelto Borges.

(5) **On maximal curves that are not Galois covered by the Hermitian curve. Massimo Giulietti**

Abstract: Let $\mathbb{F}_{q^2}$ a finite field with q^2 elements where q is a power of a prime p. An $\mathbb{F}_{q^2}$-rational curve, that is a projective, geometrically absolutely irreducible, non-singular algebraic curve defined over $\mathbb{F}_{q^2}$, is called $\mathbb{F}_{q^2}$-maximal if the number of its $\mathbb{F}_{q^2}$-rational points attains the Hasse-Weil upper bound $q^2 + 1 + 2gq$, where g is the genus of the curve. The largest possible genus that an $\mathbb{F}_{q^2}$-maximal curve can have is attained by the Hermitian curve. Other notable examples are the Deligne-Lusztig curves associated to the algebraic groups of type ${}^2B_2$ and ${}^2G_2$ defined over the finite field $\mathbb{F}_n$, which are are $\mathbb{F}_{q^2}$-maximal curves over infinitely many algebraic extensions $\mathbb{F}_{q^2}$ of $\mathbb{F}_n$. By a result commonly attributed to Serre, an $\mathbb{F}_{q^2}$-rational curve which is $\mathbb{F}_{q^2}$-covered by an $\mathbb{F}_{q^2}$-maximal curve is also $\mathbb{F}_{q^2}$-maximal. This posed the problem of the existence of $\mathbb{F}_{q^2}$-maximal curves other than the Hermitian curve and their $\mathbb{F}_{q^2}$-subcovers.

Garcia and Stichtenoth discovered the first example of maximal curve not Galois covered by the Hermitian curve, namely the curve $Y^7 = X^9 - X$ maximal over $\mathbb{F}_{3^6}$. It is a special case of the curve $\mathcal{X}_\ell$ with equation $Y^{\ell^2-\ell+1} = X^{\ell^2} - X$, which is $\mathbb{F}_{\ell^6}$-maximal for any $\ell \geq 2$. In 2009, Giulietti and Korchmáros showed that a certain Artin-Schreier extension of $\mathcal{X}_\ell$ is also $\mathbb{F}_{\ell^6}$-maximal, for any prime power ℓ, and it is not covered by the Hermitian curve for any $\ell > 2$. This curve, nowadays referred to as the GK curve, was generalized by Garcia, Güneri, and Stichtenoth to the so-called GGS curve $\mathcal{C}_{\ell^n}$, which is $\mathbb{F}_{\ell^{2n}}$-maximal for any prime power ℓ and $n \geq 3$ odd.

Duursma and Mak proved that, if $\ell \geq 3$, then $\mathcal{C}_{\ell^n}$ is not Galois covered by the Hermitian curve. In his PhD thesis, Mak also showed that $\mathcal{X}_\ell$ is not Galois covered by the Hermitian curve provided that ℓ is a prime. In this talk we discuss a number of further non-covering results regarding the curve $\mathcal{X}_\ell$ for ℓ not a prime, the curve $\mathcal{C}_{2^n}$ for $\ell = 2$ and $n \geq 5$, and the Deligne-Lusztig curves for small n's. A key role in our investigation is played by classical results by Mitchell and Hartley on the classification of maximal subgroups of $PSU(3, q)$, in terms of their order and their action on the points of the Hermitian curve.

Joint work with Maria Montanucci and Giovanni Zini.

(6) **On the support of minimal weight codewords of affine cartesian codes. *Cícero Carvalho* and V. G. Lopez Neumann.**

Abstract: Reed-Muller codes were introduced in mid-fifties by Irving S. Reed and D. E. Muller (see [6] and [5]) and soon became important for practical applications and theoretical studies. In 1968 Kasami, Lin and Peterson ([2]) extended the definition of Reed-Muller codes, from codes defined over $\mathbb{F}_2$ to codes defined over any finite field, creating the so-called Generalized Reed-Muller (GRM) codes. In 1970 Delsarte, Goethals and Mac Williams ([1]) published a thorough study on GRM codes, where they characterized the minimum distance words (a new proof has ben given more recently by E. Leduc - see [3]).

In 2014 H. López, C. Rentería-Márquez and R. Villarreal introduced a new class of codes, called affine cartesian codes. This class includes the GRM codes as a special case, and in [2] they determined the parameters of these codes. In this talk I would like to present results about the characterization of codewords of minimal for some instances of affine cartesian codes. Our results generalize the result by Delsarte et alii.

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(7) **On a class of Complete Permutation Monomials. Giovanni Zini.**

Abstract: Let $\mathbb{F}_q$ be the finite field with q elements and p be the characteristic of $\mathbb{F}_q$. A *permutation polynomial* (or PP) $f(x) \in \mathbb{F}_q[x]$ is a bijection of $\mathbb{F}_q$ onto itself. A polynomial $f(x) \in \mathbb{F}_q[x]$ is a *complete permutation polynomial* (or CPP) if both $f(x)$ and $f(x)+x$ are PPs of $\mathbb{F}_q$. We consider CPPs of $\mathbb{F}_{q^n}$ of type $f_a = ax^{\frac{q^n-1}{q-1}}$. The cases $n = 2$, $n = 3$, and $n = 4$ were investigated by Bassalygo and Zinoviev, and by Wu, Li et al. For $n = 6$ and $p \in \{3, 5, 7\}$, sufficient conditions for f_a to be a CPP were given by Wu, Li et al., and by Ma, Zhang et al.

In this work we complete the study of the case $n = 6$, for arbitrary q. In particular, we provide CPPs of type f_a over $\mathbb{F}_{q^6}$, and we show that there are no other CPPs of this type for $q \geq 421$.

This is a joint work with Daniele Bartoli and Massimo Giulietti.

(8) **On the next-to-minimal weight of affine cartesian codes. Cícero Carvalho and V. G. Lopez Neumann.**

Abstract: Let $A_1, \ldots, A_n$ be a collection of non-empty subsets of $\mathbb{F}_q$. Consider an *affine cartesian set* $\mathcal{X} := A_1 \times \cdots \times A_n$. For a nonnegative integer d write $\mathbb{F}_q[\boldsymbol{X}]_{\leq d}$ for the $\mathbb{F}_q$-vector space formed by the polynomials in $\mathbb{F}_q[X_1, \ldots, X_n]$ of degree up to d together with the zero polynomial. We denote by d_i the cardinality of A_i, for $i = 1, \ldots, n$. Let $P_1, \ldots, P_{\widetilde{m}}$ be the points of $\mathcal{X}$. Define $\phi_d : \mathbb{F}_q[\boldsymbol{X}]_{\leq d} \to \mathbb{F}_q^{\widetilde{m}}$ as the evaluation morphism $\phi_d(g) = (g(P_1), \ldots, g(P_{\widetilde{m}}))$. The image $C_{\mathcal{X}}(d)$ of ϕ_d is a vector subspace of $\mathbb{F}_q^{\widetilde{m}}$ called the *affine cartesian code* (of order d) defined over the sets $A_1, \ldots, A_n$.

These codes were introduced in [2], and also appeared independently and in a generalized form in [1]. In the special case where $A_1 = \cdots = A_n = \mathbb{F}_q$ we have the well-known generalized Reed-Muller code of order d.

One is not only interested in the minimum distance, i.e. the minimal Hamming weight of the nonzero words of $C_{\mathcal{X}}(d)$, but also in the other Hamming weights of codewords. In this work we extend the results of Rolland in [3] to affine cartesian codes, determining the next-to-minimal weights of $C_{\mathcal{X}}(d)$ for all values of $d \geq d_1 - 1$ except in some cases where $\ell = 1$.

References

[1] O. Geil, C. Thomsen, Weighted Reed-Muller codes revisited. Des. Codes Cryptogr. **66**(1–3) (2013) 195–220.

[2] H. H. López, C. Rentería-Márquez, R. H. Villarreal, Affine cartesian codes, Des. Codes Cryptogr. **71**(1) (2014) 5–19.

[3] R. Rolland, The second weight of generalized Reed-Muller codes in most cases. Cryptogr. Commun. (2010) **2**:19–40.

(9) **On maximal curves of Kummer-Fermat type. Fernando Torres.**

Abstract: For concrete applications in Coding Theory, Finite Geometry, Combinatorics or Cryptography it is desirable to work with curves defined by plane models having a reasonably handling. For instance let $n > 1$ be an integer and $f(x) \in F[x]$ be an univariate polynomial of degree $d > 1$ over F, the finite field of order ℓ; then one is led to consider curves X definded by $y^n = f(x)$ as they subsume several known examples of nice curves over finite fields. For example the data $\ell = q^2$, $n = q + 1$, $f(x) = x^{q+1} + 1$ (or $f(x) = x^q + x$) as well as the data $n = q^2 - 1$ and $f(x) = x^{q-1}(x+1)$ define the so-called Hermitian curve over F; in particular this curve has the biggest number of F-rational points according to the Hasse-Weil bound over F (i.e. it is F-maximal). We investigate for which data (q, n, m) the curve X defined by $y^n = x^m + 1$, or $y^n = x^m + x$, or $y^n = x^m(x + 1)$ is F-maximal.

(10) **Two-point AG codes on the GK maximal curves. *Alonso Sepúlveda* and Guilherme Tizziotti.**

Abstract: We determine the Weierstrass semigroup of a pair of certain rational points on the Giulietti-Korchmáros (GK) maximal curve. We use this semigroup to obtain two-point AG codes with better parameters than comparable one-point AG codes arising from these curve. These parameters are new records in the MinT's tables.

(11) **The number of points of a class of Artin-Schreier curves. Beatriz Motta.**

Abstract: We investigate the number of rational points of a class of Artin-Schreier curves, which are closely related to the arc arising from the curves $\mathcal{X}_{n,r}$, introduced by H. Borges and R. Conceição. We also point out the cases where the Artin-Schreier curves are maximal.

Joint work with F. Torres and H. Borges.

(12) **Large Automorphism Groups and p-rank of Curves. Maria Montanucci.**

Abstract: Let $\mathcal{X}$ be an (algebraic, projective, absolutely irreducible) curve defined over an algebraically closed field K of positive characteristic p. Let $\mathrm{Aut}(\mathcal{X})$ be the group of all automorphisms of $\mathcal{X}$ fixing K element-wise. By a classical result, $\mathrm{Aut}(\mathcal{X})$

is finite if the genus $\mathfrak{g}$ of $\mathcal{X}$ is at least two. Furthermore, if $\mathfrak{g} \geq 2$ and G is a subgroup of $\mathrm{Aut}(\mathcal{X})$ such that $p \nmid |G|$ then $|G| \leq 84(\mathfrak{g}-1)$.

By a result of Stichtenoth, $|\mathrm{Aut}(\mathcal{X})| < 16\mathfrak{g}^4$ with just one exception, namely the Hermitian curve of genus $\frac{1}{2}q(q-1)$. An improvement due to Henn states that $|\mathrm{Aut}(\mathcal{X})| > 8\mathfrak{g}^3$ only occurs for four curves. Each of these curves has zero p-rank.

We are interested in the study of curves with $|\mathrm{Aut}(\mathcal{X})| > c\mathfrak{g}^2$ for a constant $c > 42$ independent of $\mathfrak{g}$. Under such hypothesis, the quotient curve $\bar{\mathcal{X}} = \mathcal{X}/\mathrm{Aut}(\mathcal{X})$ is rational, and the cover $\mathcal{X}|\bar{\mathcal{X}}$ is non-tamely ramified at either one or two points of $\bar{\mathcal{X}}$. Our contribution is to prove that if this number is two then $\mathcal{X}$ has zero p-rank. Here, the p-rank of $\mathcal{X}$ (also called the Hasse-Witt invariant) is the integer γ so that the Jacobian of $\mathcal{X}$ has p^γ points of order p. It is known that $0 \leq \gamma \leq \mathfrak{g}$.

Joint work with Gábor Korchmáros and Pietro Speziali.

(13) **Curves containing all points of a finite projective Galois plane and their Hasse-Witt invariant. Gregory Duran Cunha.**

Abstract: Let $\mathcal{X}$ be an irreducible (possibly singular) plane curve defined over a finite field $\mathbb{F}_q$ such that $\mathcal{X}$ contains all points of $PG(2,q)$. By a result of G. Tallini dating back to 1960, $\deg\mathcal{X} \geq q+2$ and if equality holds then $\mathcal{X}$ is nonsingular and has a homogeneous equation $(aX_0 + bX_1 + cX_2)\varphi_{01} - X_0\varphi_{02} + X_2\varphi_{12} = 0$ where $\varphi_{ij} = X_i^q X_j - X_i X_j^q$ and a, b, c are elements in $\mathbb{F}_q$ such that the cubic polynomial $X^3 - cX^2 - aX - b$ is irreducible over $\mathbb{F}_q$. Tallini also showed that a Singer group Σ of $PG(2,q)$ is a (cyclic) automorphism group of $\mathcal{X}$ of order q^2+q+1. We prove that, up to projective equivalence in $PG(2,\mathbb{K})$, the curve $\mathcal{X}$ is projectively equivalent to the curve $\mathcal{X}_q$ of equation $X_1X_2^{q+1} + X_1^{q+1}X_0 + X_2X_0^{q+1} = 0$. Our contribution is to prove that $\mathcal{X}_p$ is a general curve, that is, its genus coincides with its Hasse-Witt invariant. We also consider quotient curves of $\mathcal{X}_q$ with respect to some subgroups of Σ. If $q = p^{2i}$, for the subgroup G of Σ of order $p^{2i} - p^i + 1$ we prove that the quotient curve $\mathcal{X}/G$ is isomorphic to the Tallini curve of degree $p^i + 2$ containing all points of the Baer-subplane $PG(2,p^i)$ of $PG(2,q)$.

Joint work with Gábor Korchmáros.

11.6 Session 6-Comutative Algebra and its Interactions

Organizers: M.E. Rossi (University of Genova), H. Hassanzadeh (Federal University of Rio de Janeiro)

Program

Monday	**29/08 (morning session)**
09:00 - 09:40	Aron Simis
09:45 - 10:25	B. Ulrich
10:30 - 11:10	L. Gatto
11:15 - 11:55	E. De Negri
Monday	**29/08 (afternoon session)**
17:30 - 18:10	P. Gimenez
18:20 - 19:00	S.H.Hassanzadeh
Tuesday	**30/08 (morning session)**
09:00 - 09:40	C. Polini
09:45 - 10:25	M. Chardin
10:30 - 11:10	M. D'Anna
11:15 - 11:55	J. Naeliton

Abstracts

(1) **Plane Fat Points of Subhomaloidal Type. Zaqueu Ramos and *Aron Simis*.**

Abstract: One aims at the ideal theoretic and homological properties of a class of plane fat ideals, based on general points, such that their second symbolic powers are fat ideals having virtual multiplicities of proper homaloidal types. For this purpose one carries a detailed examination of their linear systems at the initial degree, a good deal of the results depending on the method of applying the classical arithmetic quadratic transformations of Hudson-Nagata (called Cremona equivalence by same authors). A subsidiary guide to understand these ideals through their initial linear systems has been supplied by questions of birationality with source P^2 and target higher dimensional spaces. This leads, in particular, to the retrieval of birational maps studied by Geramita-Gimigliano-Pitteloud, including a few of the celebrated Bordiga-White parameterizations.

(2) **Duality and socle generators for residual intersections. *Bernd Ulrich* and David Eisenbud.**

Abstract: We prove duality results for residual intersections generalizing work of van Straten, Huneke-Ulrich, and Ulrich, and we settle some conjectures of van Straten and Warmt. We also generalize the classical formula for the socle of local complete intersection algebras over a field of characteristic zero.

(3) **Embedding the Grassmann Cone in a Polynomial Ring. Letterio Gatto.**

Abstract: Let $X, x_1, \ldots, x_r$ be indeterminates over the rationals. Schur polynomials in $(x_1, \ldots, x_r)$ permit to define a natural isomorphism $\phi : \bigwedge^r \mathbb{Q}[X] \to B_r := \mathbb{Q}[x_1, \ldots, x_r]$ and one says that $\eta \in \bigwedge^r \mathbb{Q}[X]$ is *decomposable* if it can be written as $p_1(X) \wedge \cdots \wedge p_r(X)$, for some $p_i \in \mathbb{Q}[X]$. The *Grassmann cone* $G_r \subseteq \bigwedge^r \mathbb{Q}[X]$ is, by definition, the locus of all decomposable tensors of $\bigwedge^r \mathbb{Q}[X]$.

The talk aims to show how to write explicit equations of $\phi(G_r(\mathbb{Q}))$, the isomorphic image of the Grassmann cone in the polynomial ring B_r, via the notion of Hasse-Schmidt derivation on a Grassmann algebra. The latter provides a method to explicitly determine a map $\Psi_r(z) : B_r \to B_{r-1}((z)) \otimes B_{r+1}((z))$ which enjoys the following property: a polynomial $p := p(x_1, \ldots, x_r) \in B_r$ belongs to $\phi(G_r)$ if and only if the residue of $\Psi_r(z)(p)$ vanishes at $z = 0$. The formula is deduced by exploiting the action of the cohomology ring of the Grassmannian $G_r(\mathbb{C}^\infty)$ on $\bigwedge^r \mathbb{Q}[X]$, which so establishes a link of the subject with Schubert calculus. Moreover, the limit for $r \to \infty$ of the equation $\mathrm{Res}_{z=0}\Psi_r(z)(p) = 0$ returns the celebrated system of infinitely many bilinear PDEs known as KP hierarchy. In fact, such system includes the generalization of the Korteweg–de Vries equation for solitary waves that, in the Seventies, the Soviet physicists Kadomtsev and Petviashvili introduced to model plasma physics.

(4) **Universal Gröbner bases and Cartwright-Sturmfels ideals. Emanuela De Negri**

Abstract: By a well-known result of Bernstein-Sturmfels-Zelevinsky, the maximal minors of a matrix of variables form a universal Gröbner basis. Also for the ideal of 2-minors of the matrix of variables the universal Gröbner basis is well described by results of Sturmfels and Villareal.

In this talk we generalize these facts; we consider multigraded matrices of linear forms, and find universal Gröbner bases of the ideals of maximal minors and the ideals of 2-minors. To this aim we introduce two families of multigraded ideals, which we call Cartwright-Sturmfels and Cartwright-Sturmfels*. Both families are characterized by properties of their multigraded generic initial ideals. It turns out that Cartwright-Sturmfels ideals are radical, and that every minimal system of generators of a Cartwright-Sturmfels* ideal is a universal Gröbner basis. Moreover the two classes are closed under standard operations on ideals, and this allows us to prove the desired results.

This is a joint work with Aldo Conca and Elisa Gorla

(5) **Pruned cellular free resolutions of monomial ideals. Philippe Gimenez.**

Abstract: Using discrete Morse theory, we describe an algorithm that provides cellular free resolutions of monomial ideals that can be smaller than the Lyubeznik resolution. We will give several families of monomial ideals where the algorithm leads to the minimal resolution.

This is an ongoing work with Josep Àlvavez Montaner and Oscar Fernández Ramos.

(6) **On the isotropy group of a simple derivation . Luciene Bertoncello and *Daniel Levcovitz*.** In this talk we give the status of the following conjecture made by Baltazar and Pan. Conjecture: Let d be a simple derivation of an affine k-algebra (k a field of characteristic zero). Then its isotropy group is finite. We present a recent result of ours and Luciene Bertoncello that shows that , if d is a simple Shamsuddin derivation of a polynomial ring, then its isotropy group is, in fact, trivial.

(7) **Simple D-module components of local cohomology modules. Claudia Polini.**

Abstract: A long standing problem in algebraic geometry and commutative algebra is to determine whether every irreducible curve in projective three-space is a set-theoretic complete intersection. One way to approach this problem is via the study of local cohomology modules. As modules over the ring, local cohomology modules are huge (neither finitely generated nor Artinian), hence intractable. However, as modules over the Weil algebra D they can be filtered by simple objects and become manageable. Hence an important task is to understand the D-module structure of local cohomology modules. In this talk we describe their simple D-module composition factors. This is joint work with Robin Hartshorne.

(8) **Residual intersections. *Marc Chardin*, José Naéliton, Quang Tran Hoa.**

Abstract: I will present recent advances on Cohen-Macaulayness of residual intersection. These in particular show that hypotheses on the local number of generators are not needed and that the canonical module of the residual can be described in most situations (for instance over a Gorenstein ring). It relies on the direct approach of Hassanzadeh, that was later extended and completed in his joint work with Naéliton.

(9) **Families of Gorenstein and almost Gorenstein rings. V. Barucci, *M. D'Anna*, F. Strazzanti.**

Abstract: Starting with a commutative ring R and an ideal I, it is possible to define a family of rings $R(I)_{a,b}$, with $a, b \in R$, as quotients of the Rees algebra $\oplus_{n\geq 0} I^n t^n$; among the rings appearing in this family we find Nagata's idealization and amalgamated duplication. Many properties of these rings depend only on R and I and not on a, b; in this talk I will focus on the Gorenstein and the almost Gorenstein properties, showing that they are independent of a, b. I will also give some applications to monomial curves and to algebroid branches.

(10) **Annihilator of KOSZUL Homologies and their relation with Residual Intersection. Jose Naeliton**

Abstract: We speak in this talk about the relation between the depth of the Koszul homologies of a generating set of an ideal I and the annihilators of the Koszul homologies of a minimal generating set of a sub-ideal $a \subseteq I$. From this we prove that

the SD condition pass from I to a in a residual intersections $J = (a : I)$ in an uniform way. This fact was known to experts only in the presence of the G_∞ condition which is not that surprising since I is then generated by a d-sequence. However this was unknown even for prefect ideals of height 2 which are not G_∞. We also showed that for any residual intersection $J = a : I$ with I satisfies sliding depth, I is contained in the uniform annihilator of the non-zero Koszul homologies of a, hence a kind of universal properties for such ideals. This shows that there is a tight relation between residual intersections and the uniform annihilator of positive Koszul homologies.

This is joint work with S. H. HASSANZADEH.

11.7 Session 7- Optimal Control

Organizers: M. S. Aronna (Fundação Getúlio Vargas, Rio de Janeiro), Piermarco Cannarsa (University of Roma Tor Vergata), G. N. Silva (University of So Paulo-S. J. do Rio Preto)

Program

Monday	**29/08 (morning session)**
09:00 - 09:30	Peter Wolenski
09:30 - 10:00	Fernando Lobo Pereira
10:00 - 10:30	Maria Soledad Aronna
10:30 - 11:00	Marco Mazzola
11:00 - 11:30	Valeriano Antunes de Oliveira
Monday	**29/08 (afternoon session)**
17:30 - 18:00	Franco Rampazzo
18:00 - 18:30	Monica Motta
18:30 - 19:00	Geraldo Nunes Silva
Thursday	**01/09 (morning session)**
09:00 - 09:30	Piermarco Cannarsa
09:30 - 10:00	Hélène Frankowska
10:00 - 10:30	Francisco Silva
10:30 - 11:30	Gianna Stefani
11:30 - 12:00	Daniela Tonon

Abstracts

(1) **Fully Convex Impulsive Control problems. Cristopher Hermosilla and *Peter Wolenski*.**

Abstract: Fully convex optimal control problems are such that the Lagrangian is jointly convex in the state and the velocity variables. A Hamilton-Jacobi (HJ) theory was developed by Rockafellar and the second author under coercivity assumptions and with the absence of state constraints. Coercivity and the effective domain of the conjugate are dual concepts, and in this context, should be treated equally. We sketch how HJ theory can be extended to this broader context by allowing arcs to have jumps (impulses) and be restricted by a state constraint. The main idea is to approximate both the dual and primal problems by the self-dualizing inf-convolution of Goebel, a technique that preserves the duality structure. Thus earlier results can then be applied to the approximations, and passing to the limit leads to a HJ theory for impulsive problems.

(2) **On Some Recent Results on Impulsive Control Theory. Aram Arutyunov, Dmitry Karamzin, *Fernando Lobo Pereira*.**

Abstract: The richer structure of the impulsive control paradigms allows them to be of greater relevance for an increasing number of application scenarii. In this talk, we address a few optimal control theory developments for a general class of impulsive systems whose trajectory well posedness requires the definition of an arc joining the trajectory jump endpoints whenever it occurs. Issues concerning the existence of solutions and necessary conditions of optimality for problems with state and mixed constraints, and, in particular, the issue of nondegeneracy will be addressed.

(3) **On *limit solutions* for control systems. *M. Soledad Aronna*, Monica Motta and Franco Rampazzo.**

Abstract: For a control Cauchy problem

$$\dot{x} = f(t, x, u, v) + \sum_{\alpha=1}^{m} g_\alpha(x)\dot{u}_\alpha, \quad x(a) = \bar{x},$$

on an interval $[a, b]$, we propose in the notion of *limit solution* x that is defined for $\mathcal{L}^1$ impulsive inputs u and for standard, bounded measurable, controls v. Here $\mathcal{L}^1$ denotes the space of everywhere defined Lebesgue integrable functions. The limit solution corresponding to a control u in $\mathcal{L}^1$ is itself a (everywhere defined) function of $\mathcal{L}^1$ and, loosely speaking, it is the limit (in some sense) of standard Carath?odory solutions associated to absolutely continuous controls approximating u.

We prove consistency with already existing concepts of standard and impulsive solutions. We also analyze existence issues, and investigate the question whether this notion of solution provides a proper extension of the standard problem with absolutely controls u, i.e. if the subset of trajectories of the latter is dense in the set of trajectories of the former and the two infimum values do coincide.

(4) **Representation of the dynamics in non-commutative impulsive control problems. María Soledad Aronna, *Marco Mazzola*.**

Abstract: We consider impulsive control systems of the form

$$\dot{x} = f_0\,(t, x, u) + \sum_{k=1}^{m} f_k(x)\dot{u}\,.$$

Notions of solutions associated to possibly discontinuous control functions u are proposed in the literature even in the non-commutative case, i.e. when the Lie algebra generated by the vector fields f_k is non trivial. These definitions are justified from the fact that the related trajectories are limits, in some sense, of more classical ones. We investigate such notions of solutions and describe the underlying dynamics.

(5) **Analytical and Numerical Study of Optimal Path Planing Problem for Autonomous Underwater Vehicles (AUV). Zahra Foroozandeh, Aníbal C. Matos and *Maria do Rosário de Pinho*.**

Abstract: We consider a simplified model for the problem of planning the path of AUV to go from one point to a target set in the minimum time on a horizontal plane of constant depth. We take into consideration velocity of ocean currents with components merely on one coordinates of the position of the vehicle but depending on the other, and, moreover, we couple the kinetic equations with a dynamic equation relating the velocity with the thrusters force. Our problem includes state constraints since the velocity of the vehicle is bounded. We treat the problem numerically using the direct method and the optimization software package IPOPTS. As an interface with IPOPTS we use both AMPL and ICLOCS . A special feature of our work is the validation of the numerical solution via a maximum principle we derive from [1].

[1] R. B. Vinter, Optimal Control, Birkhauser, 2000.

(6) **Generalization of Classical Constraint Qualifications in Continuous-Time Nonlinear Programming. Moisés R. C. do Monte and *Valeriano A. de Oliveira*.**

Abstract: In the paper [G. J. Zalmai, The Fritz John and Kuhn-Tucker optimality conditions in continuous-time nonlinear programming, J. Math. Anal. Appl. 110, 503–518, 1985], Karush-Kuhn-Tucker (KKT) type necessary optimality conditions for continuous-time nonlinear programming problems are obtained by means of a generalization of the Slater constraint qualification (SCQ). However, to the best of our knowledge, other classical constraint qualifications well known from the nonlinear mathematical programming in finite dimensions were not studied in continuous-time programming. In this work, Mangasarian-Fromovitz (MFCQ) and constant rank (CRCQ) constraint qualifications are generalized from the classical finite dimension setting to the continuous-time framework. We, then, provide KKT type necessary optimality conditions. It is worthy mentioning that MFCQ is less restrictive than SCQ, and that MFCQ and CRCQ are not related to each other. Some special cases of constrained variational and optimal control problems can be handled as continuous-time programming problems.

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(7) **Liapunov-like functions and Lie brackets. Monica Motta and *Franco Rampazzo***

Abstract: Under some controllability assumptions, time optimal function is a particular Lyapunov function, a very efficient one indeed, for it also minimizes a cost: namely, the time expenditure to reach the target. In general, the time optimal function is not smooth, and this is somehow the price one has to pay for the high

performance it guarantees. The situation is similar when the integral of a nonnegative Lagrangian replaces the time cost (in which case this Lagrangian is equal to 1). To pave the way towards an augmented regularity, we embed the standard Bellman equation in a differential inequality (DI) involving Hamiltonians built from the iterated Lie brackets of the dynamical vector fields. Actually, the solutions of (DI), besides yielding reachability of the target (in finite or infinite time) provide upper estimates for the minimum value function. Furthermore, because of the explicitly displayed controllability, solutions of (DI) can likely be expected more regular than the minimum time.

(8) **Minimum time and unbounded variation. *Monica Motta* and Caterina Sartori.**

Abstract: Given $T > 0$ and a control system with dynamics affine in the (unbounded) derivative of the control u, we introduce a notion of generalized solution, that we call BV_{loc} *graph completion solution,* for controls u with total variation bounded in $[0, t]$ for every $t < T$, but possibly infinite on $[0, T]$. This special class of generalized solutions is the natural setting for some optimal control problems with *endpoint constraints* and *lack of coercivity*. We prove that such solutions belong to the larger class of *simple limit solutions*, recently introduced by M.S. Aronna and F. Rampazzo. In addition, we single out a new, specific subclass of simple limit solutions which is in one-to-one correspondence with the class of BV_{loc} graph completion solutions. This result generalizes an analogous equivalence established by M.S. Aronna and F. Rampazzo between classical graph completion solutions and a subset of limit solutions, called BVS limit solutions, in the case of controls and trajectories with bounded total variation. Differently from the concept of limit solution, which is based on a density argument, the graph-completion approach gives an explicit representation of the solution. Furthermore, in the framework of optimal control it allows to characterize the associated value function as solution of a HJ equation and to establish approximation results in several situations.

(9) **Minimal Time Problem on Stratified Domains. Daniella Porto, Peter Robert Wolenski, *Geraldo Nunes Silva.***

Abstract: The minimal time problem is defined on stratified domains as originally introduced by Bressan and Hong, that is, $\mathbb{R}^n$ is written as an union of embedded manifolds on $\mathbb{R}^n$. On each manifold we define a multifunction that is constant, convex, compact and 0 belongs to the interior of it. We showed some necessary and sufficient conditions for such problem and we also make a comparison between Snell's law and our necessary conditions.

(10) **Generalized characteristics, singularities, and Lax-Oleinik operators. *Piermarco Cannarsa* and Wei Cheng.**

Abstract: Viscosity solutions of Hamilton-Jacobi-Bellman equations are nonsmooth functions which may fail to be differentiable on "small" sets. Such singularities,

which play an important role for the underlying optimal control problem, have been analyzed from various viewpoints. Their dynamics can be described by generalized characteristics, which are forward solutions of the charactheristic system in Filippov's sense. In this talk, for stationary Tonelli Hamiltonians we develop an intrinsic proof of the existence of generalized characteristics using sup-convolutions for the so-called fundamental solution. This approach, together with local convexity estimates for the fundamental solution, leads to new results such as the global propagation of singularities.

(11) **First and Second Order Necessary Conditions in Stochastic Optimal Control. *Hélène Frankowska*, Haisen Zhang, Xu Zhang.**

Abstract: This talk concerns the first and second order necessary optimality conditions for stochastic optimal control problems of the Bolza type. The control system is governed by a stochastic differential equation whose drift and diffusion terms are control dependent and the set of controls may be nonconvex. The optimal controls under consideration are those providing the weak local minima. The derived first order necessary condition involves one adjoint equation and a pointwise variational inequality. They are very similar to the known necessary conditions of the deterministic optimal control theory. The second order necessary condition is stated in the integral form and involves two adjoint equations. For sufficiently regular singular weak local minimizers this second order integral inequality implies a pointwise condition. To obtain these results we use the classical variational approach reinforced by the set-valued analysis and the Malliavin calculus.

(12) **Stochastic modelling of the use of bioreactors for wastewater treatment. Joaquín Fontbona, Héctor Ramírez, Víctor Riquelme and *Francisco J. Silva*.**

In this work in progress we propose and study a stochastic model of a sequential batch reactor from the microscopic scale to the macroscopic scale. We study the existence of solutions of the model as well as some properties. We study the problem of extinction of biomass and the implications for optimal control problems associated to the model.

(13) **Geometric optimality conditions for trajectories containing a singular arc, Part I. Laura Poggiolini, *Gianna Stefani*.**

We consider different optimal control problems associated to an affine system on a n-dimensional C^∞ manifold M:

$$\begin{cases} \dot{\xi}(t) = (f_0 + \sum_{i=1}^m u_i(t) f_i) \circ \xi(t) \\ \xi(0) \in N_0, \quad \xi(T) \in N_f \\ (u_1, \dots, u_m) \in L^\infty(\mathbb{R}, U) \end{cases}$$

where N_0 and N_f are C^∞ sub-manifolds of M, $f_0, \dots, f_m$ are C^∞ vector fields, the control set U is a box and the final time T may be either fixed or a variable.

We consider the case when the candidate optimal trajectory contains both bang-bang arcs and a singular (or partially singular) arc.

We explain how the Hamiltonian approach can be applied in this case thanks to the development of the theory under some "minimal regularity assumptions" and the introduction of a "super Hamiltonian" (i.e. a Hamiltonian which is greater then or equal to the maximized one).

Finally we give a coordinate-free non degenerate second variation when the singular arc satisfies the strong generalized Legendre condition.

(14) **Geometric optimality conditions for trajectories containing a singular arc, Part II. *Laura Poggiolini*, Gianna Stefani .**

Abstract: Motivated by examples in the literature, we study sufficient conditions for strong local optimality of trajectories containing two bang arcs and a singular arc in an optimal control problem of the following kind

$$\begin{aligned}
&\text{minimize } \; C(\xi) = c(\xi(T)) \text{ subject to} \\
&\dot\xi(t) = \sum_{i=1}^{m} u_i X_i(\xi(t)) \quad \text{q.o. } t \in [0,T], \\
&u \in L^\infty\left([0,T], \Delta\right), \\
&\xi(0) = x_0, \qquad \xi(T) \in N.
\end{aligned}$$

where $\Delta := \{u = (u_1, \dots, u_m) \in \mathbb{R}^m \colon u_i \geq 0 \ \forall i = 1, \dots, m, \ \sum_{i=1}^m u_i = 1\}$ and N is a submanifold of the state space, a finite dimensional manifold.

The sufficient conditions which sum up to some regularity conditions and to the coercivity of the second variation of a certain subproblem lead to strong local optimality via Hamiltonian methods. As a byproduct we find conditions also in the case of a Bolza problem.

(15) **On second order necessary conditions in Optimal Control. Hélène Frankowska and *Daniela Tonon*.**

Abstract: This talk is devoted to second order necessary optimality conditions for the Mayer optimal control problem when the control set is a closed subset of $\mathbb{R}^n$ and endpoint constraints are present. Admissible controls are supposed to be just measurable. We show how to exploit the properties of particular second order variations, obtained using the adjacent tangent cone and the second order adjacent tangent subset to the control constraint, in order to obtain several different formulations of second order necessary conditions in integral form. These second order necessary conditions are then applied to obtain Goh condition, a pointwise second order necessary optimality condition which turns out to be useful when the optimal control for the Mayer problem is singular, i.e. when the classical Legendre-Clebsch condition is no more of use.

11.8 Session 8-Classification of Projective Varieties and Related Topics

Organizers: G. Borrelli (Federal University Fluminense-Niteri), E. Esteves (Instituto de Matemtica Pura e Aplicada), F. Polizzi (University of Calabria), A. Rapagnetta (University of Roma Tor Vergata)

Program

Monday	**29/08**	**(Morning Session)**
09:00 - 09:50	Abreu	
10:00 - 10:50	Frediani	
11:00 - 11:50	Cotterill	
Monday	**29/08**	**(Afternoon Session)**
17:00 - 17:50	Garbagnati	
18:00 - 18:50	Gondim	
Tuesday	**30/08**	**(Morning Session)**
09.00 - 09:50	Iacono	
10:00 - 10:50	Fassarella	
11:00 - 11:50	Pignatelli	

Abstracts

(1) **Enriched tropical curves and their relation with enriched curves . Alex Abreu.**

Abstract: In her Ph.D. thesis, Mainò introduced the notion of enriched structure on stable curves and constructed their moduli space. In this talk we give a tropical notion of enriched structure on tropical curves and construct a moduli space parametrizing these objects. Moreover, we use this construction to give a toric description of the scheme parametrizing enriched structures on a fixed stable curve.

(2) **On totally geodesic and Shimura subvarieties contained in the Torelli locus. Paola Frediani.**

Abstract: I will explain some results on totally geodesic subvarieties of A_g contained in the Torelli locus, obtained through the study of the second fundamental form of the Torelli map. I will also discuss some geometrical properties of the second fundamental form that are of independent interest. Finally I will describe some examples of Shimura subvarieties in the Torelli locus in low genus, given by families of jacobians of Galois coverings of the projective line and of elliptic curves

(3) **Secant-exceptional linear series via elliptic chains. Ethan Cotterill.**

Abstract: In the 1950's, Macdonald computed formulas for the classes of tuples along an embedded smooth projective curve that span linear subspaces of fixed incidence and dimension. These formulas are both highly nonexplicit and not manifestly positive, since they arise from the evaluation of determinants. In this talk we will describe work in progress with Melody Chan and Naizhen Zhang aimed at recovering explicit and positive counts in cases where the class is zero-dimensional and the curve is general in moduli. Our basic tool is an analysis of limit linear series along chains of elliptic curves.

(4) **Smooth double covers of K3 surfaces. Alice Garbagnati.**

Abstract: The aim of this talk is to describe the geometry of smooth double covers X of K3 surfaces S. If the branch locus of the double cover consists of rational curves, X is a blow up either of an Abelian surface or of a K3 surface. Here we describe the other cases. In particular we observe that, if there is a curve of genus at least 2 contained in the branch locus, then $h^{2,0}(X) > 1$. So the transcendental part of the middle cohomology of X carries an Hodge structure which is not of K3 type, However, it contains a sub Hodge structure of K3 type which induces the ones of S. In particular if $h^{2,0}(X) = 2$, the Hodge structure of X splits in two sub Hodge structures of K3 type: the one related with S and its orthogonal. In certain specific cases we explicitly and geometrically describe the K3 surface W, which is related with the second sub Hodge structure of K3 type.

(5) **On higher Hessians and the Lefschetz properties . Rodrigo Gondim.**

Abstract: We deal with a generalization of a Theorem of P. Gordan and M. Noether on hypersurfaces with vanishing (first) Hessian. We prove that for any given $N \geq 3$, $d \geq 3$ and $2 \leq k < \frac{d}{2}$ there are infinitely many irreducible hypersurfaces $X = V(f) \subset \mathbb{P}^N$, of degree $\deg(f) = d$, not cones and such that their Hessian of order k, Hess^k_f, vanishes identically. The vanishing of higher Hessians is closely related with the Strong (or Weak) Lefschetz property for standard graded Artinian Gorenstein algebra, as pointed out J. Watanabe. As an application we construct for each pair $(N, d) \neq (3, 3), (3, 4)$ infinitely many standard graded Artinian Gorenstein algebras A, of codimension $N + 1 \geq 4$ and with socle degree $d \geq 3$ which do not satisfy the Strong Lefschetz property, failing at an arbitrary step k with $2 \leq k < \frac{d}{2}$. We also prove that for each pair (N, d), $N \geq 3$ and $d \geq 3$ except (3, 3), (3, 4), (3, 6) and (4, 4) there are infinitely many standard graded Artinian Gorenstein algebras of codimension $N + 1$, with socle degree d, with unimodal Hilbert vectors which do not satisfy the Weak Lefschetz property.

(6) **Unobstructed deformation problems . Donatella Iacono.**

Abstract: In this talk we focus our attention on some deformation problems that are unobstructed. In particular, we study infinitesimal deformations of pairs (X, D),

where D is a smooth divisor in a smooth projective variety X. Using differential graded Lie algebras, we are able to prove the unobstructedness in some cases.

(7) **Flat parabolic vector bundles on elliptic curves. Thiago Fassarella .**

Abstract: In this talk we will investigate the geometry of moduli spaces of rank 2 logarithmic connections on an elliptic curve minus 2 points with fixed spectral data. This is a work in progress with Frank Loray.

(8) **On quotients of product of two curves. Roberto Pignatelli.**

Abstract: Constructing surfaces by taking the quotient of a product of two curves by the action of a finite group is a very old method, but it has been extensively used only in the last decade, producing several new examples of surfaces of general type, filling holes in the geography, and contributing to the answer of some classical questions. I will report on the results about the different cases of group construction considered (surfaces isogenous to a product, product-quotient surfaces, quasi-tale quotients, semi-isogenous surfaces), and describe in detail a very recent example (this is a joint work with F. Polizzi) and its deformations.

11.9 Session 9 -Topological and impulsive methods for the qualitative analysis of differential equations, differential inclusions and difference equations

Organizers: P. Benevieri (University of São Paulo), J. G. Mesquita (University of Braslia), M. Spadini (University of Firenze)

Program

Monday	**29/08**	**(Morning session)**
09:00 - 09:30	Federson	
09:30 - 10:00	Tacuri	
10:00 - 10:30	Benevieri	
10:30 - 11:00	M. N. Rabelo	
11:00 - 11:30	Pera	
Tuesday	**30/08**	**(Morning session)**
09:00 - 09:30	Biconti	
09:30 - 10:00	Mesquita	
10:00 - 10:30	Margheri	
10:30 - 11:00	Rebelo	
11:00 - 11:30	Spadini	
Wednesday	**31/08**	**(Morning session)**
09:00 - 09:30	Garrione	
09:30 - 10:00	do Ó	
10:00 - 10:30	Feltrin	

Abstracts

(1) **Lyapunov theorems for measure functional differential equations via Kurzweil-equations. Márcia Federson.**

Abstract: This is a joint work with Eduard Toon and Jaqueline Mesquita where we consider measure functional differential equations of the form $Dx = f(x_t, t)Dg$, where f is Perron-Stieltjes integrable, x_t is given by $x_t(\theta) = x(t+\theta), \theta \in [-r, 0]$, with $r > 0$, and Dx and Dg are the distributional derivatives in the sense of the distribution of L. Schwartz, with respect to functions $x : [t_0, \infty) \to \mathbb{R}^n$ and $g : [t_0, \infty) \to \mathbb{R}$, $t_0 \in \mathbb{R}$. We introduce new concepts of stability of the trivial solution of this equation whenever it exists. These new concepts generalize, for instance, the variational stability introduced by Š. Schwabik and M. Federson for FDEs and yet we are able to establish a Lyapunov-type theorem for measure FDEs via theory of generalized ordinary differential equations.

(2) **Stability results for measure neutral functional differential equations via generalized ODEs. Patrícia H. Tacuri.**

Abstract: This is a joint work with Márcia Federson. We consider a class of measure neutral functional differential equations whose integral form is given by

$$x(t) - x(0) = \int_0^t f(x_s, s)dg(s) + \int_{-r}^0 d_\theta[\mu(t,\theta)]x(t+\theta) - \int_{-r}^0 d_\theta[\mu(0,\theta)]\varphi(\theta)$$

and we establish stability results using the correspondence between solutions of this equation and solutions of a generalized ordinary differential equations. We introduce the concept of regular stability of linear operators on a Banach space of $\mathbb{R}^n$-valued regulated functions. We discuss the total stability for a class of measure neutral functional differential equations.

(3) **On the eigenvalues of a perturbed Fredholm operator of index zero. Pierluigi Benevieri.**

Abstract: Let H be a real Hilbert space and denote by S its unit sphere. Consider the nonlinear eigenvalue problem $Lx + \varepsilon N(x) = \lambda x$, where $\varepsilon, \lambda \in \mathbb{R}$, $L : H \to H$ is a bounded self-adjoint linear operator with nontrivial kernel and closed image, and $N : H \to H$ is a (possibly) nonlinear perturbation term. A unit eigenvector $\bar{x} \in S \cap \mathrm{Ker}L$ of L, corresponding to the eigenvalue $\lambda = 0$, is said to be *persistent* if it is close to solutions $x \in S$ of the above equation for small values of the parameters $\varepsilon \neq 0$ and λ. We give an affirmative answer to a conjecture formulated by R. Chiappinelli, M. Furi and M.P. Pera. Namely, we prove that if N is Lipschitz continuous and the eigenvalue $\lambda = 0$ has odd multiplicity, then the sphere $S \cap \mathrm{Ker}L$ contains at least one persistent eigenvector. This is a joint work with A. Calamai, M. Furi and M.P. Pera.

(4) **Second order impulsive retarded differential inclusions with nonlocal conditions. Marcos Napoleão Rabelo.**

Abstract: This is a joint research with Pierluigi Benevieri. We analyze the existence of bifurcations of solutions of second order impulsive functional differential equations with state dependent delay. The approach is topological and is based on a concept of orientation and degree for locally compact perturbations of Fredholm maps in Banach space introduced by P. Benevieri and M. Furi.

(5) **Global Continuation of Periodic Solutions for Retarded Functional Differential Equations on Manifolds. Maria Patrizia Pera.**

Abstract: In this talk, I will present some results on the existence and global bifurcation of T-periodic solutions to first and second order retarded functional differential equations with infinite delay on boundaryless smooth manifolds. I will consider both cases of a topologically nontrivial compact manifold (e.g., an even dimensional sphere) and of a possibly noncompact constraint, assuming in the latter case that the topological degree of a suitable tangent vector field is nonzero. The approach is

topological and based on the fixed point index theory for locally compact maps on metric ANRs.

Finally, I will show how to deduce from our results a Rabinowitz-type global bifurcation result as well as a Mawhin-type continuation principle.

(6) **On the set of harmonic solutions of a class of perturbed coupled differential equations. Luca Bisconti.**

Abstract: In this talk we present recent results jointly obtained with Marco Spadini (University of Florence). We study the set of T-periodic solutions of a class of T-periodically perturbed coupled differential equations on manifolds. More precisely, let $M \subseteq \mathbb{R}^k$ be a boundaryless smooth manifold. Given $T > 0$, we consider T-periodic solutions to the following system of equations

$$\begin{cases} \dot{x} = A(t)x + c(t) + \lambda f_1(t, x, y), \ \lambda \geq 0 \\ \dot{y} = \lambda f_2(t, x, y), \end{cases} \tag{1}$$

where $A : \mathbb{R} \to GL(\mathbb{R}^n) \subseteq \mathbb{R}^{n\times n}$ is a continuous matrix-valued map, $c : \mathbb{R} \to \mathbb{R}^n$ is a sufficiently regular vector-valued map, $\mathbf{f} := (f_1, f_2)$ is continuous with $f_1 : \mathbb{R} \times (\mathbb{R}^n \times M) \to \mathbb{R}^n$ and $f_2 : \mathbb{R} \times (\mathbb{R}^n \times M) \to \mathbb{R}^k$ and, in particular, f_2 is a tangent vector field to M, in the sense that for every $(t, p, q) \in \mathbb{R} \times (\mathbb{R}^n \times M)$ it holds that $f_2(t, p, q) \in T_qM$. Moreover, all of these maps are assumed to be T-periodic, $T > 0$ given, with respect to the t-variable.

The main novelty of this study is related to the fact that we consider the case of T-periodic perturbations of nonautonomous coupled differential equations on $\mathbb{R}^n \times M$.

By applying degree-theoretic methods we obtain a global continuation result for the T-periodic solutions of (1). Hence, we provide sufficient conditions for the existence of branches of T-periodic solutions.

(7) **Periodic averaging principle in quantum calculus. Jaqueline Godoy Mesquita – Universidade de Brasília**

Abstract: The theory of averaging plays an important role for applications, since it can be used to study perturbation theory, control theory, stability of solutions, bifurcation, among others. In this work, we prove a periodic averaging principle for q-difference equations and present some examples to illustrate our result. This is a joint work with M. Bohner.

(8) **Dynamics of the Kepler problem with linear drag. Alessandro Margheri.**

Abstract: We will present some recent results about? the global dynamics of the Kepler problem with linear drag. The results are obtained by using techniques from the qualitative theory of ODEs.

(9) **Persistence in seasonally varying predator-prey systems. Carlota Rebelo.**

Abstract: In this talk we will present some recent results on persistence in seasonally forced population dynamics models. Using the notion of basic reproduction number R_0, given by Nicolas Bac?er in the case of periodic models, we prove uniform persistence when $R_0 > 1$. We will give some examples such as models including competition among predators, prey-mesopredator-superpredator models and Leslie-Gower systems. The results presented were obtained in collaboration with Maurizio Garrione.

(10) **Second order impulsive retarded differential inclusions with nonlocal conditions. Marco Spadini.**

Abstract: When $\mathbb{R}^k$ space is decomposed in the union of $n \leq 4$ polyhedral cones (with nonempty interior and common vertex at the origin), our main result provides sufficient conditions for any map g, that is continuous and piecewise C^1 relatively to this slicing, to be invertible. This result extend a previous one by the same authors valid for $k = 2$. It is proved by a combination of linear algebra and topological arguments. This is a joint work with Laura Poggiolini.

(11) **Some recent results about traveling waves for reaction-diffusion equations with saturating diffusion. Maurizio Garrione.**

Abstract: We present some recent results, in collaboration with L. Sanchez and M. Strani, about existence of heteroclinic traveling waves for the 1-dimensional reaction-diffusion equation

$$u_t = \left(\frac{u_x}{\sqrt{1+u_x^2}} \right)_x + h'(u)u_x + f(u).$$

Here we assume the diffusion to be of mean-curvature type, embodying an effect of saturation for large gradients, and 0 and 1 to be equilibria (for instance, u(t, x) can be thought about as the relative concentration of a gene inside a population). We examine the features of the set of the admissible speeds (i.e., the values $c \in \mathbb{R}$ for which a solution $u(t, x) = v(x + ct)$ connecting 0 and 1 exists) in dependence of the shape of the reaction term f, and underline analogies and differences with the linear diffusion case.

(12) **A Priori Bounds for Positive Solutions of Semilinear Elliptic Systems in $\mathbb{R}^2$. João Marcos do Ó.**

Abstract: Our purpose in this talk is to establish a priori bounds for positive solutions of a class of semilinear elliptic systems defined in a bounded and convex domain of $\mathbb{R}^2$ with smooth boundary. We have results concerning such bounds under two different sets of assumptions on the nonlinearities. This is a joint work with Djairo G. de Figueiredo and Bernhard Ruf.

(13) **Multiplicity of positive periodic solutions for a superlinear indefinite problem: a topological approach. Guglielmo Feltrin.**

Abstract: We consider the second order nonlinear differential equation

$$u'' + cu' + \big(a^+(t) - \mu a^-(t)\big)g(u) = 0,$$

where $g(u)$ has superlinear growth at zero and at infinity, $a(t)$ is a periodic sign-changing weight, $c \in \mathbb{R}$ and $\mu > 0$ is a real parameter. We prove the existence of $2^m - 1$ positive solutions when $a(t)$ has m positive humps separated by m negative ones (in a periodicity interval) and μ is sufficiently large. The proof is based on the extension of Mawhin's coincidence degree defined in open (possibly unbounded) sets. Our method also provides a topological approach to detect infinitely many subharmonic solutions and to study positive solutions with complex behavior. This is a joint work with F. Zanolin (University of Udine, Italy).

11.10 Session 10-Inverse Problems for PDEs

Organizers: M. Di Cristo (Politecnico di Milano), A. Leitão (Federal University of Santa Catarina)

Program

Wednesday	**31/08**	**(Morning session)**
09:00 - 09:30	Giulio Ciraolo	
09:30 - 10.00	Fàbio Margotti	
10:00 - 10:30	Eva Sincich	
10:30 - 11:00	Romina Gaburro	
11:00 - 11:30	Jorge Zubelli	
11:30 - 12:00	Michele Di Cristo	

Abstracts

(1) **On compact hypersurfaces with almost constant mean curvature. Giulio Ciraolo.**

Abstract: Alexandrov?s theorem asserts that spheres are the only closed compact embedded hypersurfaces with constant mean curvature in the Euclidean space. In this talk we will discuss some quantitative versions of Alexandrov?s theorem, i.e. we will consider a hypersurface with mean curvature close to a constant and quantitatively describe its proximity to a sphere or a collection of tangent spheres of equal radii in terms of the oscillation of the mean curvature.

We will also discuss these issues for the nonlocal mean curvature, showing a remarkable rigidity property of the nonlocal problem which prevents bubbling phenomena and proving the proximity to a single sphere.

(4) **Inexact Newton combined with gradient methods in Banach spaces. Fábio Margotti.**

Abstract: Inexact Newton methods have proven to be a powerful class of iterative methods for solving nonlinear ill-posed problems in Hilbert spaces. In order to realize such a method, one must linearize the original equation around the current iterate and then apply a regularization technique to solve the resulting linear system. We propose the adaptation of some classical gradient-type regularization methods for solving the linear systems in a relatively general Banach space setting.

(3) **Lipschitz stability for the electrostatic inverse boundary value problem with piecewise linear conductivities. Eva Sincich.**

Abstract: We consider the inverse boundary value problem associated with the elliptic equation for an electric potential, where the objective is to recover the conductivity from partial data. We focus our attention on the stability of this inverse problem, in particular, when the conductivity is isotropic. We obtain a Lipschitz stability result if the conductivity is known to be piecewise linear on a given domain partition.

We let Ω be a bounded domain in $\mathbb{R}^n$, $n \geq 2$. In the absence of internal sources, the electric potential, u, satisfies the elliptic equation

$$\operatorname{div}(\gamma \nabla u) = 0 \qquad \text{in} \quad \Omega, \tag{2}$$

where the function γ signifies the *conductivity* in Ω; γ is a bounded measurable function satisfying the ellipticity condition,

$$0 < \lambda^{-1} \leq \gamma \leq \lambda, \qquad \text{almost everywhere in } \Omega, \tag{3}$$

for some positive $\lambda \in \mathbb{R}$. The inverse conductivity problem consists of finding γ when the so-called Dirichlet-to-Neumann (DtoN) map

$$\Lambda_\gamma : \ u|_{\partial\Omega} \in H^{\frac{1}{2}}(\partial\Omega) \longrightarrow \gamma \nabla u \cdot \nu|_{\partial\Omega} \in H^{-\frac{1}{2}}(\partial\Omega) \tag{4}$$

is given for any weak solution $u \in H^1(\Omega)$ to (2). Here, ν denotes the unit outward normal to $\partial\Omega$. If measurements can be taken on a portion Σ of $\partial\Omega$ only, then the relevant map is referred to as the local DtoN map.

(4) **The inverse conductivity problem for anisotropic materials. Romina Gaburro.**

Abstract: We consider the inverse problem of determining the conductivity of a body by taking measurements of voltage and current on its surface. This means, in mathematical terms, to solve an inverse boundary value problem where the unknown is the coefficient matrix (the conductivity) of a partial differential equation (the conductivity equation), from the knowledge of the so-called Dirichlet-to-Neumann (DtoN) map (the data or measurements). Different materials display different electrical properties, so that a map of the conductivity can be used to investigate internal properties of the body under investigation and to obtain an image of its interior. This inverse problem has came to be known as Electrical Impedance Tomography (EIT). EIT has many important applications in fields such as geophysics, medicine and non destructive testing of materials. Although is well known that this problem is severely ill-posed, quite a lot of progress has been made for the case when the body to be imaged is filled with isotropic material. In this talk we will focus our attention on the anisotropic case and will present some recent results of uniqueness and stability for certain type of anisotropic materials.

(5) **A stability result for quantitative photoacoustic tomography. Michele Di Cristo.**

Abstract: We treat the stability issue for the three dimensional inverse imaging modality called Quantitative Photoacoustic Tomography. We provide universal choices of the illuminations which enable to recover, in a Hölder stable fashion, the diffusion and absorption coefficients from the interior pressure data. With such choices of illuminations we do not need the nondegeneracy conditions commonly used in previous studies, which are difficult to be verified a-priori.

(6) **TBA. Jorge Zubelli.**

11.11 Session 11-Variational and geometric methods

Organizers: M. Gross (University of Roma La Sapienza), B. Ruf (Universty of Milano), D. de Figueiredo (State University of Campinas), E. dos Santos (University of So Paulo-So Carlos), J. M. do (Federal University of Paraiba), C. Tomei (Catolic University of Rio de Janeiro)

Program

Tuesday	**30/08 (afternoon session)**
17:30 - 17:55	Angela Pistoia
18:00 - 18:25	Benedetta Pellacci
18:25 - 18:50	David Costa
19:00 - 19:25	Claudianor Alves
19:25 - 19:55	Emerson Abreu
Wednesday	**31/08 (morning session)**
09:00 - 09:25	Enzo Mitidieri
09:25 - 09:50	Filomena Pacella
10:00 - 10:25	Giovany Figueiredo
10:25 - 10:50	Jaeyoung Byeon
11:00 - 11:25	Liliane Maia
11:25 - 11:50	Marco Ghimenti
Wednesday	**31/08 (afternoon session)**
17:30 - 17:55	Maria Michaela Porzio
18:00 - 18:25	Marta Calanchi
18:25 - 18:50	Massimo Grossi
19:00 - 19:25	Monica Musso
19:25 - 19:55	Olivaine de Queiroz

Abstracts

(1) **Blowing-up solutions for Yamabe-type problems. Angela Pistoia.**

Abstract: The Yamabe equation is one of the most natural and well-studied second-order semilinear elliptic equations arising in geometric variational problems. The issue of the compactness of the set of solutions of the geometric Yamabe equation has been recently studied and it is strictly related to the existence of solutions blowing-up at one or more points in the manifold. In this lecture, I will review these results and present more recent works on the Yamabe problem, where solutions blowing-up at multiple (clustering and towering) points have been found.

(2) **Morse index of sign changing solutions of semilinear elliptic problems. Benedetta Pellacci.**

Abstract: Optimization of the positive principal eigenvalue for fractional Neumann problems We will study Neumann boundary value problems under the action of fractional diffusion. This kind of model are particularly suitable to study populations dynamic when long jumps, the so-called Lévy flights, are admitted in order to search prey. We will focus on the study of the optimization of the positive principal eigenvalue in dependence on the indefinite potential, on the motility function and on the fractional exponent. This analysis is related to the optimization of the survival threshold in populations dynamic.

(3) $\mathcal{D}^{1,2}(\mathbf{R}^N)$ **versus** $C(\mathbf{R}^N)$ **Local Minimizer and a Hopf-Type Maximum Principle. C. Siegfried , *David G. Costa* and H. Tehrani.**

Abstract: We consider functionals of the form $\Phi(u) = \frac{1}{2}\int_{\mathbf{R}^N} |\nabla u|^2 - \int_{\mathbf{R}^N} b(x)G(u)$ on $\mathcal{D}^{1,2}(\mathbf{R}^N)$, $N \geq 3$, whose critical points are the weak solutions of a corresponding elliptic equation in the whole $\mathbf{R}^N$. We present a Brezis-Nirenberg type result and a Hopf-type maximum principle in the context of the space $\mathcal{D}^{1,2}(\mathbf{R}^N)$. More precisely, we prove that a local minimizer of Φ in the topology of the subspace V must be a local minimizer of Φ in the $\mathcal{D}^{1,2}(\mathbf{R}^N)$-topology, where V is given by $V := \{v \in \mathcal{D}^{1,2}(\mathbf{R}^N) : v \in C(\mathbf{R}^N) \text{ with } \sup_{x\in\mathbf{R}^N}(1+|x|^{N-2})|v(x)| < \infty\}$

(4) **Existence and concentration phenomena for a GKP equation in** $\mathbb{R}^2$. ***Claudianor O. Alves*** **and Olimpio H. Miyagaki.**

Abstract: In this talk, we intend to show some results concerning the existence, concentration phenomena and regularity of solutions for a *Generalized Kadomtsev Petviashvili* equation - GKP in $\mathbb{R}^2$.

(5) **A Faber-Krahn inequality for solutions of Schrödinger's equation on Riemannian manifolds. *Emerson Abreu*** **and Ezequiel Barbosa.**

Abstract: We consider a bounded open set with smooth boundary $\Omega \subset M$ in a Riemannian manifold (M, g), and suppose that there exists $u \in C(\overline{\Omega})$ solving the problem

$$-\Delta u = V(x)u, \text{ in } \Omega,$$

in the distributional sense, with $V \in L^\infty(\Omega)$, where $u \equiv 0$ on $\partial\Omega$. We prove a sharp inequality involving $||V||_\infty$ and the first eigenvalue of the Laplacian for special domains, which generalizes the well known Faber-Krahn inequality.

(6) **Quasilinear elliptic equations with critical potentials. Enzo Mitidieri.**

Abstract: Variants of Kato's inequality are proved for general quasilinear elliptic operators L. As an outcome we show that, dealing with Liouville theorems for coercive equations of the type

$$Lu = f(x, u, \nabla_L u) \quad on\ \Omega \subset \mathbf{R}^N,$$

where f is such that $f(x,t,\xi)\,t \geq 0$, the assumption that the possible solutions are nonnegative involves no loss of generality. Related consequences such as comparison principles, *a priori* bounds on solutions and implication to Schrödinger type equations are also presented. An underlying structure throughout this work is the framework of Carnot groups.

(7) **Morse index of sign changing solutions of semilinear elliptic problems. Filomena Pacella.**

Abstract: We will present recent results about the computation of the Morse index of radial sign changing solutions in the ball of Lane-Emden problems . The method used relies in analyzing some limit weighted eigenvalue problems in the whole space which naturally arises when studying the linearized operator for asymptotic values of the exponent of the nonlinearity. The results have been obtained in collaboration with F.De Marchis and I.Ianni.

(8) **Existence of a ground state solution for a problem involving 1-Laplacian operator. *Giovany M. Figueiredo* and Marcos T. O. Pimenta.**

Abstract: We investigate the existence of ground states for functionals that is not C^1 class. Roughly speaking, we show that the Nehari manifold method requires no regularity of the functional. As an application, we prove the existence of a ground state solution for a problem involving the 1-Laplacian operator.

(9) **Henon equation with Neumann boundary condition. Jaeyoung Byeon.**

Abstract: We consider the Henon equation on a bounded domain with the homogeneous Neumann boundary condition. One of basic concerns on the equation is to understand asymptotic behavior of least energy solutions when $\alpha \to \infty$ for the nonautonomous term $|x|^\alpha$. In this talk, I would like to explain that as $\alpha \to \infty$, many new different types of asymptotic behavior of least energy solutions arise depending on a geometry of the domain and the growth rate of a nonlinear term.

(10) **Positive Solutions for Asymptotically Linear Problems in Exterior Domains. *Liliane A. Maia* and Benedetta Pellacci.**

Abstract: We will present some recent results on the existence of a positive solution for the following class of elliptic problems

$$-\Delta u + \lambda u = f(u), \quad \text{in} \quad \Omega, \quad u \in H_0^1(\Omega),$$

where Ω is an unbounded domain in $\mathbb{R}^N$ not necessarily symmetric, $N \geq 3$, with smooth boundary $\partial\Omega \neq \emptyset$ bounded, and such that $\mathbb{R}^N \setminus \Omega$ is bounded. The nonlinearity f is super-linear at zero and asymptotically linear at infinity. This result is established via a linking argument on the Nehari manifold and by means of a barycenter function. This is a work in collaboration with Benedetta Pellacci from Università degli Studi di Napoli *Parthenope*, Italy.

(11) **On Yamabe type problems on Riemannian manifolds with boundary. Marco Ghimenti.**

Abstract: Let (M, g) be a n-dimensional compact Riemannian manifold with boundary. We consider the following problem in the slightly supercritical and slightly subcritical case

$$\begin{cases} -\Delta_g u + au = 0 & \text{on } M \\ \partial_\nu u + \frac{n-2}{2} bu = (n-2) u^{\frac{n}{n-2} \pm \varepsilon} & \text{on } \partial M \end{cases}$$

This problem represents the analogous of Yamabe problem when the manifold has a non empty boundary.

We build solutions which blow-up at a point of the boundary as the parameter ε goes to zero. The blowing-up behavior is ruled by the function $b - H$, where H is the boundary mean curvature. The proof of the result relies on a Ljapunov-Schmidt procedure.

(12) **On the regularity and asymptotic behavior of the solutions to some parabolic PDE. Maria Michaela Porzio.**

Abstract: It is well known that the heat equation exhibits a very strong regularization phenomenon: the solutions become "immediately bounded" also in presence of only summable initial data.

Indeed, this "strong regularizing effect" is not a peculiarity of the heat equation since it appears also for a lot of other parabolic problems, also nonlinear, degenerate or singular like degenerate p-Laplacian equation, the porous medium equation, etc. In the same time there are evolution problems for which this regularization does not appear like some singular p-Laplacian or fast diffusion equations. We show a new method to describe this phenomenon and to derive regularity estimates. Moreover, we investigate what happens when this regularizing effect does not appear and which is the solutions' behavior in all these different cases.

(13) **Ruf's cubic perturbation of the Laplacian yields a global cusp. Marta Calanchi.**

Abstract: Following the paper of Ruf [1], let $F(u) = -\Delta u - f(u)$, where f is a specific cubic nonlinearity. Ruf was one step away from proving the existence of global coordinates both in domain and counterdomain (Holder spaces with Neumann boundary conditions) converting F into a map $(x, y, v) \mapsto (x, y^3 - xy, v)$ of $\mathbb{R}\times\mathbb{R}R\times X$ into itself. We provide the missing step. Joint work with Nicolau Saldanha and Carlos Tomei.

[1] B. Ruf, Singularity theory and the geometry of a nonlinear elliptic equation, Ann. Scuola Norm. Sup. Pisa C1. Sc., (2), 17 (1990), 1-33.

(14) **A nonvariational system involving the critical Sobolev exponent. Massimo Grossi.**

We consider the non-variational system

$$\begin{cases} -\Delta u_i = \sum_{j=1}^{k} a_{ij} u_j^{\frac{N+2}{N-2}} & \text{in } \mathbf{R}^N, \\ u_i > 0 & \text{in } \mathbf{R}^N, \\ u_i \in D^{1,2}(\mathbf{R}^N). \end{cases} \tag{5}$$

and we give some sufficient conditions on the matrix $(a_{ij})_{i,j=1,\dots,k}$ which ensure the existence of solution bifurcating from the bubble of the critical Sobolev equation. This is a joint paper with F. Gladiali and C. Troestler.

(15) **A non-compactness result on the fractional Yamabe problem in large dimensions. Monica Musso.**

Abstract: Let (X^{n+1}, g^+) be an $(n+1)$-dimensional asymptotically hyperbolic manifold with a conformal infinity (M^n, h). The fractional Yamabe problem addresses to solve

$$P^\gamma[g^+, h](u) = cu^{\frac{n+2\gamma}{n-2\gamma}}, \quad u > 0 \quad \text{on } M$$

where $c \in \mathbf{R}$ and $P^\gamma[g^+, h]$ is the fractional conformal Laplacian whose principal symbol is $(-\Delta)^\gamma$. In this paper, we construct a metric on the half space $X = \mathbf{R}^{n+1}_+$, which is conformally equivalent to the unit ball, for which the solution set of the fractional Yamabe equation is non-compact provided that $n \geq 24$ for $\gamma \in (0, \gamma^*)$ and $n \geq 25$ for $\gamma \in [\gamma^*, 1)$ where $\gamma^* \in (0, 1)$ is a certain transition exponent. The value of γ^* turns out to be approximately 0.940197. This is a joint work with S. Kim and J. Wei.

(16) **Some classical inequalities revisited in the fractional Laplacian framework. Olivaine S. de Queiroz.**

Abstract: We are interested in the study of some classical inequalities such as Sobolev-Trudinger-Moser and also the Faber-Khran in the fractional Laplacian framework. We apply our results in the study of some free boundary problems and also in some nonlinear PDE's from Conformal Geometry.

11.12 Session 12-(Non)Local Models and Applications

Organizers: A. Fiscella (State University of Campinas), G. Molica Bisci (Mediterranea University of Reggio Calabria)

Introduction: Besides analysis of classical elliptic problems, the topics of the session include free boundary problems, calculus of variations and recent trends on local and nonlocal equations. In particular, in the last years a great interest has been devoted to the study of fractional and nonlocal operators of elliptic type. This interest is motivated both by the pure mathematical research and in view of concrete applications, since these operators arise in a quite natural way in many different contexts, such as, among the others, the thin obstacle problem, optimization, finance, phase transitions, stratified materials, anomalous diffusion, crystal dislocation, soft thin films, semipermeable membranes, flame propagation, conservation laws, ultra-relativistic limits of quantum mechanics, quasi-geostrophic flows, multiple scattering, minimal surfaces, materials science and water waves. The aim of this Special Session is to introduce recent progress and future applications in the field of local and nonlocal problems, inviting experts to discuss and exchange their ideas.

In what follows we recall the list of confirmed speakers:

- Bernhard Ruf (Università degli Studi di Milano)
- Claudianor Oliveira Alves (Universidade Federal de Campina Grande)
- Gaetano Siciliano (Universidade de São Paulo)
- João Marcos Bezerra do Ó (Universidade Federal da Paraiba)
- Liliane de Almeida Maia (Universidade de Brasília)
- María Medina (Pontificia Universidad Católica de Chile)
- Olìmpio Hiroshi Miyagaki (Universidade Federal de Juiz de Fora)
- Sandra Imaculada Moreira Neto (Universidade Estadual do Maranhão)

The duration of each seminar of our session will be of 25 minutes (plus 5 minutes for questions).

Program

Thursday	**01/08**	**(morning session)**
09:30 - 10:00	Bernhard Ruf	
10:00 - 10:30	Claudianor Oliveira Alves	
10:30 - 11:00	João Marcos Bezerra do Ó	
11:00 - 11:30	Olimpio Hiroshi Miyagaki	
11:25 - 11:50	Gaetano Siciliano	

Thursday	**01/08**	**(afternoon session)**
17:30 - 18:00	Liliane de Almeida Maia	
18:00 - 18:30	Maria Medina	
18:30 - 19:00	Sandra Imaculada Moreira Neto	

Abstracts

(1) **On a heat equation with exponential nonlinearity in $\mathbb{R}^2$. Bernhard Ruf.**

Abstract: We consider a semilinear heat equation with exponential nonlinearities in $\mathbb{R}^2$.

In $\mathbb{R}^N, N \geq 3$, critical growth is polinomial, and has been studied by several authors: existence and non-existence results were obtained for singular initial data in suitable L^p-spaces by F. Weissler and H. Brezis–T. Cazenave; furthermore, non-uniqueness results were obtained by W.-M. Ni–P. Sacks and E. Terraneo for certain singular initial data.

In $N = 2$ critical growth is given by nonlinearities of exponential type. With prove that similar phenomena occur for suitable exponential nonlinearities and singular initial data in certain Orlicz spaces.

(2) **On a Class of Intermediate Local-Nonlocal Elliptic Problems. *Claudianor O. Alves*, Francisco Julio S. A. Corrêa and Michel Chipot.**

Abstract: In this talk, we will show the the existence of solutions for a class of local-nonlocal boundary value problems of the following type

$$(IP) \qquad -div\left[a\left(\int_{\Omega(x,r)} u(y)dy\right)\nabla u\right] = f(x,u,\nabla u) \text{ in } \Omega, \quad u \in H_0^1(\Omega)$$

where Ω is a smooth bounded domain of $\mathbb{R}^N$, $a : \mathbb{R} \to \mathbb{R}$ is a continuous function, $f : \Omega \times \mathbb{R} \times \mathbb{R}^N \to \mathbb{R}$ is a given function, $r > 0$ is a fixed number, $\Omega(x,r) = \Omega \cap B(x,r)$, where $B(x,r) = \left\{y \in \mathbb{R}^N; |y-x| < r\right\}$. Here $|\cdot|$ is the Euclidian norm, $\displaystyle\int_{\Omega(x,r)} u(y)dy = \frac{1}{|\Omega(x,r)|}\int_{\Omega(x,r)} u(y)dy$ and $|X|$ denotes the Lebesgue measure of a measurable set $X \subset \mathbb{R}^N$.

(3) **Concentration-compactness principle for nonlocal scalar field equations with critical growth. *João Marcos do Ó* & Diego Ferraz.**

Abstract: We study a concentration-compactness principle for homogeneous fractional Sobolev space $\mathcal{D}^{s,2}(\mathbb{R}^N)$ for $0 < s < N/2$. As an application we establish Palais-Smale compactness for the Lagrangian associated to the fractional scalar field equation $(-\Delta)^s u = f(x,u)$ for $0 < s < 1$. Moreover, using an analytic framework based on $\mathcal{D}^{s,2}(\mathbb{R}^N)$, we obtain existence results for a wide class of nonlinearities in the critical growth range.

(4) **Nonlinear fractional elliptic equation with saddle-like potentical in $\mathbb{R}^N$. Claudianor O. Alves and *Olímpio H. Miyagaki*.**

Abstract: In this paper, we study the existence of positive solution for the following class of fractional elliptic equation

$$\epsilon^{2s}(-\Delta)^s u + V(z)u = \lambda|u|^{q-2}u + |u|^{2_s^*-2}u \text{ in } \mathbb{R}^N,$$

where $\epsilon, \lambda > 0$ are positive parameters, $q \in (2, 2_s^*)$, $2_s^* = \frac{2N}{N-2s}$, $N > 2s$, $s \in (0,1)$, $(-\Delta)^s u$ is the fractional laplacian, and V is a saddle-like potential. The result is proved by using minimizing method constrained to the Nehari manifold. A special minimax level is obtained by using an argument made by Benci and Cerami.

(5) **Semiclassical states for a fractional Schrödinger-Poisson system. Edwin G. Murcia, *Gaetano Siciliano*.**

Abstract: We consider the following doubly singularly perturbed fractional Schrödinger-Poisson system in $\mathbb{R}^N$:

$$\begin{cases} \varepsilon^{2s}(-\Delta)^s w + V(x)w + \psi w = f(w) \\ \varepsilon^{\theta}(-\Delta)^{\alpha/2}\psi = w^2, \end{cases}$$

in the unknown w, ψ. Here ε is a positive parameter, V an external potential and f a nonlinearity. Under suitable assumptions on $V, f, s, \alpha, \theta, N$ we show by variational methods that, for sufficiently small ε, the number of positive solutions of the system is estimated below by the Ljusternick-Schnirelmann category of the set of minima of the potential V.

(6) **On fractional p-Laplacian problems with weight. Raquel Lehrer, *Liliane A. Maia* and Marco Squassina.**

Abstract: We will present recent results on the existence of nonnegative solutions for a nonlinear problem involving the fractional p-Laplacian operator. The problem is set on a unbounded domain, and compactness issues have to be handled. This work is in collaboration with Raquel Lehrer from UNIOESTE, Brazil, and Marco Squassina from Università degli Studi di Verona, Italy.

(7) **The effect of the Hardy potential in some Calderón-Zygmund properties for the fractional Laplacian. María Medina.**

Abstract: In this talk we will consider the nonlocal problem

$$\begin{cases} (-\Delta)^s u - \lambda \dfrac{u}{|x|^{2s}} = f(x) & \text{in } \Omega, \\ u = 0 & \text{in } \mathbb{R}^N \setminus \Omega, \\ u > 0 & \text{in } \Omega, \end{cases}$$

where $s \in (0,1)$, Ω is a smooth bounded domain containing the origin and $N > 2s$. We will study its solvability, and the summability of the corresponding solution,

according to the integrability of f, in the spirit of the classical results of Stampacchia. In particular, we will try to find the optimal conditions on f and λ in order to obtain a solution, seeing that the techniques applied in (2), where the authors study this problem in the case $s = 1$, do not provide optimality in this setting.

This work can be found in (1).

References:

(a) B. Abdellaoui, M. Medina, A. Primo, I. Peral, *The effect of the Hardy potential in some Caldern-Zygmund properties for the fractional Laplacian.* Journal of Differential Equations, 260 (2016), pp. 8160-8206. DOI: 10.1016/j.jde.2016.02.016.

(b) L. Boccardo, L. Orsina, I. Peral, *A remark on existence and optimal summability of solutions of elliptic problems involving Hardy potential.* Discrete and continuous dynamical systems, Volume 16, Number 3 (2006), pp. 513-523.

(8) **Multiplicity of nonnegative solutions for quasilinear Schrödinger equations. Olímpio H. Miyagaki, *Sandra Im. Moreira* and Patrizia Pucci.**

Abstract: We establish the existence and multiplicity of nonnegative weak solutions for quasilinear Schrödinger equations involving nonlinearities with possibly supercritical growth at infinity and indefinite sign. By changing the variables, the quasilinear equations are reduced to a semilinear form and variational methods are then applied in order to obtain the main results.

11.13 Session 13 - Population Dynamics and Evolution

A. G. M. Neves (Federal University of Minas Gerais) , G. Gaeta (Universty of Milano)

Program

Monday	**29/08**	**(morning session)**
09:00 - 10:00	Max O. Souza	
10:00 - 11:00	Armando G. M. Neves	
Tuesday	**30/08**	**(morning session)**
09:00 - 10:00	Paulo F. A. Mancera	
10:00 - 11:00	Sônia Pinto de Carvalho	
11:00 - 12:00	Fernando L. Pio dos Santos	
Wednesday	**31/08**	**(morning session)**
09:00 - 10:00	Claudia Pio Ferreira	
10:00 - 11:00	Diomar C. Mistro and Luiz A. D. Rodrigues	
11:00 - 12:00	Lourdes Esteva	

Abstracts

(1) **Fixation in large populations: a continuous view of a discrete problem. Fabio A. C. C. Chalub and *Max O. Souza*.**

Abstract: We study fixation in large, but finite, populations with two types, and dynamics governed by birth-death processes. By considering a restricted class of such processes, which includes many of the evolutionary processes usually discussed in the literature, we derive a continuous approximation for the probability of fixation that is valid beyond the weak-selection (WS) limit. Indeed, in the derivation three regimes naturally appear: selection-driven, balanced, and quasi-neutral — the latter two require WS, while the former can appear with or without WS. From the continuous approximations, we then obtain asymptotic approximations for evolutionary dynamics with at most one equilibrium, in the selection-driven regime, that does not preclude a weak-selection regime.

(2) **Evolution of cooperation in a particular case of the infinitely repeated Prisoner's Dilemma with three strategies. Irene Núñez Rodríguez and *Armando G. M.* .**

Abstract: We study a population of individuals playing the infinitely repeated Prisoner's Dilemma under replicator dynamics. The population consists of three kinds of individuals adopting the following reactive strategies: ALLD (individuals which always defect), ATFT (almost tit-for-tat: individuals which almost always repeat the opponent's last move) and G (generous individuals, which always cooperate when the

opponent cooperated in the last move and have a positive probability q of cooperating when their opponent has defected). Our aim is studying in a mathematically rigorous fashion the dynamics of a simplified version for the computer experiment in [Nowak MA, Sigmund K (1992) *Tit for tat in heterogeneus populations*, Nature 355:255–253] involving 100 reactive strategies. We see that as the generosity degree q of the G individuals varies, equilibria (rest points) of the dynamics appear or disappear, and the dynamics changes accordingly. We prove that the results of the experiment are true in our simplified version: cooperation may evolve if q is smaller than a threshold. But we also have complete control on the existence or non-existence of the equilbria for the dynamics for all possible values of the parameters, given that ATFT individuals are close enough to TFT. For most values of the parameters the dynamics can be completely determined.

(3) **Evaluating the efficacies of MTD and metronomic chemotherapies via a mathematical model . Rafael T. Guiraldello and *Paulo F. A. Mancera***

Abstract: A mathematical model based on partial differential equations is considered to understand tumor development and its response to chemotherapy treatments. We evaluate the efficacies of two chemotherapeutic protocols, Maximum Tolerated Dose (MTD) and metronomic, as well as two methods of drug delivery (density-dependent and uniform). The results indicate that the metronomic protocol is more effective in prolonging a patients life than the MTD protocol. Furthermore, uniform drug delivery combined with the metronomic protocol promotes the greatest tumor remission over the length of the treatment. However, if failed, metronomic therapy with uniform drug delivery leads to a faster regrowth of a non-eradicated tumor, thus engendering a clinically relevant dilemma.

(4) **Modelling the mass treatment of a population infected with Schistosoma mansoni. *Sônia Pinto-de-Carvalho*, Máderson Alvares de Souza Cabral, Rodrigo Correa-Oliveira, Andréa Gazzinelli, Roberta Oliveira-Prado, Sylvie Marie Oliffson Kamphorst.**

Abstract: Schistosomiasis is an important public health problem that affects especially human populations living in poor socioeconomic environments, without adequate sanitation and clean water.

We propose to work on the issue: does annual mass treatment with praziquantel lead to an important and long-lasting sustained reduction of S. mansoni reinfections, independent of other interventions such as snail control, better sanitation, and health education programs?

We have modelled the problem with a system of non-linear ordinary differential equations, describing the evolution of the infected and non infected populations. It has an unique global attractor and predicts that, although treatment reduces significantly the prevalence, the only way to extinguish the epidemic is to avoid (re)infection. In

other words, our conclusion is that, in order to eliminate Schistomiasis, public health policies aimed at both treatment and sanitation are mandatory.

We applied to our model parameters extracted from IBGE and a longitudinal study performed between 2001 and 2010 with the total population from the endemic area of Virgem das Graças, a rural community located in northern Minas Gerais State, Brazil, obtaining a limit prevalence of 5.3%, which agrees with values obtained by the Ministério da Saude.

We have also addressed the question of how often should a treatment be applied: annually, every six months, etc? We changed slightly our model and calculated the prevalences after four years of treatment, concluding that a six months treatment will give the same results as the more frequent ones.

(5) **Application of Parameters Estimation Technique in Dengue. *Fernando L. Pio dos Santos* and Antoine dos Santos.**

Abstract: In this work we describe an investigation of biological parameters of dengue mosquito by applying the parameters estimation technique. This technique was applied to estimate a set of unknown parameters of a nonlinear model of dengue that describes the dynamics of mosquitoes in water and winged phases, and a single serotype of dengue. The *Levenberg-Marquardt* (*LM*) algorithm was explored to minimize the cost function to fit the model to the dengue data available and taking into account the parameters estimated. Numerical simulations have been performed. The numerical results showed the robustness of *LM* in estimating of the important parameters of dengue mosquito populations.

(6) **Dynamics of *Corynebacterium bovis* intramammary infections during a mastitis control program. Claudia Pio Ferreira.**

Abstract: A mathematical model is used to estimate transmission rates of *Corynebacterium bovis* in a dairy herd. In underdeveloped countries the prevalence of this bacteria can rise 30% of all subclinical cases, and understand its temporal and spatial transmission dynamics is crucial for herd management. A sensitivity analysis shows that infected individuals are the target for control program. Also, we obtained that recovered individuals are more susceptible to the disease. Disease prevalence diminished from 7 to 1% after twelve months of management practices that comprised, for example, pre- and pos- milking teat disinfection, culling of individuals infected with major mastitis pathogens, and improvement of stall design and bedding management.

(7) **Patchy Invasion of Stage-Structured Alien Species. *Diomar Cristina Mistro* and Luiz Alberto Díaz Rodrigues.**

Abstract: Understanding of spatiotemporal patterns arising in invasive species spread is necessary for successful management and control of harmful species. The conventional view of the typical invasion pattern as a continuous population travelling front has been recently challenged by both empirical and theoretical results revealing

more complicated, alternative scenarios. In particular, the so-called patchy invasion has been a focus of considerable interest; however, its theoretical study was restricted to time continuous models of biological invasion. Meanwhile, many species presents discrete generations for which time discrete models seems to be more appropriate. In this talk, we will show that patchy invasion can arise in two different modelling frameworks: in space- and time-discrete system described by coupled map lattices and in space-continuous and discrete-time systems described by integrodifference equations.

This is a joint work with Elisa Regina Cara, Sergei Petrovskii and Natalia Petrovskaya.

(8) **A model for Leshmaniasis disease. *Lourdes Esteva*, Cristobal Vargas and Cruz Vargas de León.**

Abstract: Leshmaniasis is a parasite disease transmitted by the bites of sand fly bites. Around 70 animal species, including humans, have been found as natural reservoir hosts of Leshmania parasites. Among the reservoirs, dogs are the most important ones due to their proximity to the human habitat. Infection by leshmaniasis does not invariably cause illness in the host, and can remain asymptomatic for a long period specially in dogs.

In this work we formulate a model to study the transmission of the disease among the vector, humans and dogs. Our main objective is to asses the impact of asymptomatics and dogs on the spread of Leshmaniasis. For this end we calculate the Basic Reproduction Number of the disease and we carry out sensitivity analysis of this parameter with respect the epidemiological and demographic parameters.

11.14 Session 14 - Stochastic processes in random environment and applications

Organizers: F. Zucca (Politecnico di Milano), P. M. Rodriguez and F. P. Machado (University of So Paulo - São Carlos)

Random structures typically consist of many mutually interacting random components. Even if the interaction is local and simple, the collective behavior of a large number of degrees of freedom may show intriguing phenomena like anomalous fluctuations, phase transitions, complex time evolutions and metastability. Systems of this type play an important role in statistical physics, biology and theoretical computer science. Moreover, it is widely recognized that a deep mathematical understanding of these systems is crucial even for concrete applications. The aim of this session is to present some classic results and new challenges on this topics both from the theoretical and applied points of view. We expect to address a potential audience ranging from experts of the area to PhD students. The main topics are: interacting particle systems, Markov processes, disordered systems, statistical physics, stochastic models in biology and computer science.

Program

Monday	**29/08 (morning session)**
09:00 - 10:00	I. Ben-Ari
10:00 - 11:00	S. Popov
11:00 - 12:00	D. Bertacchi
Monday	**29/08 (afternoon session)**
17:30 - 18:30	F. Polito
18:30 - 19:30	H. Matzinger
Tuesday	**30/08 (morning session)**
09:00 - 10:00	A. Bianchi
10:00 - 11:00	C. Gallesco
11:00 - 12:00	E. Andjel

Abstracts

(1) **Title:** Poisson Boundary and Transformations of Markov Chains.

Authors: **Iddo Ben-Ari**.

Abstract: We discuss the stability of the Poisson boundary of a Markov chain under transformations. We will focus on the following class of transformations. Given a Markov chain $X = (X_n : n \geq 0)$, a stopping time for X, τ, a non-decreasing sequence of stopping times is defined: $\tau_0 = 0$, $\tau_{n+1}(X) = \tau \circ \theta_{\tau_n}(X)$, where θ_n is the

shift operator $\theta_n(X) = (X_n, X_{n+1}, \dots)$. The transformed process $Y = (Y_n : n \geq 0)$ is obtained by letting $Y_n = X_{\tau_n}$, namely Y_n is equal to X sampled at the "n-th iteration" of τ, and we ask when the Poisson boundary of Y and X coincide.

(2) **Title:** Two-dimensional random interlacements and late points for random walks

Authors: Serguei Popov.

Abstract: We define the model of two-dimensional random interlacements using simple random walk trajectories conditioned on never hitting the origin, and then obtain some properties of this model. Also, for random walk on a large torus conditioned on not hitting the origin up to some time proportional to the mean cover time, we show that the law of the vacant set around the origin is close to that of random interlacements at the corresponding level. Thus, this new model provides a way to understand the structure of the set of late points of the covering process from a microscopic point of view. Also, we discuss a continuous version of the model.

(3) **Title:** Modified contact processes as models for biological colonies

Authors: Daniela Bertacchi.

Abstract: In this talk we discuss the asymptotic behaviour of a population which lives on a spatial structure, which is $\mathbb{Z}^d$ or its percolation cluster. Individuals breed and die; offspring are placed onto neighbouring sites. In the classical contact process, when one individual is present at site x, no other individual is allowed to be placed at x. In our processes, there is a penalization function which penalizes birth at crowded sites (if the penalization is the highest possible, then births are prevented on occupied sites and one obtains the usual contact process). We provide conditions for extinction or survival.

(4) **Title:** Generalized Nonlinear Yule Models

Authors: Federico Polito.

Abstract: We propose a fractional nonlinear modification of the classical Yule model often studied in the context of macrovolution. The model is analyzed and interpreted in the framework of the development of networks such as the World-wide Web. Nonlinearity is introduced by replacing the linear birth process governing the growth of the in-links of each specific webpage with a fractional nonlinear birth process with completely general birth rates. The fractional nonlinear birth process can be viewed as a classical nonlinear birth process evolving in a suitable random environment. Furthermore the fractionality added by the presence of fractional operators furnishes the model with a persistent memory. Among the main results we derive the explicit distribution of the number of in-links of a webpage chosen uniformly at random taking separated the contribution to the asymptotics and the finite time correction. The mean value of the latter distribution is also calculated explicitly in the most general case. Furthermore, in order to show the usefulness of our results,

we particularize them in the case of specific birth rates giving rise to a saturating behaviour, a property that is often observed in nature.

(5) **Title:** TBA

Authors: Heinrich Matzinger

Abstract:

(6) **Title:** Dynamics of the condensate in the reversible inclusion process on a finite set.

Authors: A. Bianchi.

Abstract: The inclusion process is an interacting particle system where particles perform random walks subjected to mutual attraction, thus providing the natural bosonic counterpart of the well-studied exclusion process. Due to attractive interaction between particles, the inclusion process can exhibit a condensation transition, where a positive fraction of all particles concentrates on a single site. In this talk we characterize the dynamics of the condensate for the reversible inclusion process on a finite set S, in the limit of total number of particles going to infinity. By potential theoretic techniques, we determine the time-scales associated to the transitions of the condensate from one site to another, and we show that the limiting dynamics of the condensate is a suitable continuous time random walk on S. Joint work with S. Dommers and C. Giardinà.

(7) **Title:** A Decoupling of Random Interlacements.

Authors: Christophe Gallesco.

Abstract: In this talk, we will first present the random interlacements process introduced by Sznitman in 2010. Then, we will construct a coupling between the random interlacements process restricted to two disjoint balls of the same size and a "soup" of independent excursions of simple random walks. Our construction is obtained by mean of the soft local time technique introduced by Popov and Teixeira in 2012. Finally, we will provide an application of this result.

(8) **Title: Convergence to upper equilibrium for two state contact process**

Authors: E. Andjel.

Abstract: We consider a two state contact process where one state is subordinate to the other on a natural "one sided" set of configurations. We characterize the equilibrium distributions for the process seen from the rightmost dominant class element and give necessary and sufficient conditions for convergence to the upper invariant distribution.

11.15 Session 15 - Probability and Statistical Mechanics

Organizers: A. De Masi (University of Aquila), L. R. Fontes (University of So Paulo), E. Presutti (University of Aquila), M. E. Vares (Federal University of Rio de Janeiro)

Program

Tuesday	**30/08**	**(afternoon session)**
17:30 - 18:30	Valle	
18:30 - 19:30	Procacci	
Wednesday	**31/08**	**(morning session)**
09:00 - 10:00	Andjel	
10:00 - 11:00	Mariani	
Wednesday	**31/08**	**(afternoon session)**
17:30 - 18:30	Gaudillière	
18:30 - 19:30	Bissacot	

Abstracts

(1) **Exponential convergence for the Fredrikson-Andersen one spin facilitated model on bounded degree graphs. Glauco Valle.**

Abstract: We prove exponential convergence to equilibrium for the Fredrikson-Andersen one spin facilitated model on bounded degree graphs under subexponential growth condition. This was a classical conjecture related to non-attractive spin systems.

(2) **Convergence of Mayer and Virial expansions for non ideal gas and the Penrose tree-graph identity. Aldo Procacci.**

Abstract: We establish new lower bounds for the convergence radius of the Mayer series and the Virial series of a continuous particle system interacting via a stable and tempered pair potential. Our bounds considerably improve those given by Penrose and Ruelle in 1963 for the Mayer series and by Lebowitz and Penrose in 1964 for the Virial series. To get our results we exploit the tree-graph identity given by Penrose in 1967 using a new partition scheme based on minimum spanning trees.

(3) **Zero range process with rapidly growing rates. Enrique D. Andjel**

Abstract: We construct a Zero Range process with increasing rates that may grow very fast. We then show that if the initial condition is translation invariant and has finite mean, no explosions occur. More complete results are obtained when the underlying 1 particle system is a nearest neighbor random walk on $\mathbb{Z}$. In this case, to avoid explosions we only require the initial condition to have a finite Cesàro mean. Work in collaboration with Ines Armendariz and Milton Jara.

(4) **Quasi invariant measures for diffusion process in evolutionary Biology. Mauro Mariani.**

Abstract: I will give an overview of some techniques to prove the existence of quasi invariant measures for diffusion systems. I will discuss a 1d example, then focus on a multi-dimensional model motivated from a well-known paradigm evolutionary Biology (the Muller's ratchet).

(5) **Local equilibria and spanning forests or metastability revisited through signal processing ideas. Alexandre Gaudillière.**

Abstract: We extend classical pyramidal algorithms of signal processing on the torus to the case of generic weighted graphs. This is done by making a connection with "local equilibria" appearing in Diaconis and Fill's intertwining relation. This connection actually provides a way to identify local equilibria of generic Markov chains, and to described the associated metastable phenomena, by starting from the adaptation, through random spanning forests, of the classical subsampling procedure of signal processing. This is work in collaboration with Luca Avena, Fabienne Castell and Clothilde Mélot.

(6) **Ferromagnetic spin models with deterministic and nonconstant external fields. Rodrigo Bissacot.**

Abstract: We discuss recent results for ferromagnetic spin systems with deterministic and nonconstant external fields. For regular and amenable lattices ($\mathbb{Z}^d$ e.g.), ferromagnetic Ising models present (or not) phase transitions when the field decays to zero at infinity according to the decay rate. Some of the results obtained are theorems from the Brazil-Italy cooperation involving researchers from both countries.

11.16 Session 16 - Algebraic Geometry

Organizers: M. Jardim (State University of Campinas), S. Marchesi (State University of Campinas), G. Ottaviani (University of Firenze)

Program

Tuesday	**August 30th**	**(afternoon session)**
17h30 - 18h20	A Laface	
18h30 - 18h55	E Postinghel	
19h00 - 19h25	M Artebani	
19h30 - 19h55	P Lella	
Wednesday	**August 31st**	**(morning session)**
09h00 - 09h50	E Esteves	
10h00 - 10h25	R V Martins	
10h30 - 10h55	A Massarenti	
11h00 - 11h50	I Vainsencher	
Wednesday	**August 31st**	**(afternoon session)**
17h30 - 18h20	D Faenzi	
18h30 - 18h55	A Boralevi	
19h00 - 19h25	L Scala	
19h30 - 20h00	E Franco	

Abstracts

(1) **Cox rings and birational morphisms. Antonio Laface.**

Abstract: Let $\mathbb{K}$ be an algebraically closed field of characteristic 0. Given a normal projective $\mathbb{K}$-variety X with finitely generated divisor class group $\mathrm{Cl}(X)$ one can define the *Cox ring* [4, 1] of X to be the graded algebra over $\mathbb{K}$:

$$\mathcal{R}(X) := \bigoplus_{[D]\in \mathrm{Cl}(X)} H^0(X, \mathcal{O}_X(D)).$$

If $\mathcal{R}(X)$ is finitely generated the variety X is a *Mori dream space*. Given a morphism $f\colon X \to Y$ of Mori dream spaces it is an open problem to relate the Cox ring of X with that of Y. In this talk, I will discuss some recent results about birational morphisms, extending those in [3, 2].
This work has been partially supported by Proyecto Fondecyt Regular N. 1150732 and Anillo ACT 1415 PIA Conicyt.

This is joint work in progress with J. Hausen and S. Keicher.

References

[1] Arzhantsev, Ivan, Derenthal, Ulrich, Hausen, Jürgen, Laface, Antonio, *Cox rings*, Cambridge Studies in Advanced Mathematics, 144, Cambridge University Press, Cambridge, 2015

[2] Arzhantsev, Ivan, Derenthal, Ulrich, Hausen, Jürgen, Laface, Antonio *Cox rings of cubic surfaces and Fano threefolds*, J. Algebra, 436, 2015, 228–276

[3] Hausen, Jürgen, Keicher, Simon, Laface, Antonio *Computing Cox rings*, Math. Comp, 85, 2016, n. 297, 467–502

[4] Hu, Yi, Keel, Sean, *Mori dream spaces and GIT*, Michigan Math J., 48, 2000, 331–348.

(2) **Positivity of divisors on blown-up projective spaces. Elisa Postinghel.**

Abstract: The minimal model program aims at a birational classification of complex algebraic varieties. The classification of surfaces was completed in the beginning of the 20th century by the Italian school of Algebraic Geometry. In the 1980s, Mori and other researchers in this field extended the concept of minimal model to higher dimension by admitting the presence of suitable singularities. The abundance conjecture and the existence of good models are among the main open problems in the minimal model program.

In this talk we study log canonical pairs given by divisors on the blow-up of projective spaces in collections of points in general position. We give a cohomological description of the strict transforms of these divisors in the iterated blow-up along the cycles of the singular locus. Vanishing theorems for the higher cohomologies are used to give a systematic study of semi-ample divisors on these further blown-up spaces. This implies a proof of the abundance conjecture for the corresponding pairs, and an explicit construction of good minimal models.

This is a joint work with Olivia Dumitrescu.

(3) **A duality for Calabi-Yau hypersurfaces in $\mathbb{Q}$-Fano toric varieties. Michela Artebani.**

Abstract: In this talk we will present a duality between families of Calabi-Yau hypersurfaces in $\mathbb{Q}$-Fano toric varieties which generalizes the mirror symmetry construction given by Batyrev [2]. This is based on a duality between pairs (Δ_1, Δ_2) of polytopes, where Δ_1 is the Newton polytope of the family and Δ_2 is the anticanonical polytope of the ambient toric variety. Batyrev construction corresponds to the case when $\Delta_1 = \Delta_2$ is reflexive, while in case Δ_1, Δ_2 are both simplices we find a generalization of a mirror construction due to Berglund, Hübsch and Krawitz [3, 4] for certain Calabi-Yau hypersurfaces in fake weighted projective spaces. This is joint work with Paola Comparin and Robin Guilbot [1].

References

[1] M. Artebani, P. Comparin, R. Guilbot. *Families of Calabi-Yau hypersurfaces in $\mathbb{Q}$-Fano toric varieties*, to appear in J. Math. Pures Appl. 2015.

[2] V.V. Batyrev. *Dual polyhedra and mirror symmetry for Calabi-Yau hypersurfaces in toric varieties*, J. Algebraic Geom., 3, 1994, no. 3, 493–535.

[3] P. Berglund and T. Hübsch. *A generalized construction of mirror manifolds*, Nuclear Phys. B, 393, 1993, no. 1-2, 377–391.

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(4) **Construction of matrices of constant rank. Paolo Lella.**

Abstract: A space of matrices of constant rank is a vector subspace V, say of dimension $n+1$, of the set $\mathrm{M}_{a,b}(\boldsymbol{k})$ of matrices of size $a \times b$ over a field $\boldsymbol{k}$, such that any element of $V \setminus \{0\}$ has fixed rank r. It is a classical problem, to look for such spaces of matrices, and to give relations among the possible values of the parameters a, b, r, n.

I will report on a joint work with Ada Boralevi and Daniele Faenzi, where we introduce a new effective method to construct matrices of constant rank. The starting point is to interpret the space V as an $a \times b$ matrix whose entries are linear forms and whose cokernel is a vector bundle over $\mathbb{P}^n$. Then, the main idea is that linear matrices of relatively small size can be cooked up with three ingredients, namely two finitely generated graded modules $\boldsymbol{E}$ and $\boldsymbol{G}$ over the ring $\boldsymbol{k}[x_0, \ldots, x_n]$, admitting a linear resolution up to a certain step, and a surjective map $\mu : \boldsymbol{E} \to \boldsymbol{G}$. If the sheaves $\widetilde{\boldsymbol{E}}$ and $\widetilde{\boldsymbol{G}}$ are vector bundles of rank r and s, under suitable conditions on the Betti numbers of $\boldsymbol{E}$ and $\boldsymbol{G}$ and on the map μ, the linear part of the presentation of the module $\ker \mu$ turns out to have constant rank $r - s$. Here, the module $\boldsymbol{G}$ should be thought of as a "small" modification of $\boldsymbol{E}$, as the presentation matrix of $\mathbf{G}$ is "subtracted" from that of $\mathbf{E}$.

Considering classical vector bundles over projective spaces, we produce several new examples of constant rank matrices, that are not easy to construct with previously known techniques. Finally, this technique allows to construct infinitely many examples of skew-symmetric 10×10 matrices of constant rank 8 in 4 variables; up to now, only one example of Westwick was known.

(5) **Limit linear series, a new perspective. Eduardo Esteves.**

Abstract: The notion of limit linear series was introduced by Eisenbud and Harris in the 80's to explain degenerations of linear series as smooth curves approach singular curves of compact type. Their theory has been used in several applications to explain the geometry of the moduli space of stable curves. Unfortunately though, stable curves of compact type, or more generally, treelike curves, give only divisorial

information on the moduli space, thus the desire to extend the theory to all stable curves. Attempts to extend the theory have been made by several people, including the speaker, with only partial success. In this talk I will describe a new approach, that of degenerating points, to overcome the failures of past attempts. Joint work with Omid Amini (ENS, Paris).

(6) **Dimension counts for rational singular curves. Renato Vidal da Silva Martins.**

Abstract: The space $M(n,d)$ of integral projective rational curves of degree d on $\mathbb{P}^n$ can naturally be parametrized by the Grassmannian $G(n,d)$. We look for a bound for the codimension of the subvariety $M(n,d,g)$ of curves of arithmetic genus g in $M(n,d)$. When these curves are cusps, this codimension is associated to inflection (or ramification) conditions on the singularities, which are connected to the weight of such points, so that we are able to explicit an estimate. In the general case, we study the problem for small genus via stratification of the subvariety by semigroups of values. This is a joint work with Ethan Cotterill (UFF) and Lia Feital (UFV).

(7) **Geometry of the spaces of holomorphic foliations in $\mathbb{CP}^n$. Israel Vainsencher.**

Abstract: A holomorphic foliation of codimension one and degree d in $\mathbb{CP}^n$ is defined by a 1-form $w = A_0dx_0 + ... + A_ndx_n$, where the A_i,(i=0...n), denote homogeneous polynomials of degree $d+1$, satisfying the conditions

(i) projectivity: $A_0x_0 + ... + A_nx_n = 0$, and

(ii) Frobenius integrability: $w/\ dw = 0$.

The family of such foliations is parameterized by a closed subscheme $F(n,d)$ of a suitable $\mathbb{CP}^N$, projectivization of the space of global sections of the twisted cotangent bundle. Condition (i) (resp.(ii)) yields linear (resp.quadratic) equations for the space of foliations $F(n,d)$ in $\mathbb{CP}^N$.

The description of the irreducible components of $F(n,d)$ seems hard to tackle in full generality. For degrees $d = 0$ or $d = 1$ all components are known thanks to J. P. Jouanolou. For $d = 2$ and $n > 2$, D. Cerveau and A. Lins Neto have shown that there are just six irreducible components.

For larger degree, other components have been described by O. Calvo-Andrade, X. Gomez-Mont, A. Lins Neto, D. Cerveau, B. Edixhoven, J. V. Pereira, T. Fassarella, W. Costa e Silva, just to name a few.

Our goal is to determine the degrees of certain irreducible components of $F(n,d)$.

(8) **On the representation type of projective varieties. Daniele Faenzi.**

Abstract: In connection with the representation theory of quivers, one says that a projective variety X is of finite type if its homogeneous coordinate ring R has finitely many maximal Cohen-Macaulay (CM) indecomposable modules; also X is tame if

these modules vary in families of dimension 1 at most, or wild if the dimension of these families is unbounded. I will show that, if R is CM and X is not a cone, then X is wild except for a number of completely classified cases. If time allows I will describe CM modules on a few tame varieties. [In collaboration with J. Pons-Llopis].

(9) **Orthogonal and unitary tensor decomposition from an algebraic perspective. Ada Boralevi.**

Abstract: While every matrix admits a singular value decomposition, in which the terms are pairwise orthogonal in a strong sense, higher-order tensors typically do not admit such an orthogonal decomposition. In this talk I will present an intrinsic characterization of those tensors that do, by means of polynomial equations of degree at most four. This is a joint work with J. Draisma, E. Horobet, and E. Robeva.

(10) **Diagonal Ideals, Isospectral Hilbert Schemes and Tautological Bundles. Luca Scala.**

Abstract: The geometry of the big diagonal Δ_n in the product variety X^n of a smooth quasi-projective surface X is, by construction, fundamentally related to the geometry of the Hilbert scheme $X^{[n]}$ of n points over X and the isospectral Hilbert scheme B^n. We will first show how certain properties of the diagonal ideal mcI_{Δ_n}, namely the log-canonical thresholds of the pair (X^n, mcI_{Δ_n}), are related to the log-canonical thresholds of the pair $(B^n, \emptyset)$ and hence to the singularities of the isospectral Hilbert scheme B^n. We will then prove that powers of the ideal sheaf mcI_{Δ_n} correspond, under the Bridgeland-King-Reid transform, to powers of determinants of tautological bundles over the Hilbert scheme of points $X^{[n]}$; as a consequence, by comparing cohomological properties of the two sides when X is projective, we can deduce on one hand a universal formula for the Euler-Poincaré characteristic of $(\det L^{[n]})^2$ for $n \leq 4$ and on the other hand an upper bound for the Casterlnuovo-Mumford regularity of the ideal sheaves $mcI^k_{\Delta_n}$ and $(mcI^k_{\Delta_n})^{\mathfrak{S}_n}$.

(11) **Moduli spaces of Λ-modules on abelian varieties. Emilio Franco.**

Abstract: Let Λ be a D-algebra in the sense of Bernstein and Beilinson. Higgs bundles, vector bundles with flat connections, co-Higgs bundles... are examples of Λ-modules for particular choices of Λ. Simpson studied the moduli problem for the classification of Λ-modules over Kähler varieties, proving the existence of a moduli space Λ-modules. Using the Polishchuck-Rothstein transform for modules of D-algebras over abelian varieties, we obtain a description of the moduli spaces of Λ-modules of rank 1. We also proof that polystable Λ module decompose as a direct sum of rank 1 Λ-modules. This allow us to describe the module spaces of arbitrary rank in terms of a certain symmetric product. We also give a moduli interpretation of the associted Hilbert scheme. This is a joint work with Pietro Tortella.

11.17 Session 17-Geometric Topology and Dynamics

Organizers: D. G. Lima (University of Sao Paulo), C. Petronio (University of Pisa), S. Francaviglia (University of Bologna), S. Martins (University of Sao Paulo), Isaia Nisoli (Federal University of Rio de Janeiro)

Program

Tuesday	**30/08 (afternoon session)**
17:30 - 17:55	Jean-Francois Lafont
18:00 - 18:25	Natlia Andrea Viana Bedoya
18:30 - 18:55	Alessandro Sisto
19:00 - 19:25	Gabriele Mondello
19:30 - 19:55	Stefano Francaviglia
Wednesday	**31/08 (Morning session)**
09:00 - 09:25	Bruno Zimemermann
09:30 - 09:55	Alexandre Paiva Barreto
10:00 - 10:25	Darlam Girão
10:30 - 10:55	Bruno Martelli
11:00 - 11:25	Roberto Frigerio
11:30 - 11:55	Joan Porti
Wednesday	**31/08 (Afternoon session)**
17:30 - 17:55	Gabriel Calsamiglia
18:00 - 18:25	Washington Mio
18:30 - 18:55	Misha Belolipetsky
19:00 - 19:25	Stephan Tillmann

Abstracts

(1) **Aspherical products which do not support Anosov diffeomorphisms. *J.-F. Lafont* , A. Gogolev.**

Abstract: A famous conjecture of Smale predicts that the only closed manifolds that support Anosov diffeomorphisms are infranilmanifolds. I will explain why the product of infranilmanifolds with certain aspherical closed manifolds do not support Anosov diffeomorphisms. As a special case, we obtain that products of a nilmanifold and negatively curved manifolds of dimension at least three do not support Anosov diffeomorphisms. This is joint work with Andrey Gogolev (Binghamton University).

(2) **Grids and branched coverings of the sphere. Natalia A. Viana Bedoya.**

Abstract: In this work we study $m \times n$ grids of nodes and edges realizing branched coverings of the sphere. We will introduce this relation and their properties.

(3) **A Central Limit Theorem for acylindrically hyperbolic groups. *Alessandro Sisto*, Pierre Mathieu.**

Abstract: Acylindrically hyperbolic groups form a very large class of groups that includes non-elementary (relatively) hyperbolic groups, mapping class groups, $Out(F_n)$, many groups acting on CAT(0) spaces, etc. I will discuss the behaviour of random walks on such groups, in particular illustrating the fact that random paths tend to stay close to geodesics, and I will explain how this can be used to get a central limit theorem for the distance from the identity of the random walk.

(4) **Surfaces with spherical metrics. *Gabriele Mondello*, Dmitri Panov.**

Abstract: McOwen and Troyanov proved existence and uniqueness of conformal metrics of constant non-positive curvature and conical singularities of prescribed angles on every compact Riemann surface with marked points, provided the obvious Gauss-Bonnet constraint is satisfied. Thus, the moduli space of such metrics can be essentially identified to the moduli space of Riemann surfaces with marked points.

Quite differently, in constant positive curvature no such existence and uniqueness hold in general. I will illustrate that there is a natural obstruction to the existence, which can be easily expressed in terms of the angles. Moreover, given angles $\underline{\vartheta}$ for which such obstruction vanishes, I will discuss some properties of the moduli space of surfaces of genus g with a metric of curvature 1 and conical points of angles $\underline{\theta}$.

(5) **The theory of train tracks and the conjugacy problem for automorphisms of free groups. *Stefano Francaviglia*, Armando Martino.**

Abstract: In this talk we will discuss the topological approach to the study of outer automorphisms of free groups given by the study of free homotopy classes of maps between graphs. The moduli space of marked graphs with fundamental group F_n is know as Culler-Vogtmann Outer Space, and the group of outer automorphism of F_n acts by isometries on that space. We will show how the axis of $\phi \in Out(F_n)$ — that is to say the points of the outer space that are minimally displaced by ϕ — can be described in terms of train-track maps (introduced in this setting by Bestvina and Handel), and how train tracks are a powerful tool in studying automorphisms, with particular attention to the reducibility problem (solved by I. Kapovich) and the conjugacy problem in $Out(F_n)$ (solved by J. Loss for irreducible automorphisms).

(6) **On finite group actions on surfaces, finite graphs and 3-manifolds. *Bruno P. Zimmermann* , Chao Wang, Shicheng Wang, Yimu Zhang.**

Abstract: We report on two recent results on finite group actions of large order on surfaces and finite graphs embedded in S^3, and on closed 3-manifolds:

i) By a classical result of Hurwitz, the maximal possible order of a finite orientation-preserving group action on a closed orientable surface F_g of genus $g > 1$ is $84(g-1)$. In a program to visualize finite group actions of large orders on surfaces, in joint

work with Chao Wang, Shicheng Wang and Yimu Zhang, we consider finite group actions on pairs (S^3, F_g) where F_g is a closed surface of genus g embedded in S^3. An upper bound for the order is $12(g-1)$ now, and we determine the maximal order of such an action for each $g > 1$; in fact, we classify all finite group actions on such pairs (S^3, F_g) of orders larger than $4(g-1)$. Then we give a similar classification for finite group actions on finite graphs of rank $g > 1$ embedded in S^3.

ii) If there remains time, we will discuss also joint work with M. Boileau, C. Franchi, M. Mecchia and L. Paoluzzi where we show that, given a closed 3-manifold M, there is a universal bound on the number of inequivalent knots in S^3 which have M as a cyclic branched covering. The most interesting and difficult case here is that of a hyperbolic 3-manifold M (in particular, with a finite group of isometries) where one has to rely heavily on methods from finite group theory, including the classification of the finite simple groups.

(7) **Involutions on closed Sol 3-manifolds and the Borsuk-Ulam Theorem for maps into $\mathbb{R}^n$. *Alexandre Paiva Barreto* , D. L. Gonçalves, D. Vendrúscolo**

Abstract: In this talk we classify the free involutions of a Sapphire Sol 3-manifold. We determine also whether a triple $(M, \tau; \mathbb{R}^n)$, where M is a Sol 3-manifold and τ is a free involution on M, has the Borsuk-Ulam Property or not.

(8) **Tunnel number of knots from a combinatorial perspective. *Darlan Girão*, J. Nogueira, A. Salgueiro.**

Abstract: In this talk we discuss a combinatorial approach for the problem of computing the tunnel number of knots and links in S^3. By considering minimal crossing diagrams, we study properties associated to *percolation* in graph theory and show how this gives estimates on tunnel number. We then show how this behaves in particular classes of links.

(9) **Hyperbolic four-manifolds. Bruno Martelli.** We survey some recent constructions of hyperbolic four-manifolds, focusing on some aspects that are familiar to three-dimensional topologists: cusp shapes, volumes, Dehn filling. The main technique is the assembling of Coxeter hyperbolic four-dimensional polytopes.

(10) **Ergodic actions and intergral approximations of Gromov's simplicial volume. R. Frigerio.**

Abstract: The simplicial volume is a homotopy invariant of closed manifolds defined by Gromov in 1982. For a manifold M, it is bounded from above by the minimal number of top-dimensional simplices in a triangulation of M, and roughly speaking it measures the minimal size of triangulations of M "with real coefficients". A long-standing conjecture by Gromov asserts that, for aspherical manifolds, the vanishing of the simplicial volume implies the vanishing of the Euler characteristic. In this talk

I describe an approach to this conjecture that makes use of discrete approximations of the simplicial volume in towers of coverings, as well as of ergodic actions of the fundamental group of M on suitable probability spaces.

(11) **Reidemeister torsion, hyperbolic three-manifolds, and character varieties. Joan Porti.**

Abstract: In this talk I plan to overview recent results on the behavihor of Reidemeister torsions from two viewpoints: as topological invariants of closed hyperbolic three-manifolds, and also as functions on the variety of representations of cusped manifolds in $\mathrm{SL}_2(\mathbb{C})$. In addition, I consider torsions obtained after composing with a finite dimensional representation of $\mathrm{SL}_2(\mathbb{C})$.

(12) **The Riemann-Hilbert mapping on $\mathfrak{sl}_2$-systems. *G. Calsamiglia*, B. Deroin, V. Heu and F. Loray.**

Abstract: The Riemann-Hilbert mapping on $\mathfrak{sl}_2$-systems associates, to any $\mathfrak{sl}_2$ connection on a trivial bundle $X \times \mathbb{C}^2$ over a genus $g \geq 2$ Riemann surface X, the class of its monodromy representation in the SL_2 character variety.
We prove that the Riemann-Hilbert mapping is a local diffeomorphism around any point of genus $g = 2$ with irreducible monodromy.

(13) **Persistent Homology and Barcode Fields. Washington Mio, Mao Li.**

Abstract: Persistent homology lets us construct informative summaries of the geometry and topology of data and probability measures via barcodes. We propose a local-to-global form of homology represented by continuous barcode fields that are stable with respect to small perturbations of a probability measure as measured by the Wasserstein distance. We also discuss applications to shape analysis.

(14) **Counting isospectral manifolds. *Mikhail Belolipetsky*, Benjamin Linowitz.**

Abstract: I will talk about a recent joint work with Benjamin Linowitz, in which we show that surprisingly many higher rank locally symmetric spaces are mutually isospectral.

(15) **Tessellating moduli spaces of strictly convex projective structures. *Stephan Tillmann*, Sampson Wong, Robert Haraway.**

Abstract: Associating the Euclidean cell decomposition due to Cooper and Long to each point of the moduli space of framed strictly convex real projective structures of finite volume on a non-compact manifold gives this moduli space a natural decomposition. I will describe algorithms to compute these decompositions for surfaces and discuss some applications.

11.18 Session 18 - Geometric Analysis

Organizers: B. Nelli, (University of Aquila), M. F. Elbert (Federal University of Rio de Janeiro)

Program

Tuesday	**August, 30th (afternoon session)**
17.30 - 18.15	Luciano Mari
18.20 - 19.05	Heudson Mirandola
19.10 - 19.55	Miriam Telichevesky
Wednesday	**August 31st (morning session)**
09.00 - 09.45	Leonardo Biliotti
10.00 - 10.45	Magdalena Rodriguez
11.00 - 11.45	Francesco Mercuri
Wednesday	**August 31st (afternoon session)**
17.30 - 18.15	José Maria Espinar
18.20 - 19.05	Asunción Jiménez
19.10 - 19.55	Graham Smith

Abstracts

(1) **The Ahlfors-Khasminskii duality for fully nonlinear PDEs, and geometric applications. Luciano Mari.**

Abstract: Maximum principles at infinity (or *almost maximum principles*) are a powerful tool to investigate the geometry of Riemannian manifolds. Among them, we stress the Ekeland, the Omori-Yau principles and their weak versions, in the sense of Pigola-Rigoli-Setti. These last have nice probabilistic counterparts in terms of stochastic and martingale completeness, which in turn are related to potential theory and parabolicity. The validity of such principles is usually granted via suitable exhaustion functions called Evans-Khasminskii potentials. In this talk, I discuss an underlying, unifying duality that allows to uncover relations between the principles. Indeed, duality holds for a broad class of fully-nonlinear operators of geometric interest. Our methods use the approach to nonlinear PDEs pioneered by Krylov ('95) and Harvey-Lawson ('09 -), and involve the study of viscosity *almost solutions* of obstacle type problems.
This is joint work with Leandro F. Pessoa.

(2) **The Caffarelli-Kohn-Nirenberg inequality for submanifolds in Riemannian manifolds. Heudson Mirandola.**

Abstract: After works by Michael and Simon, Hoffman and Spruck, and White, the celebrated Sobolev inequality could be extended to submanifolds in a huge class of Riemannian manifolds. The universal constant obtained by them depends only on the dimension of the submanifold. A sort of applications to the submanifold theory and geometric analysis have been obtained from that inequality. It is worthwhile to point out that, by a Nash Theorem, every Riemannian manifold can be seen as a submanifold in some Euclidean space. In the same spirit, Carron obtained a Hardy inequality for submanifolds in Euclidean spaces. In this talk, we will speak about the Hardy, the weighted Sobolev and the Caffarelli-Kohn-Nirenberg inequalities, as well as some of their derivatives, as Galiardo-Nirenberg and Heisenberg-Pauli-Weyl inequalities, for submanifolds in a class of Riemannian manifolds, that include, the Cartan-Hadamard ones.

(3) **Strict convexity condition at infinity and minimal graphs over unbounded domains of Hadamard manifolds. Miriam Telichevesky.**

Abstract: In this talk I will define the *strict convexity condition at infinity* of a Hadamard manifold M and then describe how it may be useful to investigate the existence of minimal graphs over unbounded domains in M. Some other applications of this condition will also be presented.

(4) **Stability of measures on Kähler manifolds. Leonardo Biliotti.**

Abstract: Let (M, ω) be a Kähler manifold and let K be a compact group that acts on M in a Hamiltonian fashion. We will study the action of K and $K^{\mathbb{C}}$ on the space of probability measures on M. First of all we identify an abstract setting for the momentum mapping and give numerical criteria for stability, semi-stability and polystability. Next we apply this setting to the action of $K^{\mathbb{C}}$ on measures. We get various stability criteria for measures on Kähler manifolds. The same circle of ideas gives a very general surjectivity result for a map originaly studied by Hersch and Bourguignon-Li-Yau.

This is a joint work with and Alessandro Ghigi.

(5) **Harmonic diffeomorphism between complete surfaces of finite topology. Magdalena Rodríguez.**

Abstract: Heinz proved in 1952 there is no harmonic diffeomorphism from a disk onto the complex plane (with the euclidean metric). Collin and Rosenberg constructed in 2010 harmonic diffeomorphisms from the complex plane onto the hyperbolic plane, disproving a conjecture by Schoen and Yau. In a joint work with Laurent Mazet and Harold Rosenberg we prove, following similar ideas: Given any hyperbolic complete surface S of finite topology and infinite area, there exists a parabolic complete surface $\hat{S}$ (it is nothing but S with a parabolic conformal structure) and a harmonic diffeomorphism from $\hat{S}$ to S.

(6) **On the Gauss map of complete minimal surfaces in $\mathbb{R}^3$. Francesco Mercuri.**

Abstract: The Gauss map of a minimal surface in $\mathbb{R}^3$ is a holomorphic map. A natural question for such maps is to study the size of the image. For example is there a Picard type Theorem for the Gauss map of a complete minimal surface? I this talk we will comment on classical results on this line and report on some work in progress (joint work with L. Jorge).

(7) **f-extremal domains in hyperbolic space. José Espinar.**

Abstract: In this talk we study the geometry and the topology of bounded and unbounded domains in the Hyperbolic Space $\mathbb{H}^n$ supporting a bounded positive solution to an overdetermined elliptic problem. Under suitable conditions on the elliptic problem and the behaviour of the bounded solution at infinity, we are able to show that symmetries of the boundary at infinity imply symmetries on the domain itself. In dimension two, we can strengthen our results proving that a connected domain $\Omega \subset \mathbb{H}^2$ with C^2 boundary whose complement is connected and supports a bounded positive solution u to an overdetermined problem, assuming natural conditions on the equation and the behaviour at infinity of the solution, must be either a geodesic ball or, a horodisk or, a half-space determined by a complete equidistant curve or, the complement of any of the above example. Moreover, in each case, the solution u is invariant by the isometries fixing Ω.

This talk is based on two joint works with J. Mao, A. Farina and L. Mazet.

(8) **Isolated singularities of the prescribed mean curvature equation in Minkowski 3-space. Asunción Jiménez.**

Abstract: In this talk we will study non-removable isolated singularities of the following quasilinear, non-uniformly elliptic PDE in two variables:

$$(1 - z_y^2)z_{xx} + 2z_x z_y z_{xy} + (1 - z_x^2)z_{yy} = 2\mathcal{H}(1 - z_x^2 - z_y^2)^{3/2},$$

where $\mathcal{H} = \mathcal{H}(x, y, z)$ is a C^k positive function ($k \geq 1$) and $z = z(x, y)$ satisfies the ellipticity condition $z_x^2 + z_y^2 < 1$. The solutions of this equation have a geometric interpretation, since they represent spacelike graphs of prescribed mean curvature $\mathcal{H}$ in the Lorentz-Minkowski space $\mathbb{L}^3$. More specifically, we will consider elliptic solutions $z(x, y)$ that are C^2 on a certain punctured disk

$$\Omega = \{(x, y) : (x - x_0)^2 + (y - y_0)^2 < \rho^2\} \subset \mathbb{R}^2,$$

and do not extend smoothly to the puncture (x_0, y_0). We will describe the asymptotic behavior around such a non-removable isolated singularity, and to classify the associated moduli space.

Joint work with: Jose A. Galvez, Asun Jimenez, Pablo Mira.

(9) **Morse homology and problems of prescribed mean curvature. Graham Smith.**

Abstract: The construction of constant curvature hypersurfaces subject to geometric or topological restrictions is a standard one of riemannian geometry. Closely related to this is the problem of constructing hypersurfaces of curvature *prescribed* by some function of the ambient space. In fact, a complete understanding of the one generally entails a complete understanding of the other.

In constructing constant and prescribed curvature hypersurfaces, the techniques of infinite-dimensional differential topology have yielded many pleasing existence results (c.f. the work of Jost, Schneider, Tomi, Tromba, White, and so on). However, in various interesting cases, the number of solutions that these techniques promise is (algebraically!) equal to zero. This is clearly not very helpful. To get round this, we aim to develop a deeper, Morse homology theory, built around forced mean curvature flows, which, by counting separately solutions of different Morse index, should yield a far greater number of solutions.

In the present exposé, we show the effectiveness of this technique in the case where the mean curvature is prescribed by a suitably controlled, positive function, and the ambient space is a flat $(d+1)$-dimensional torus. In this manner we show that, for generic data, there exist at least 2^{d+1} locally strictly convex, immersed hyperspheres with mean curvature prescribed by that data.

11.19 Session 19-Control and Asymptotics of Nonlinear PDE Dynamics

Organizers: F. Bucci (University of Firenze), A. N. de Carvalho (University of So Paulo), E. Rocca (Universitá di Pavia)

Program

Tuesday Aug 30 09:00-12:00 (Morning: five talks, 25(+5) minutes long)

(1) Eduard Feireisl - CZ- On well/ill posedness of certain problems in fluid mechanics

(2) Ma To Fu - BR - Wave equations with moving boundary

(3) Piermarco Cannarsa - IT - Multiplicative controllability for semilinear reaction-diffusion equations

(4) Helene Frankowska - FR - State constrained control problems in infinite dimension

(5) Marcone Correa Pereira - BR - An approach to spatial spread in thin structures

(6) Possible discussion

Tuesday Aug 30 17:30-20:00 (Afternoon: three talks, 25(+5) minutes long)

(1) Alain Miranville - FR - Cahn-Hilliard inpainting

(2) Giulio Schimperna - IT - On the fractional Cahn-Hilliard equation

(3) Rodrigo Nunes Monteiro - BR - Long-time dynamics of a full von Karman system with nonlinear thermal effects and partially dissipative free boundary conditions

Wednesday Aug 31 9:00-12:00 (Morning: six talks, 25(+5) minutes long)

(1) Tomas Caraballo - ES - Stability of stochastic delay evolution equations

(2) Jaime E. Munhoz Rivera - BR - About pointwise dissipative mechanism

(3) Luciano Pandolfi - IT - Control properties of Viscoelastic materials with large memory

(4) Sergio Frigeri - IT - Optimal control for some diffuse-interface models for binary fluids with nonlocal interaction

(5) Cristina Pignotti - IT - On the Cucker-Smale model with time delay

(6) Marcelo Moreira Cavalcanti - BR - Unilateral problem for the wave equation with spatial-time degenerate nonlinear damping: well-posedness and exponential stability

(7) Closing

Abstracts

(1) **On well/ill posedness of certain problems in fluid mechanics. Eduard Feireisl.**

Abstract: We discuss several systems of partial differential equations arising in the mathematical theory of compressible *inviscid* fluids. We show that one can always assert the existence of infinitely many weak solutions that are global in time and emanate from the same initial data. In addition, we show that there is a large class of initial data for which these problems admit infinitely many solutions satisfying, in addition, a variant of energy inequality. The results are based on application of the method of convex integration.

(2) **Wave equations with moving boundary. To Fu Ma.**

Abstract: This talk is concerned with long-time dynamics of weakly damped semilinear wave equations defined on domains with moving boundary. Since the boundary is a function of the time variable the problem is intrinsically non-autonomous. Under the hypothesis that the exterior normal to the lateral boundary does not belong to the corresponding light cone, the solution operator of the problem generates an evolution process defined on time-dependent Sobolev spaces. Then, by assuming the domain is expanding, we establish the existence of a minimal pullback attractor with respect to a universe of tempered sets defined by the forcing terms. This is done by presenting an appropriate criterion for asymptotic compactness.

References

[1] C. Bardos and G. Chen, Control and stabilization for the wave equation. III. Domain with moving boundary, *SIAM J. Control Optim.* **19** (1981), 123-138.

[2] P. E. Kloeden, J. Real and C. Sun, Pullback attractors for a semilinear heat equation on time-varying domains, *J. Differential Equations* **246** (2009), 4702-4730.

[3] T. F. Ma, P. Marín-Rubio and C. M. Surco-Chuño, Dynamics of wave equations with moving boundary. Preprint 2016.

(3) **Multiplicative controllability for semilinear reaction-diffusion equations. *Piermarco Cannarsa*, Giuseppe Floridia, Alexander Khapalov.**

Abstract: We study the global approximate controllability properties of a one dimensional semilinear reaction-diffusion equation

$$u_t \ = \ u_{xx} \ + \ v(x,t)u \ + \ f(u)$$

where the control action is the coefficient of the reaction term. It is assumed that both the initial and target states admit no more than finitely many changes of sign. Our goal is to show that any target state, with as many changes of sign in the same order as the given initial data, can be approximately reached in the $L^2(0,1)$-norm at some time $T > 0$.

(4) **State constrained control problems in infinite dimension.**
***Hélène Frankowska*, Elsa M. Marchini, Marco Mazzola.**

Abstract: In this talk some new results on state constrained differential inclusions of the type

$$\dot{x}(t) \in Ax(t) + F(t, x(t)), \tag{6}$$

with $x(t) \in K$, are discussed. The setting is quite general, hence our analysis applies to some interesting and delicate frameworks: the operator A is the infinitesimal generator of a strongly continuous semigroup $S(t) : X \to X$, and X is an infinite dimensional separable Banach space. Assuming an *inward pointing condition* on the state constraint K (allowed to be nonsmooth), we prove neighboring feasible trajectories theorems, in order to approximate trajectories of (6) by trajectories lying in the interior of K. Applications of these abstract results on regularity of the value function associated to control problems, variational inclusions, non degeneracy of first order necessary condition for the optimality, are provided. Some control problems involving PDEs are presented as well.

(5) **An approach to spatial spread in thin structures. Marcone C. Pereira.**

Abstract: In this talk we discuss an approach to considerer spatial spread in N-dimensional thin structures. We introduce equations with nonlocal dispersal and defined in tight domains contrasting it with its corresponding local diffusion equation with Neumaan and Dirichlet boundary conditions. Here the thin structure effect is modeled by an ϵ-parameter family of open sets which squeezes to a lower dimension open set as $\epsilon \to 0$. The asymptotic behavior of the solutions is analyzed and the results are compared with classical situations to elliptic equations in thin domains.

(6) **Cahn-Hilliard inpainting. Alain Miranville.**

Abstract: Our aim in this talk is to discuss variants of the Cahn-Hilliard equation in view of applications to image inpainting. We will present theoretical results as well as numerical simulations.

(7) **On the fractional Cahn-Hilliard equation. Goro Akagi, *Giulio Schimperna*, Antonio Segatti.**

Abstract: In this talk we will present some results related to existence, regularity, and long-time behavior of solutions to a fractional version of the Cahn-Hilliard equation settled in a smooth bounded domain $\Omega \subset \mathbb{R}^3$. More precisely, we will consider

the case where diffusion is ruled by the so-called "restricted Dirichlet fractional Laplacian", meaning that homogeneous Dirichlet conditions of "solid" type are assumed on the whole of $\mathbb{R}^3 \setminus \Omega$. In particular, we will show that, under suitable conditions, the ω-limit set of any solution trajectory consists of a single point. The proof of this fact relies on a new "fractional" version of the Simon-Łojasiewicz inequality.
(The results presented in this talk have been obtained in collaboration with Goro Akagi (University of Kobe) and Antonio Segatti (University of Pavia).)

(8) **Long-time dynamics of a full von Karman system with nonlinear thermal effects and partially dissipative free boundary conditions. *Rodrigo Nunes Monteiro*, Irena Lasiecka, To Fu Ma.**

Abstract: This talk is concerned with long-time dynamics of a full von Karman thermoelastic system with nonlinear thermal coupling and free boundary conditions. Full von Karman system accounts for vertical and in plane displacements. It is shown that the system admits global attractor which is also *smooth and of finite fractal dimension.* This result has been established without any mechanical dissipation imposed on vertical displacements. In order to handle highly supercritical nature of the von Karman nonlinearities, new results on "hidden" partial regularity generated by thermal effects are exploited. These lead to asymptotic compensated compactness of trajectories which then allows to prove that the dynamical system is *quasi stable*.

(9) **Stability of stochastic delay evolution equations. Tomás Caraballo.**

Abstract: We will report on some recent results concerning the stability of solutions of delay stochastic evolution equations. Almost sure stability as well as mean square stability will be analyzed. Also stability with general decay rate will be shown in some particular cases. We will emphasize that, using different Lyapunov functionals, we will be able to show how one can obtain different stability regions for some stochastic partial differential equations.

(10) **About pointwise dissipative mechanism. *Jaime E. Munoz Rivera*, Maria Grazia Naso, Alessia Berti.**

Abstract: In this lecture we consider the pointwise dissipative mechanism modeled over a Timoshenko beam and to circular beams, called Bresse model. We show that the position where this dissipative mechanism is introduced is important to define de rate of decay of the solution. There exists a large set of point over the domain, where the beam is configured, where this pointwise dissipation is not effective. There exist others points for which the pointwise dissipation is effective and can produce polynomial or exponential stability. Such strategical points depends on the boundary condition that the beam is supported. We show some applications of this problems.

(11) **Control properties of Viscoelastic materials with large memory. Luciano Pandolfi.**

Abstract: A viscoelastic material (of the Maxwell-Boltzmann type) is described by a Volterra integrodifferential equation

$$w'' = \mathcal{L}w + \int_0^t M(t-s)\mathcal{L}w(s)\,\mathrm{d}s \qquad (\mathbf{A})$$

where $\mathcal{L}$ is a suitable elliptic operator (the Laplacian, the bilaplacian, the Lame' operator...) and $M(t)$ is a memory kernel with suitable properties. Here $w = w(x,t)$ with $t > 0$ and $x \in \Omega$ (a suitable region whose boundary we assume smooth). Equation **(A)** has to be supplemented with initial conditions (in a suitable *state space*) and boundary conditions on $\partial\Omega$.

We assume that the system described by **(A)** is controlled using a boundary control of Dirichlet type (possibly acting on a part of the boundary) and we study the controllability properties, i.e. we study whether every element of the *state space* can re reached, using a square integrable boundary control, from the rest (equivalently, from every initial condition).

We shall illustrate the most recent results, when $\mathcal{L}$ is either the Lame' operator or the bilaplacian.

Eq. **(A)** is also encountered in the thermodynamics of systems with memory, often written in integrated form

$$w' = \int_0^t N(t-s)\mathcal{L}w(s)\,\mathrm{d}s \qquad (\mathbf{B})\,.$$

A companion equation is the equation

$$w' = \mathcal{L}w(t) + \int_0^t N(t-s)\mathcal{L}w(s)\,\mathrm{d}s \qquad (\mathbf{C})\,.$$

whose control properties will be contrasted with those of **(B)**.

(12) **Optimal control for some diffuse-interface models for binary fluids with nonlocal interaction. Sergio Frigeri.**

Abstract: In the first part of the talk we shall recall the main results recently proven concerning well-posedness, regularity and long-time behavior for the nonlocal Cahn-Hilliard/Navier-Stokes system with different assumptions on the double-well potential, mobility and viscosity. Then, in the situation of regular potential and constant mobility and singular potential associated with a degenerate mobility we shall consider some related optimal control problems in 2D. For these cases, first order necessary conditions for the existence of the optimal control will be presented. Joint work with E. Rocca, M. Grasselli and J. Sprekels.

(13) **On the Cucker-Smale model with time delay. *Cristina Pignotti* and Emmanuel Trélat.**

Abstract: The Cucker-Smale model has been proposed in 2007 as a model for flocking of birds. In general, it may describe phenomena where autonomous agents reach a consensus or self-alignment without a central direction, based on environmental information. Taking into account a delayed answer of the agents to signals from environment, we introduce a time delay in the model. This makes the problem more difficult to deal with due to the loss of some good geometric properties of the classical Cucker-Smale system. Under suitable conditions, an asymptotic flocking result is obtained when the delay is sufficiently small.

11.20 Session 20 - Variational Methods and PDE in Imaging

Organizers: A. Leaci (University of Salento), E. Teixeira (Federal University of Ceará)

Program

Thursday	**01/09 (morning session)**
09:00 - 09:40	Franco Tomarelli
09:45 - 10:25	Alexandre N. Carvalho
10:30 - 11:10	Matteo Focardi
11:15 - 11:55	Antonio Leitão
Thursday	**01/09 (afternoon session)**
17:30 - 18:10	Michele Miranda Jr
18:15 - 18:55	Simone Parisotto
19:00 - 19:40	Massimo Zanetti

Abstracts

(1) **Variational Approach to Image Segmentation and Inpainting. Franco Tomarelli.**

Abstract: This presentation deals with some second order free discontinuity problems related to image segmentation and inpainting. It is mainly focused on the mathematical analysis of Blake & Zisserman functional under various kind of boundary conditions: existence of strong solution; extremality conditions on optimal segmentation; well-posedness of the problem; variational approximation schemes; nontrivial candidate local minimizers; power series expansion and Almansi decomposition around a crack-tip.

(2) **Structural stability of uniform attractors: topological and geometrical. Alexandre Carvalho.**

Abstract: We present a careful description of the relationship between pullback and uniform attractors, leading to a detailed description of the uniform attractor and providing the understanding of its dynamical structures. That description is used to show continuity (upper and lower semicontinuity) and structural stability (topological and geometrical) of uniform attractors, at least for a non-autonomous perturbation of a semigroup.

(3) **Existence for the stationary Griffith fracture model in dimension two. S. Conti, *M. Focardi*, F. Iurlano.**

Abstract: We prove existence of strong minimizers for the Griffith fracture model in 2d. The key tools are two decay estimates: a generalization of the one by De Giorgi, Carriero and Leaci to the vectorial situation, true only in 2d, and one for vectorial elliptic problems of the elasticity type valid in any dimension.

(4) **Fast nonstationary iterated Tikhonov method for ill-posed problems with endogenous strategy for choosing the Lagrange multipliers: Application to Image Deblurring. Antonio Leitão.**

Abstract: In this talk we propose a novel *nonstationary iterated Tikhonov* (nIT) type method for obtaining stable approximate solutions to ill-posed operator equations modeled by linear operators acting between Hilbert spaces.

Geometrical properties of the problem are used to derive an endogenous strategy for choosing a sequence of regularization parameters (Lagrange multipliers) for the niT iteration. Converge analysis for this new method is provided.

Numerical experiments are presented for an image deblurring problem. The obtained results validate the efficiency of our method compared with standard implementations of the nIT method (where a geometrical choice is typically used for the sequence of Lagrange multipliers).

(5) **Total variation and Cheeger sets in Gauss space. Vicent Caselles, *Michele Miranda jr.*, Matteo Novaga.**

Abstract: The aim of this talk is to show the isoperimetric problem with fixed volume inside convex sets and other related geometric variational problems in the Gauss space. We prove the existence of a maximal Cheeger set which is convex inside any bounded convex set. We also prove the uniqueness and convexity of solutions of the isoperimetric problem with fixed volume inside any convex set. We relate all these properties with the total variation denoising problem in this context.

(6) **Patchmatch-based Osmosis Linear Filter for Local Shadow Removal. *Simone Parisotto*, Simon Masnou, Carola Schönlieb, Marco Caliari.**

Abstract: The Shadow Removal Problem in image processing is related to the propagation of the correct light coefficient into a shadowed domain, preserving its natural texture and geometry. For solving it, we mix the osmosis filter (Weickert et al. '13) with the variational inpainting model (Arias et al. 11).

(7) **A numerical approach to the minimization of an elliptic approximation of the Blake-Zisserman functional. *Massimo Zanetti*, Valeria Ruggiero, Michele Miranda Jr.**

Abstract: The 2nd-order model for segmentation by Blake-Zisserman is outperforming compared to the well-known Mumford-Shah. However, its numerical treatment is so far considered only for very small images because of inherent computational burden. We address the numerical minimization of a variational approximation of the functional given by Ambrosio, Faina and March, by an efficient block-coordinate descent method that exploits a compact matricial formulation of the objective functional and its decomposition into quadratic sparse convex sub-problems. Results show that 2nd-order segmentation can be addressed in competitive time also for large images.

11.21 Session 21-Analytical and Numerical Aspects of Modeling Biological Systems

Organizers: M. Amar (University of Roma La Sapienza), G. Pontrelli (Istituto per le Applicazioni del Calcolo-CNR-Roma) and J. A. Cuminato (University of So Paulo-So Carlos)

Program

Part 1 (September 1 h. 09-12)

(1) D. A. Tarzia, Cumulative Uptake Formulas in Plant Nutrient and the Temporal Weight Averaged Influx

(2) C. Kunz et al., Study on the data clustering impact on the diffusion coefficient estimation for ecological problems.

(3) G. L. Diniz et al., Dispersion of carbonic dioxid in flooded areas: modelling and simulations.

(4) S. McGinty et al., A mathematical model of cellular drug binding within in-vitro cell culture systems.

(5) G. Pontrelli, A multi-layer model for transdermal drug delivery: analysis and simulation.

Part 2 (September 1 h. 17.30-20)

(1) H.M. Yang, Vaccination of rubella infection using a series of pulses - Periodic orbits and chaos.

(2) B. Thomé et al. , Mathematical Modeling of the Control of Aedes aegypti with the Introduction of Wolbachia Contaminated Male Mosquitoes.

(3) T.Y. Miyaoka et al., Zika epidemy: how to avoid an endemic situation.

(4) F. Lopes, A space-dependent bistable model to understand the gene reading mechanism.

(5) A. Bersani et al., On the Mathematical Justification of the total Quasi-Steady StateApproximation in Enzyme Kinetics

Part 3 (September 2 , h 09-12)

(1) A. Colosimo, Modeling complex biological events by MAS

(2) G. Romanazzi et al., Multiscale and Homogenization Models for the Aberrant Crypt Foci

(3) I. Silva et al., The Use of a kNN classifier to Modelling Fire Risk.

(4) D. Andreucci et al., Nonlinear modeling of electrical conduction in biological tissues.

(5) M. Amar et al., Alternating Robin-Neumann boundary value problem as a model for transport through biological membranes.

Abstracts

(1) **Cumulative Uptake Formulas in Plant Nutrient and the Temporal Weight Averaged Influx. Domingo Alberto Tarzia.**

Abstract: A generalized cumulative uptake formula of nutrient uptake by roots following our previous formula (Reginato and Tarzia, Commun. Soil Sci. Plant Anal., 33 (2002), 821-830) is developed. Cumulative nutrient uptake obtained by this formula is compared with the simulated results obtained by the Claassen-Barber (Claasen and Barber, Agron. J., 68 (1976) 961?964) and Cushman (Cushman, Soil Sci. Soc. Am. J., 43 (1979) 1087-1090) formulas. A mass balance is analyzed for the three formulas of cumulative nutrient uptake in order to decide which of them is correct. Moreover, the mass balance is also verified through a computational algorithm using data obtained from literature and we compute the K uptake for maize for low and high soil concentrations using the three mentioned formulas. The theoretical analysis shows that Claassen-Barber and Cushman formulas do not verify, in general, the mass balance condition. The Claassen-Barber formula only verifies this condition when the influx is constant and root grows linearly. The Cushman formula verifies the mass balance when the influx is constant regardless of the law of root growth. Reginato-Tarzia formula always verifies the mass balance whatever be the representative functions for the influx and the law of root growth. Moreover, we propose a redefinition of the averaged influx from which the Williams formula can be deduced. We remark that Williams formula is a consequence of our definition of temporal weight averaged influx for all root growth law expressions. Also, we present a comparison of influx and cumulative uptake of Cd with data extracted from literature. Cumulative uptake is obtained through the Barber-Cushman model and our new moving boundary model by using the redefinition of averaged influx on root surface and the correct cumulative uptake formula presented in this paper.

This is a joint paper with Juan Carlos Reginato and Jorge Blengino Albrieu (Univ. Nacional de Río Cuarto), Río Cuarto, Argentina.

(2) **Study on the data clustering impact on the diffusion coefficient estimation for ecological problems. *Camile Fraga Delfino Kunz*, João Frederico da Costa Azevedo Meyer, Juliana Marta Rodrigues de Souza.**

Abstract: The main goal attained by this work is to evaluate the impact of the data clustering treatment on the diffusion coefficient estimation for ecological problems. In a previous work, a method for the estimation of the diffusion coefficient was created

and validated, but only for cases with a single source of events. The validation of this method relies on data simulation techniques to generate diffusive data. The present work approaches the case where there are two distinct sources of events. The data clustering algorithm applied to the simulated data was the K-means, and two distinct computational experiments were developed and meticulously analyzed. In the end, a practical application is approached by the case study of H5N1 in Nigeria.

(3) **Dispersion of cabonic dioxid in flooded areas: modelling and simulations. *Diniz, Geraldo L.* and Siqueira, Jesumar L.**

Abstract: The carbon dynamics in tropical ecosystems has received considerable importance because of the need to understand the effects of changing land cover in global and regional biogeochemical cycles, as well as the role of tropical terrestrial ecosystems in the carbon dioxide balance. It is estimated that tropical wetlands known as swamps, occupying an area of ??the Earth's surface between 5% and 7%.

The high net primary production of organic matter produced by natural decay, makes tropical wetlands an important carbon sink. Small changes in climate, water and nutrient regime, as well as in land use can alter the delicate balance of these areas. In this work, we investigated the CO_2 flow problem in the Pantanal of Mato Grosso region, considered an important regulatory system of the environment, because of the rain and flood regime affecting the seasonal distribution of energy and carbon in this region.

The objective is to propose a mathematical model that can represent the dynamics of CO_2 flow in the local atmosphere. In this case it has been proposed a two-dimensional model that describes the process of CO_2 dispersion for laminar flow in a horizontal direction in its classic formulation, using an equation of advection-diffusion-reaction. For computer simulations of the phenomenon we used the finite element method through the Petrov-Galerkin scheme for the spatial discretization of the model obtained and the Crank-Nicolson method for the time discretization.

The numerical codes were implemented in Matlab and the approximations of the solutions in certain moments of time have been presented through graphical animations by this feature of Matlab.

(4) **A mathematical model of cellular drug binding within in-vitro cell culture systems. *Sean McGinty* and Sean McKee.**

Abstract: Local drug delivery is becoming an increasingly important tool to clinicians, with devices such as drug-eluting stents, transdermal patches and drug-releasing orthopaedic implants all now routinely used in practice. This is currently an area of intense research activity due to the desire to improve current local drug delivery devices and develop new devices with novel applications. However, there is currently an incomplete understanding of drug redistribution in biological tissue following delivery. Depending on the application, once released, the drug may diffuse through bodily

fluid, undergo advection due to pressure gradients and bind with specific and/or non-specific binding sites within tissue and/or on cells. Several models of drug binding to tissue have been proposed in the literature but the validation of these models is limited by the difficulty in experimentally determining the many parameters of the models. In particular, drug binding-on and binding-off rates as well as the density of binding sites can be extremely difficult to measure directly. However, by making use of relatively simple in-vitro cell culture systems, experimental measurements can in principle be made of drug bound to cells as a function of time. When compared with a mathematical model of the experiment, it may be possible to not only validate the model, but also to reliably estimate the unknown parameters of the model. These could, in turn, feed into more sophisticated models of the in-vivo system.

In this talk we present a mathematical model of cellular drug binding within in-vitro cell culture systems. The components to which the drug binds could be, for example, non-specific general extracellular matrix binding sites or specific binding sites on the surface of cells. We consider both a linear and a non-linear model of drug binding and discuss the pros and cons of each. An analytical solution is derived for the linear model. It is then shown how the non-linear model results in a Volterra integro-differential equation which we solve numerically and also by way of perturbation techniques. Small and large t solutions are derived and are in excellent agreement with the numerics.

(5) **A multi-layer model for transdermal drug delivery: analysis and simulation. *Giuseppe Pontrelli*, Marco Lauricella, Roberto Natalini.**

Abstract: Mathematical models for drug delivery are extensively used as a powerful predictive tool for a fundamental understanding of biotransport processes. For example, many studies have been carried out to investigate the release properties of a therapeutic agent from a device across the skin, as in a transdermal patch, or sometimes with the use of an electrical field to enhance the release, as in iontophoresis.

To study these processes, a mathematical model describing the dynamics of a substance between a multi-layer media of different properties and extents is presented. The first layer is the polymeric platform (vehicle) where the drug is initially contained, and the other ones represent the dermal tissue where the drug is directed to. A system of partial differential equations describes the diffusion and the convection induced by the electrical potential.

The typical drug dynamics, the concentration levels, the optimal delivery rate are shown as outcomes of simulations and discussed in some case studies. The results are used to discuss the roles of the different model parameters, to evaluate drug release efficacy and to assess an optimal control strategy in the rational design of advanced delivery systems.

(6) **Vaccination of rubella infection using a series of pulses – Periodic orbits and chaos. Hyun Mo Yang.**

Abstract: When a SIR model with a constant contact rate is used to describe the dynamics of directly transmitted infections, oscillations decaying exponentially as time goes on are obtained. Due to damped oscillations, intermittent vaccination schemes can be designed in order to reduce or even eliminate the infection. By numerical simulations, the appearance of period orbits and chaos was determined.

(7) **Mathematical Modeling of the Control of *Aedes aegypti* with the Introduction of Wolbachia Contaminated Male Mosquitoes. Baptista, G. M., R. C. A. Thomé, C. M. Dias, E. F. Arruda, D. H. Pastore & H. M. Yang.**

Abstract: Mosquitoes of the *Aedes* gender, popularly known as dengue mosquitoes, are the vectors of seven diseases: 4 types of dengue fever, chikungunya, zika and yellow fever. The main vector of these diseases is the *Aedes aegypti*, whose life cycle can be divided into two stages: the aquatic phase and the terrestrial (winged) phase. We propose a mathematical model with a control that consists in the introduction of mosquitos contaminated with the Wolbachia bacteria, which is found in about 70% of the insects in the natural environment. The proposed model is based on ordinary differential equations that represent the mosquitoes dynamics both in the aquatic and winged phases, as well as the interactions between male and female insects, contaminated or not.

(8) **Zika epidemy: how to avoid an endemic situation. *Souza, Juliana M. R.*, Miyaoka, Tiago Y., Meyer, João F. C. A., Barros, L. C.**

Abstract: Zika virus is a serious worldwide concern nowadays, due to also to microcephaly in babies born from mothers that have been infected during pregnancy. The disease vector, the aedes aegypt mosquito, is also the vector responsible to the spread of chikungunya and dengue, this last with a considerable mortality rate in Brazil. In this work, a compartimental SIS mathematical model is considered, with logistic growth for the insect population. The infection rate takes into account the vector growht and activity relevance. A stability analisys of the system's equilibria points is undertaken by means of a Monte Carlo generation of the model's parameters and it's statistical analysis. These results indicate that the endemic equilibrium is stable in 25% of the cases and, moreover, there is a -0.9 correlation between the intrinsic reproduction rate of the population and one of the negative eigenvalues corresponding to this equilibrium point. Therefore, the authorities' reccomendation, is that of trying to avoid pregnancy at this time, leads to a possible, albeirt partial, control strategy , not only in reducing microcephaly cases but, also, in the sense of abringing about a significant delay in this disease's spread and influence.

(9) **A space-dependent bistable model to understand the gene reading mechanism. Francisco JP Lopes.**

Abstract: During embryonic development, the reading of the genetic information produces spatially distributed patterns of proteins. These patterns define precise spatial domains that will later determine the tissue distribution in the adult organism.

How the genetic information is read during this process is a fundamental question in biology. Using the fruit fly *Drosophila melanogaster* as the biological model we applied a systems biology strategy combining analytical and numerical approaches with biological experimental data. Our research is focused in understanding the microscopic mechanisms responsible for the establishment of sharp borders between the protein spatial patterns, which are required for establishing the precise spatial domains. We developed a predictive reaction-diffusion model to describe the molecular mechanism of gene regulation(1). Using the Zero Eigenvalue Analysis(2), which establishes a set of sign compatible relations that must be satisfied if the reaction network exhibits multiple stationary states, we shown that the model ODE does exhibit bistability. We used a finite difference method to solve the model PDE?s and simulated annealing to determine the model parameters that reproduce the experimental behavior. Our results indicate that space-dependent bistability plays a critical role in the flux of information from the microscopically stored genetic information to the macroscopic organization of cells and tissues.

(1) Lopes, F.J.P., et al. (2008). PLoS Comput. Biol., 4.
(2) Li HY (1998). Zeitschrift fr Naturforschung A. 53: 171-177.

(10) **On the Mathematical Justification of the total Quasi-Steady State Approximation in Enzyme Kinetics. *A. M. Bersani*, E. Bersani, A. Borri, B. Coluzzi, P. Vellucci.**

Abstract: The total quasi-steady state (tQSSA) approximation was introduced by Borghans et al. in the Nineties of the last Century and has shown to be very useful for the approximation of the solutions of the system of differential equations describing enzyme kinetics (in particular, phosphorylation and dephosphorylation).

As the standard quasi-steady state (sQSSA) approximation, introduced in the pioneering papers by Michaelis and Menten (1913) and Briggs and Haldane (1925), the tQSSA can be interpreted as the leading order approximation of an asymptotic expansion in terms of a suitable perturbation parameter ε (see the papers by Heineken et al. (1967) and Segel and Slemrod (1989) for what concerns the sQSSA and Schauer and Heinrich (1979), Schnell and Maini (2002) and Dell'Acqua and Bersani (2012) for the tQSSA).

In this communication we report some recent results of our research group, showing that:

i) the tQSSA can be interpreted as the center manifold of the system describing the reaction, satisfying a Tychonoff-like theorem;

ii) as the sQSSA, despite of some their peculiarities, the tQSSA can be studied by means of Renormalization Group (RG) techniques, introduced in Theoretical Physics and adapted to the study of singular perturbation problems by Chen et al. in 1996.

(11) **Modeling complex biological events by MAS. Alfredo Colosimo.**

Abstract: The Galileo's dream of using a mathematical language for simple, complete and deterministic descriptions of physical phenomena, after an impressive success in the XVIII and XIX centuries was somehow downsized, in the first half of the XX century, by the uncertainty principle and the occurrence of unpredictable atmospheric events. Moreover, any quantitative study of living objects had to face the even more intriguing problems due to their complex interactions among each other and with the environment. As a matter of fact, it was soon realized that the uncertainty levels of mathematical models based on differential equations rapidly increase with: A) the spatial resolution of the structural, descriptive information, and B) the width of the time window spanned by functional, dynamic predictions.

Since its introduction in 1970 by the British mathematician John Conway, the cellular automaton named *game of life* paved the way to an original simulation strategy of collective biological phenomena like evolution, competition, adaptation, etc. The seminal idea of the underlying algorithm was the simplified representation of the physical space through a n-dimensional grid (matrix) where the living objects (?cellular automata?) move and interact among each other and with the environment. In the last quarter of the XX century, the idea provided significant contributions to Bioinformatics and Biocomputing. In this frame, the present contribution deals with the heuristic power of Multi Agents Systems (M.A.S.), some non trivial members of the ?cellular automata? class of models, and illustrates their efficiency and flexibility in the simulation of:

- the influence of environmental force fields (e.g. electromagnetic or gravitational) on the morphofunctional phenotypic changes occurring in cellular populations;
- the mechanisms of information processing in artificial neural networks and their dependence upon the (a)symmetric arrangement of links among the network's nodes.

In the former case, changes in the relative abundance of different cellular populations can be made sensitive to aggregation phenomena induced by external force fields; in the latter, the role of (randomic) rearrangements of connections between the network?s nodes was investigated in model systems of minimal size.

(12) **Multiscale and Homogenization Models for the Aberrant Crypt Foci.** ***Giuseppe Romanazzi*, Isabel Figueiredo, Carlos Leal.**

Abstract: Colorectal cancer is one of the most frequent type of cancer in the Western World. Different scientific communities have studied its morphogenesis from geneticists to computing scientists. The colon is a suitable place for the appearance of cancer because of its continuous self-renewal with a large number of cell divisions per day. The inner part of the colon is lined by millions of small pits, called crypts and it is widely accepted that the cell mutations in the crypts are responsible for the cancer initiation process. It is consensual in the medical community, that a potential first manifestation of the carcinogenic process, observed in conventional colonoscopy

images, is the appearance of Aberrant Crypt Foci (ACF). These are clusters of abnormal crypts, morphologically characterized by an atypical behavior of the cells that populate the crypts.

In this presentation, I describe a periodic multiscale and a homogenization model for the ACF dynamics based on the cellular dynamics in the colon epithelium. The goal is to simulate and predict the spread and evolution of ACF, as it can be observed in colonoscopy images. Numerical results showing the convergence of the periodic model to the homogenized model are presented.

(13) **The Use of a kNN classifier to Modelling Fire Risk . *Isaac D. B. Silva*; Laécio C. Barros; João F. C. A. Meyer.**

Abstract: Forest fires that generaly happen in the Amazon region considered as a whole system have been a result of severe draughts that occur in the region, besides the use of 'cut-and-set-fire' technique of openig up spaces for agricultural purposes. These fires often escape human control and containment activities, running out of control. The main purpose of this work is to model the fire risk associated with spatial informations using a function R_e which associates spatial variables in a certain domain $\Omega \subset \mathbb{R}^n$ to the image set $\mathbb{R}$ in way that, for each $x \in \mathbb{R}^n$, $y = R_e(x) \in [0, 1]$ represents the risk of fire spatially associated. To get these results, the original problem was reformulated and transformed into a problem of binary classification including georeferenced information for both, independent and dependent variables. For this, computational learning was used in order to obtain an eficient classificator and the fire risk is treated as the posteriori probability of that classification. This binary classification algorithm of the closest k-neighbors (k-NN stands for k-Nearest Neighbors) has a learning procedure based upon memory and identifies the class of a particular test vector x_t from the majority vote of the k-nearest neighbors of x_t. For computational simulations, the data (georeferenced) from the State of Acre in the Brazilian Amazon region were used.

(14) **Nonlinear modeling of electrical conduction in biological tissues. Micol Amar, *Daniele Andreucci*, Roberto Gianni.**

Abstract: The behavior for large times of models of electrical conduction in biological tissues becomes relevant in connection with applications, e.g., with electrical impedance tomography, when the boundary data are time periodic. Indeed this is the feature which makes comparison with currently used phenomenological models possible.

We consider both microscopic and macroscopic models. The microscopic problems involve the equation for the electric potential u and a condition prescribed on the interface separating the intra- and extra-cellular spaces. This condition relates in a nonlinear fashion the time evolution of the jump of the potential u across the interface to the resistive behavior of the membrane and to the electric current flowing through the membrane.

We discuss the asymptotic behavior of these models as well as of their homogenized macroscopic versions. The homogenization limit is performed as the spatial period of the micro-structure (i.e., the cells) becomes vanishingly small.

(15) **ALTERNATING ROBIN–NEUMANN BOUNDARY VALUE PROBLEM AS A MODEL FOR TRANSPORT THROUGH BIOLOGICAL MEMBRANES. *M. Amar*,D. Andreucci,D. Bellaveglia.**

Abstract: It is known that transport of chemical species through biological membranes often can not be modelled by standard diffusion through openings (*pores*, or channels) in the membrane. Actually, it has been observed that in many physical situations, pores alternate between two states (*open* and *closed*), either periodically or according to a random scheme. As shown by Andreucci–Bellaveglia in a previous paper through homogenization techniques, the limiting behavior of problems of this kind sharply depends on the relative scalings of the time and space variables. Here, having in mind a model of cell absorption of a selected protein or drug, we consider the homogenization of a parabolic problem in a perforated domain with Robin–Neumann boundary conditions oscillating in time. Such oscillations must compensate the blow up of the boundary measure of the holes.

We use the technique of time–periodic unfolding in order to obtain a macroscopic parabolic problem containing an extra linear term due to the absorption determined by the Robin condition. Our approach is based on the results obtained in a previous paper of the same authors, where the time-periodic unfolding operator is introduced, inspired by the operators of space-periodic unfolding introduced and applied by Cioranescu, Damlamian, Donato, Griso, Onofrei, Zaki in some quite recent researches.

Finally, we identify two possible limiting behaviors depending on the relative magnitude of the time-period of the oscillations and the diameter of the holes and spatial period of the lattice.

11.22 Session 22 - Dynamical Systems and Ergodic Theory

Organizers: L. J. Daz (Catholic University of Rio de Janeiro), S. Luzzatto (International Center for Theoretical Physics Abdus Salam)

Program

1st September (morning session)

09:00 - 09:40	Kocsard
09:45 - 10:25	Lomonaco
10:35 - 11:15	Cellarosi
11:20 - 12:00	Tal

1st September (afternoon session)

17:30 - 18:10	Pinheiro
18:15 - 18:55	Giulietti
19:05 - 19:45	Pacifico

2nd September (morning session)

09:00 - 09:40	Luzzatto
09:45 - 10:25	Castro
10:35 - 11:15	Monge
11:20 - 12:00	Abate

Abstracts

(1) **Invariant pseudo-foliations for minimal torus homeomorphisms. Alejandro Kocsard.**

Abstract: We shall discuss some recent rigidity results about minimal 2-torus homeomorphisms which are isotopic to the identity.

Minimal rotations are archetypal examples of such systems. However, it is well-known that there exist minimal diffeomorphisms on $\mathbb{T}^2$ exhibiting a very rich and complicate dynamics which are very faw away from those of rigid rotations. In fact, it has been recently shown that there exist minimal diffeomorphisms which do not even have a well-defined rotation vector.

In this talk, we shall show that such systems are not as "wild" as it was originally thought and in fact, they exhibit certain form of rigidity.

(2) **Satellite copies of the Mandelbrot set. Luna Lomonaco.**

Abstract: Douady and Hubbard proved the existence of homeomorphic copies of the Mandelbrot set M inside of M. These copies can be primitive (roughly speaking the ones with a cusp) or satellite (without a cusp). Lyubich proved that the primitive

copies of M are quasiconformally homeomorphic to M, and that the satellite ones are quasiconformally homeomorphic to M outside any small neighbourhood of the root. The satellite copies are not quasiconformally homeomorphic to M, but are they mutually quasiconformally homeomorphic? In a joint work with C. Petersen we prove that this question has in general a negative answer.

(3) **Supersymmetric Quantum Mechanics and Homogeneous Dynamics. Francesco Cellarosi.**

Abstract: SUSY quantum mechanics is concerned with the study of quantum evolution of two so-called "partner Hamiltonians". I will describe a limit theorem for autocorrelation functions for a class of SUSY quantum systems (Pöschl-Teller potentials) at random times. The result is based on the equidistribution of closed horocycles under the action of the geodesic flow in a suitably defined homogeneous space and Ratner theory.

(4) **Zero entropy homeomorphisms of surfaces. Fabio Tal.**

Abstract: In a joint work with P. Le Calvez, we develop a new orbit forcing theory for homeomorphisms of surfaces homotopic to the identity. As a consequence of the new techniques, we are able to derive new results describing properties of entropy zero homeomorphisms of surfaces. In particular, we extend Franks and Handel's caractherization to non-wandering homeomorphisms, showing that the entropy zero case is very close to integrable, and we also prove that annullar Birkhoffs regions of instability always carry positive entropy.

(5) **Lorenz maps with abundance of invariant ergodic probabilities having $+\infty$ as Lyapunov exponent. Vilton Pinheiro.**

Abstract: We give sufficient conditions for a Lorenz map to present an uncountable set of ergodic invariant probabilities having full support, positive entropy, fast recurrence to the singularity and infinite Lyapunov exponent. We also discuss the Thermodynamic Formalism for these maps (this is a joint work with Renaud Leplaideur).

(6) **Parabolic dynamics and Anisotropic Banach spaces. Paolo Giulietti.**

Abstract: In a simple model I will explain a relation between the distributions appearing in the study of ergodic averages of parabolic flows (e.g. in the work of Forni) and the distributions appearing in the study of the statistical properties of hyperbolic dynamical systems (i.e. the eigendistributions of the transfer operator). This is joint work with C.Liverani.

(7) **Lagrange and Markov dynamical spectra of Lorenz-like attractors. Maria José Pacifico.**

Abstract: In a joint work with S. Romaño and C. G. Moreira, we prove that the Hausdorff dimension of a geometric Lorenz attractor is strictally greater than 2.

From this, we conclude that the interior of the Lagrange dynamical spectra as well the interior of the Markov dynamical spectra of a geometric Lorenz attractor is non empty.

(8) **Young towers and SRB measures for nonuniformly hyperbolic surface diffeomorphisms. Stefano Luzzatto.**

Abstract: We prove that surface diffeorphisms with non-zero Lyapunov exponents satisfying some natural recurrence condition admit a Young Tower and therefore an SRB measure. This essentially proves, in the two-dimensional setting, Viana's conjecture. This is joint work with V. Climenhaga and Y. Pesin.

(9) **Partially hyperbolic attractors: fine statistical properties and linear response formula. Armando Castro.**

Abstract: We prove the existence and uniqueness of pressure maximizing measures associated to low variation potentials in the context of partially hyperbolic attractors with prevalence of expansion in the central bundle. For such measures we prove fine properties (Exponential decay of correlations, CLT, statistical stability, Large Deviations results, etc.) and Linear response formula. Joint work with C. Liverani.

(10) **Rigorous Approximation of stationary Measures and Convergence to Equilbrium for Iterated Function Systems. Maurizio Monge**

Abstract: We study the problem of the rigorous computation of the stationary measure and of the rate of convergence to equilibrium of an Iterated Function System described by a stochastic mixture of two or more dynamical systems that are either all uniformly expanding on the interval, either all contracting. In the expanding case, the associated transfer operators satisfy a Lasota-Yorke inequality, we show how to compute a rigorous approximations of the stationary measure in the L1 norm and an estimate for the rate of convergence. The rigorous computation requires a computer-aided proof of the contraction of the transfer operators for the maps, and we show that this property propagates to the transfer operators of the IFS. In the contracting case we perform a rigorous approximation of the stationary measure in the Wasserstein-Kantorovich distance and rate of convergence, using the same functional analytic approach. We show that a finite computation can produce a realistic computation of all contraction rates for the whole parameter space. We conclude with a description of the implementation and numerical experiments. Joint work with S. Galatolo and I. Nisoli.

(11) **The geodesic flow of meromorphic connections on compact Riemann surfaces. Marco Abate.**

Abstract: A geodesic for a meromorphic connection on a Riemann surface can locally be seen as a real solution of a geodesic equation with meromorphic coefficients, or as a geodesic for a conformal family of flat metrics. Using both these characterizations we shall be able to discuss the asymptotic behavior of the geodesic flow,

proving in particular a theorem extending to this setting the classical theorem of Poincaré-Bendixson. Finally, we shall show why this theory is related to the study of the local dynamics of holomorphic germs tangent to the identity in several complex variables. (Joint work with F. Tovena and F. Bianchi).

11.23 Session 23 - Ring Theory

Organizers: I. Shestako (University of So Paulo), P. Koshlukov (State University of Campinas), F. C. P. Milies (University of So Paulo), and A. Giambruno (University of Palermo)

Program

Thursday 01/09 (morning session)

09:00 - 10:00 Ivan Shestakov.
10:00 - 10:30 Irina Svidova.
10:30 - 11:00 Alexei Krasinikov.
11:00 - 11:30 Jess Laliena
11:30 - 12:00 Pilar Benito.

Thursday 01/09 (afternoon session)

17:30 - 18:30 Onofrio Di Vicenzo.
18:30 - 19:00 Viviane R.T. da Silva.
19:00 - 19:30 Victor Petrogradsky
19:30 - 20:00 Michael Dokuchaev

Friday 02/09 (morning session)

09:00 - 09:30 Alveri Alves Sant'Ana
09:30 - 10:00 Jairo Z. Gonçalves.
10:00 - 10:30 Lucio Centrone.
10:30 - 11:00 Javier Sanchez Serdá.
11:00 - 11:30 César Polcino Milies.

Abstracts

(1) **Identities of free alternative algebras. Ivan Shestakov.**

Abstract: We prove that for any natural number n there exists a natural number $f(n)$ such that any skew-symmetric multilinear polynomial on $f(n)$ variables which vanishes in the free associative algebra is an identity in the free n-generated alternative algebra. Before it was known only one family of such polynomials constructed by the author.

(2) **Algebras with involution generating *-varieties. Irina Sviridova.**

Abstract: The Specht problem is the central problem of theory of polynomial identities of algebras. All the known positive answers for the Specht problem for various types of identities are based on the classification type theorems for varieties (classes of algebras defined by families of identities). These theorems essentially restrict types

of algebras that generate varieties. Particularly, it means that any concerned variety can be generated by an algebra with a rather good explicit description. These results are very useful for study of identities and varieties.

We are going to discuss the structure properties of algebras generating varieties of associative algebras with some complementary structures such as involutions and graded involutions. We also will consider the relations of some properties and characteristic of the algebras with the corresponding identities. The work was partially supported by FAPESP, CNPq, Capes.

(4) **On the Lie structure in associative superalgebras and associative superalgebras with superinvolution. Authors: J. Laliena**

Abstract: It is known that, if we take an associative superalgebra, A, and we change the product in A by the superbracket product $[a, b] = ab - (-1)^{\bar{a}\bar{b}}ba$, where $\bar{a}, \bar{b}$ denotes the degree of a and b, homogeneous elements in $A = A_0 + A_1$, we obtain a Lie superalgebra, denoted by A^-. Also if A is an associative superalgebra and has a superinvolution, that is, a graded linear map $* : A \longrightarrow A$ such that $a^{**} = a$ and $(ab)^* = (-1)^{\bar{a}\bar{b}}b^*a^*$, for $a, b \in A$ homogeneous elements, the set of skewsymmetric elements, $K = \{x \in A : x^* = -x\}$, is a subalgebra of the Lie superalgebra A^-. In fact, in the classification of the finite dimensional simple Lie superalgebras given by V. Kac in 1977, several types are of this kind. In this talk we give some results about the relationship among the ideals of A as associative superalgebra and the ideals of A^- and K as Lie superalgebras.

(5) **Free nilpotent Lie algebras and related topics. Pilar Benito.**

Abstract: Any finite-dimensional Lie algebra of characteristic zero decomposes as a direct sum of a semisimple Lie algebra and its unique maximal solvable ideal. The classification of semisimple Lie algebras over the complex field was settled at the beginning of the last century. Arround 1945, A.I. Malcev [4] reduced the classification of complex solvable Lie algebras to the classification of nilpotent Lie algebras, their derivation algebras, groups of automorphisms and several invariants. But the classification of nilpotent algebras is a wild problem. In 1971 T. Sato [5] shows that any nilpotent Lie algebra is isomorphic to a quotient of a free nilpotent Lie algebra of the same nilindex and type. In this talk we will survey some recent research on nilpotent Lie algebras and its relationship to free nilpotent Lie algebras (see [1], [2] and [3]).

References

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[5] T. Sato: The derivations of the Lie algebras, Tohoku. Math. Journ., 23 (1971) 21-36.

(6) **On minimal superalgebras and minimal supervarieties. Onofrio Mario Di Vincenzo.**

Abstract: In this talk we consider the *minimal superalgebras* introduced by Giambruno and Zaicev in their characterization of varieties of associative PI-algebras over a field of characteristic zero which are minimal of fixed exponent. [**?**]. These superalgebras are also involved in the description of generators of minimal supervarieties of finite basic rank. In fact it is know that any minimal supervariety of finite basic rank is generated by a suitable minimal superalgebra, [**?**]. According to this, the complete characterization of minimal supervarieties of finite basic rank of exponential growth is reduced to decide whether any minimal superalgebra generates a minimal supervariety. This problem is still open. Recently we provided a family of minimal superalgebras not generating minimal supervarieties.

In this talk we discuss some obstruction on the structure of a given superalgebra forcing it to generate a non-minimal supervariety.

(7) **On $\mathbb{Z}_p$-graded identities and cocharacters of the Grassmann algebra. Viviane Ribeiro Tomaz da Silva.**

Abstract: Let p be an odd prime number, F a field of characteristic zero, and let E be the unitary Grassmann algebra generated by the infinite-dimensional F-vector space L. In this talk we will show some recent results about the $\mathbb{Z}_p$-graded identities and cocharacters of the algebra E endowed with any $\mathbb{Z}_p$-grading such that L is a homogeneous subspace. This is a joint work with Onofrio Mario Di Vincenzo (Università della Basilicata - Italy) and Plamen Koshlukov (Universidade Estadual de Campinas - Brazil).

(8) **Identical relations in group rings and enveloping algebras. Victor Petrogradsky.**

Abstract: We discuss rather old and recent results on existence of identical relations in group rings, enveloping algebras of Lie algebras, and smash products. We describe the situation for different characteristics, the cases of universal and restricted enveloping algebras, group rings, smash products, Lie algebras, Lie superalgebras, restricted Lie (super)algebras. Also we consider Poisson identical relations. As particular cases, we discuss conditions for these algebras to be Lie nilpotent or Lie solvable.

(9) **On exponent matrices of tiled orders. *M. Dokuchaev*, G. Kudryavtseva, V. Kirichenko and M. Plakhotnyk.**

Abstract: A ring Λ is called a *tiled order* if Λ is a prime Noetherian semi-prefect semi-distributive ring with non-zero Jacobson radical. Any tiled order can be constructed from a (non-necessarily commutative) discrete valuation ring and an exponent matrix. The latter means a square integer matrix $A = (\alpha_{ps})$, whose diagonal entries are equal to zero, and for all possible indices i, j, k, the following inequality holds:

$$\alpha_{ij} + \alpha_{jk} \geq \alpha_{ik}.$$

Every tiled order Λ is isomorphic to a ring of the form

$$\Lambda = \sum_{i,j=1}^{n} e_{ij}(\pi^{\alpha_{ij}}\mathcal{O}) \subseteq M_n(\mathcal{O}), \tag{7}$$

where $n \geq 1$, $\mathcal{O}$ is a (non-necessarily commutative) discrete valuation ring with prime element π, (α_{ij}) is an exponent matrix, $e_{ij}(\pi^{\alpha_{ij}}\mathcal{O}) = \{e_{ij}(a), a \in \pi^{\alpha_{ij}}\mathcal{O}\}$ and $e_{ij}(a)$ is the $n \times n$-matrix whose unique non-zero entry a is placed in the (i, j)-position.

Since the paper by R. B. Tarsy [8] on global dimension of orders published in 1970, tiled orders draw attention of a number of experts in ring theory and representation theory (see, in particular, [1] – [7]).

We shall present some results in collaboration with G. Kudryavtseva, V. Kirichenko and M. Plakhotnyk. In particular we endow the set of non-negative exponents matrices $\mathcal{E}_n$ with the following two operations: the component-wise addition, which we denote by $\odot$ and the component-wise maximum, which we denote by $\oplus$. It follows that $(\mathcal{E}_n, \odot, \oplus, 0)$ is a max-plus algebra of matrices where 0 denotes the zero matrix. Most of usual axioms of an idempotent semiring hold in this algebra: both operations are associative, commutative, 0 is the neutral element with respect to each of these operations, $\oplus$ is idempotent and $\odot$ distributes over $\oplus$.

One of our results provides a basis for this max-plus algebra.

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(10) **On Inner actions of weak Hopf algebras. Dirceu Bagio, Daiana Flores and *Alveri Sant'Ana.***

Abstract: Let R be an associative ring and e, f idempotent elements of R. In this talk we discuss about the notion of (e, f)-invertibility for an element of R and use it to define inner actions of weak Hopf algebras. Given a weak Hopf algebra H and an algebra A, we present sufficient conditions for A to admit an inner action of H. We also prove that if A is a left H-module algebra then H acts innerly on the smash product $A\#H$ if and only if H is a quantum commutative weak Hopf algebra.

(11) **Free groups in a normal subgroup of the field of fractions of a skew polynomial ring. Jairo Z. Goncalves.**

Abstract: Let $k(t)$ be the field of rational functions over the field k, let σ be a k-automorphism of $K = k(t)$, let $D = K(X;\sigma)$ the ring of fractions of the skew polynomial ring $K[X;\sigma]$, and let $D^\bullet$ be the multiplicative group of D. We show that if N is a non central normal subgroup of $D^\bullet$, then N contains a free subgroup.

(12) **On the growth of graded identities. Lucio Centrone.**

Abstract: We summarize the results obtained by the author about the growth of graded polynomial identities of algebras (not necessarily associative). We point out that these results give a "hint" about the existence and the structure of a grading which maximizes such a growth.

(13) **On the existence of free group algebras in division rings. Javier Sánchez Serdà.**

Abstract: In 1984, L. Makar-Limanov conjectured the following:

- Let D be a division ring with center Z. If D is finitely generated (as a division ring) over Z and $[D : Z] = \infty$, then D contains a noncommutative free Z-algebra.

In many of the examples for which the conjecture is known to be valid, the division ring D contains a (noncommutative) free group algebra over Z, not only a free Z-algebra.

In our work, we obtain sufficient conditions for the existence of a free group algebra in division rings.

(14) **Star-group identities on units of group algebras. César Polcino Milies.**

Abstract: Let G be a group, R a commutative ring with unity and RG the group algebra of G over R. In the last decades, there has been intensive research on the structure of $U(FG)$ the unit group of this algebra. This group can be very large; B. Hartley and P.F. Pickel [1] proved taht if G is neiter abelian nor a Hamiltonian 2-group, then $U(\mathbb{Z}G)$ contains a free group of rank 2 and J.Z. Gon?alves [4] described conditions for $U(FG)$ to contain free groups of rank 2, when F is a field.

On the opposite direction, it has also been investigated when the unit groups has some regularty, e.g. when it satisfies a group identity. In this talk we consider a group algebra FG as an algebra with involution and determine when $U(FG)$, satisfies a *-group identity. This is joint work with A. Giambruno and S.K. Sehgal [2], [3].

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11.24 Session 24-Geometric Variational and Evolution Problems

Organizers: S. Nardulli (Federal University of Rio de Janeiro), G. Orlandi (University of Verona)

Program

Morning Session 01/09

09:00 - 09:45 Frank Morgan
10:00 - 10:45 Ezequiel Barbosa
11:00 - 11:45 Robert Jerrard

Afternoon Session 01/09

17:30 - 18:15 Sergio Almaraz
18:30 - 19:15 Daniel Cibotaru

Morning Session 02/09

09:00 - 09:45 Vieri Benci
10:00 - 10:45 Roberto Mossa
11:00 - 11:45 Giandomenico Orlandi

Abstracts

(1) **Isoperimetric Problems with Density**. **Frank Morgan**.

Abstract: Since their appearance in Perelman's proof of the Poincaré Conjecture, there has been a huge surge of interest in spaces with density and the isoperimetric problem. We describe some recent results and open problems.

(2) **Sharp Riemmanian entropy inequalities. Marcos Montenegro** .

Abstract: We deals with Riemannian counterparts of the famous Gross's entropy inequality. We show how sharp entropy inequalities can be established as a limiting case of sharp Nash inequalities. Our method consists in controlling two optimal Nash constants and relies mainly on a careful analysis of concentration of minimizers to related energy functionals. This is joint work with Jurandir Ceccon.

(3) **Effective energy of nearly-parallel Ginzburg-Landau vortex filaments. Robert Jerrard**

Abstract: Starting from the Ginzburg-Landau model in cylindrical 3d domains, we derive an effective free energy functional for nearly-parallel vortex filaments. As a consequence, we establish the existence of solutions of the Ginzburg- Landau equations in certain scaling regimes, possessing a collection of vortex filaments minimizing this effective energy. This is joint work with Andres Contreras.

(4) **Topological line defects in nematic liquid crystals. Giacomo Canevari.**

Abstract: Nematic liquid crystals are composed by rod-shaped molecules with long-range orientation order. These materials exhibit topological defects, that is, discontinuities in the orientation parameter which depend on the topological behaviour of the configuration around them. A popular variational theory for nematic liquid crystals is the Landau-de Gennes theory, which shares common features with the Ginzburg-Landau functional for superconductivity and the harmonic maps problem. In particular, topological defects are associated with the homotopy groups of a manifold which, in the case under consideration, is a real projective plane. In this talk, we consider minimisers in a 3D-domain and take the limit as the material-dependent elastic constant tends to zero. We prove convergence to a map which has both point and line defects, and we describe the structure of line defects.

(5) **Constant nonlocal mean curvatures hypersurfaces. Mouhammed Moustapha Fall.**

Abstract: While Constant Mean Curvature (CMC) hypersurfaces are equilibrium hypersurfaces for the area functional, Constant Nonlocal Mean Curvatures (CNMC) appears when looking at equilibrium hypersurfaces for the nonlocal (or fractional) area functional. We will describe newly discovered CNMC hypersurfaces: those which have analogues in the theory of CMC (e.g. Delauney hypersurfaces) and those which do not have. These are joint works with: Xavier Cabré, Joan Solão-Morales and Tobias Weth.

(6) **Finite volume flows, Lefschetz Duality and Chern-Gauss-Bonnet Daniel Cibotaru.**

Abstract: We will describe an extension of the work of Harvey and Lawson on finite volume flows to manifolds with boundary. We show that using an appropriate formalism with currents, Chern-Gauss-Bonnet on manifolds with boundary can be seen as a manifestation of Lefschetz Duality. Other applications of this formalism such as the construction of new, geometric Thom forms in both the even and the odd rank cases will also be presented.

(7) **Generalized solution in Variational problems. Vieri Benci**.

Abstract: In many circumstances, the notion of function is not su cient to the needs of a theory and it is necessary to extend it. We can recall, for example, the heuristic use of symbolic methods, called operational calculus developed by Oliver Heaviside in his book Electromagnetic Theory of 1899. The theory of Dirac and the theory of weak derivatives where unified by Schwartz in the beautiful theory of distributions, also thanks to the previous work of Leray and Sobolev. Among people working in partial differential equations, the theory of Schwartz has been accepted as definitive (at least until now), but other notions of generalized functions have been introduced by Colombeau and Mikio Sato. This conference deals with a new kind of generalized

functions, called ultrafunctions, which have been recently introduced. The peculiarity of ultrafunctions is that they are based on the Non-Archimedean Mathematics (NAM). NAM is mathematics on fields which contain infinite and infinitesimal numbers (Non-Archimedan fields). The ultrafunctions have been introduced to provide generalized solutions to equations which do not have any solutions not even among the distributions. In this talk, we will present some variational problems which do not have distribution solutions, but which have reasonable candidate solutions which can be interpreted as solutions in the framework of ultrafunctions.

(8) **On stable CMC hypersurfaces with free-boundary in a Euclidean Ball. Ezequiel Barbosa**.

Abstract: In this talk, we will discuss how to prove that if B is a ball in a Euclidean space with dimension n, $n \geq 3$, then a stable CMC hypersurface Σ with free boundary in B satisfies

$$nA \leq L \leq nA\left(\frac{1+\sqrt{1+4(n+1)H^2}}{2}\right),$$

where L, A and H denote the length of $\partial\Sigma$, the area of Σ and the mean curvature of Σ, respectively. Consequently, if the boundary $\partial\Sigma$ is embedded then Σ must be totally geodesic or starshaped with respect to the center of the ball. This result is an improvement of a theorem proved by A. Ros and E. Vergasta In particular, if $n = 3$, the only stable CMC surfaces with free boundary in B are the totally geodesic disks or the spherical caps. This last result was proved very recently by I. Nunes using an extended stability result and a modified Hersch type balancing argument to get a better control on the genus. We don't use that modified Hersch type argument. However, we use a Nunes type Stability Lemma and a crucial result due to A. Ros and E. Vergasta.

(9) **Weighted tv minimization and applications to vortex density models. Giandomenico Orlandi.**

Abstract: Motivated by models arising from mathematical descriptions of Bose-Einstein condensation, we consider total variation minimization problems in which the total variation is weighted by a function that may degenerate near the domain boundary, and the fidelity term contains a weight that may be both degenerate and singular. We develop a general theory for a class of such problems, with special attention to the examples arising from physical models. Joint with P. Athavale, R. Jerrard, M. Novaga.

11.25 Session 25 - New developments in nonlinear evolutionary PDEs

Organizers: F. Dell'Oro (Institute of Mathematics of the Academy Sciences of the Czech Republic), J. Rivera (Federal University of Rio de Janeiro), M. G. Naso (University of Brescia), J. Pimentel (University of São Paulo-São Carlos)

Program

Thursday	**01/09**	**(morning session)**
09:00 - 09:30	Alexandre Carvalho	
09:30 - 10:00	Michele Coti Zelati	
10:00 - 10:30	Gabriela Planas	
10:30 - 11:00	Hugo Fernandez Sare	
11:00 - 11:30	Valeria Neves Domingos Cavalcanti	
11:30 - 12:00	Mauro Fabrizio	

Abstracts

(1) **Structural stability of uniform attractors: topological and geometrical. A. Carvalho.**

Abstract: We present a careful description of the relationship between pullback and uniform attractors, leading to a detailed description of the uniform attractor and providing the understanding of its dynamical structures. That description is used to show continuity (upper and lower semicontinuity) and structural stability (topological and geometrical) of uniform attractors, at least for a non-autonomous perturbation of a semigroup.

(2) **Enhanced dissipation and hypoellipticity in shear flows. Jacob Bedrossian and *Michele Coti Zelati*.**

Abstract: We analyze the decay and instant regularization properties of the evolution semigroups generated by two-dimensional drift-diffusion equations in which the scalar is advected by a shear flow and dissipated by full or partial diffusion. We consider both the case of space-periodic and the case of a bounded channel with no-flux boundary conditions. In the infinite Péclet number limit, our work quantifies the enhanced dissipation effect due to the shear. We also obtain hypoelliptic regularization, showing that solutions are instantly Gevrey regular even with only partial diffusion.

(3) **On the fractional regularity of solutions for a doubly nonlinear differential inclusion. José L. Boldrini, Luís H. De Miranda and *Gabriela Planas*.**

Abstract: In this talk, we consider the issues of existence and regularity of solutions to a doubly nonlinear differential inclusion involving the p-Laplacian and a maximal monotone operator. The investigation on fractional regularity is based on the Galerkin method combined with a suitable basis for the Sobolev space $W^{1,p}$. This approach also allows the obtaining of estimates in the so-called Nikolskii spaces, since it balances the interplay between the maximal monotone operator with the appearing higher-order nonlinear terms.

(4) **Stability of Bresse system with indefinite memory dissipation. H.D. Fernández Sare.**

Abstract: We consider a weakly dissipative Bresse system with memory, where the memory is given by a non-dissipative kernel acting only on one equation of the system. We show that the exponential stability depends on conditions regarding the decay rate of the kernel and a nice relationship between the coefficients of the system.

(5) **Exponential stability for the wave equation with degenerate nonlocal weak damping. M. M. Cavalcanti, *V. N. Domingos Cavalcanti*, M. A. Jorge Silva and C. M. Webler.**

Abstract: A damped nonlinear wave equation with a degenerate and nonlocal damping term is considered. Well posedness results are discussed, as well as the exponential stability of the solutions. The degeneracy of the damping term is the novelty of this stability approach.

11.26 Session 26-Geometric Structures, Lie Theory and Applications

Organizers: Anna Fino (University of Torino), Simon Chiossi (Federal University Fluminense-Niterói)

Program

Thursday 1/9 (morning session)

09.45 - 10.30 Marcos Jardim
10.30 - 11.15 Letterio Gatto
11.15 - 12.00 Luigi Verdiani

Thursday 1/9 (afternoon session)

17.30 - 18.15 Paolo Piccione
18.15 - 19.00 Henrique Sá Earp

Friday 2/9 (morning session)

09.45 - 10.30 Maurizio Parton
10.30 - 11.15 Giovanni Bazzoni
11.15 - 12.00 Daniele Angella

Friday 2/9 (afternoon session)

14.30 - 15.15 Claudio Gorodski
15:45 - 16:30 Andrew Clarke

Abstracts

(1) **Geometric structure of the nested Hilbert scheme of points. Marcos Jardim.**

Abstract: The nested Hilbert scheme of points on surfaces has been studied from the algebraic geometric points of view, and it is known to be connected and smooth in some cases. We study the geometry of such cases, showing that they admit a closed holomorphic 2-form which is generically non-degenerate.

(2) **Integrals on Grassmannians of Lines. Letterio Gatto (Politecnico di Torino)**

Abstract: Let $G(r,n)$ be the complex Grassmann variety parametrizing r-dimensional subspaces of $\mathbb{C}^n$. By an integral on $G(r,n)$ one usually means the degree of a product of Chern classes of the universal quotient bundles $\mathcal{Q}$ over it. The most popular is $\int_{G(r,n)} c_1(\mathcal{Q})^{r(n-r)} \cap [G(r,n)]$, which coincides with the Plücker degree of $G(r,n)$. Within the framework of Gaudin models and representation theory of the Lie algebra $\mathfrak{s}l_2(\mathbb{C})$, basing on previous work with Varchenko [5] about critical points of the generating function of the Wronski map, I. Scherbak proves in [4] a formula computing

arbitrary integrals on $G(2, n+2)$. A purely algebraic proof of Scherbak's result will be offered in the talk by exploiting the fact that the Chern polynomial $c_t(\mathcal{Q})$ defines a Hasse-Schmidt derivation on a Grassmann algebra, in the sense of [1]. In addition, if time permits, we shall briefly discuss i) the fact, observed by Santiago, that the generating function of the degrees of the Grassmannian $G(2, n)$ of lines in $\mathbb{P}^{n-1}$ can be expressed in terms of modified Bessel functions of the first kind and ii) the relationship of the subject with the combinatorics of the so called Catalan traffic [2, 3].

References

[1] L. Gatto, P. Salehyan, *Hasse-Schmidt Derivations on Grassmann Algebras*, Impa Monographs n. **4**, Springer, 2016

[2] H. Niederhausen, *Catalan Traffic at the Beach*, The Eletronical Journal of Combinatorics, **9**, (R33) (2002), 1–17.

[3] T. Santiago, *"Catalan traffic" and integrals on the Grassmannian of lines*, Discrete Mathematics **308** (2008) 148–152.

[4] I. Scherbak, *Gaudin Models and the generating function of the Wronski map*, Geometry and topology of Caustics, 2002, Banach Center Publications, Vol **62**, 2002, 249–262.

[5] I. Scherbak, A. Varchenko, *Critical points of functions, $\mathfrak{sl}_2$ representations, and Fuchsian differential equations with only univalued solutions*s, Mosc. Math. J. 3 (2003), no. **2**, 621–645.

(3) **Smoothness of cohomogeneity one metrics and obstructions to nonnegative curvature. Luigi Verdiani.**

Abstract: Compact simply connected Riemannian manifolds with an isometric action of a compact Lie group that has an hypersurface orbit (cohomogeneity one manifolds) are classified up to dimension seven. Among the, except for two families, parametrised by an integer, in dimension 7, the ones that admit invariant metrics of nonnegative sectional curvature are classified. We show that nonnegative curvature is obstructed on the manifolds that belong to one of these families. In order to prove it we develop a method, of independent interest, for describing smooth invariant metrics on cohomogeneity one manifolds.

(4) **Infinitely many solutions to the Yamabe problem on noncompact manifolds. Paolo Piccione (Universidade de São Paulo)**

Abstract: I will discuss the existence of infinitely many complete metrics with constant positive scalar curvature on prescribed conformal classes on certain noncompact product manifolds. These include products of closed manifolds with constant positive scalar curvature and simply-connected symmetric spaces of noncompact or

Euclidean type; in particular, $S^m \times \mathbb{R}^d$ and $S^m \times \mathcal{H}^d$. As a consequence, one obtains infinitely many periodic solutions to the singular Yamabe problem on $S^m \setminus S^k$, for all $0 \leq k < (m-2)/2$. I will also show that all Bieberbach groups are periods of bifurcating branches of solutions to the Yamabe problem on $S^m \times \mathbb{R}^d$. This is a joint work with R. Bettiol, UPenn.

(5) **Gauge theory on Milnor links. Henrique Sá Earp.**

Abstract: We show Milnor's links of certain isolated hypersurface singularities admit a natural cocalibrated G_2-structure and a Yang-Mills instanton moduli space bearing a promising relationship to the Donaldson-Thomas construction for Calabi-Yau 3-folds.

(7) **A zoo of symplectic, complex and non-Kähler manifolds. Giovanni Bazzoni.**

Abstract: It is well known that a Kähler manifold has an underlying symplectic structure. Forty years ago Thurston provided the first example of a compact symplectic manifold that admits no Kähler metrics. Giving examples of these manifolds is hampered by a twofold problem. On the one hand, constructing compact symplectic manifolds is a challenging task: among the available techniques, we mention the symplectic blow-up of Gromov and McDuff, the symplectic connected sum of Gompf and the asymptotically holomorphic theory of Donaldson. A slightly more difficult problem is to construct manifolds which, although not Kähler, are at the same time symplectic *and* complex. On the other hand, one needs to know whether the existence of a Kähler structure influences the underlying smooth manifold, and how. The Hard Lefschetz property and the formality of the rational homotopy type answer this second problem.

The talk surveys examples of manifolds which are complex and symplectic and do not carry a Kähler metric, emphasizing the role played by the fundamental group. The only example missing in this bestiary is that of a six-dimensional simply connected, compact, symplectic and complex manifold which admits no Kähler metrics. Based on the preprint [BFM], we complete the picture by constructing such missing exemplar.

[BFM] G.Bazzoni, M.Fernández and V.Muñoz, *A 6-dimensional simply connected complex and symplectic manifold with no Kähler metric*, preprint
`http://arxiv.org/abs/1410.6045`

(8) **Cohomological and metric properties of non-Kähler manifolds. Daniele Angella.**

Abstract: We study cohomological properties of compact non-Kähler manifolds, and we investigate the existence of special metrics. For example, we can consider the existence of Hermitian metrics in a conformal class with the property of having constant scalar curvature with respect to the Chern connection. (Note that the Chern

Ricci form defines a class in Bott-Chern cohomology.) The problem can be solved at least in the case of non-negative Kodaira dimension.

(9) **The curvature of orbit spaces. Claudio Gorodski**

Abstract: Let a compact Lie group act by isometries on the unit sphere. The space of orbits X is an Alexandrov space of curvature at least 1 and diameter at most π with respect to the natural quotient metric. The following question of K. Grove has been investigated by several authors and remains widely open in general:

How small can the diameter of X be?

In this talk, we discuss the closely related problem:

How curved can X be?

(Joint work with A. Lytchak (Köln).)

(10) **The modified K-energy and complex deformation. Andrew Clarke.**

Abstract: A theorem of Mabuchi, following Donaldson in the cscK case, says that if a Kähler class admits an extremal Kähler metric, then the modified K-energy is bounded below on that class and takes its minimum value on that extremal metric. If one deforms the complex structure the new manifold can in principal lose the extremal metric. We show however that under small appropriate deformations the modified K-energy does remain bounded.

11.27 Session 27 - Elliptic PDEs

Organizers: F. Leoni (University of Roma La Sapienza), B. Sirakov (Catolic University of Rio de Janeiro), A. Vitolo (University of Salerno)

Program

Thursday	**Sep 1**	**(morning session)**
09:00 - 09:30	I. Capuzzo Dolcetta	
09:30 - 10:00	D. Moreira	
10:00 - 10:30	A. Porretta	
11:00 - 11:30	B. Sirakov	
11:30 - 12:00	I. Birindelli	
Thursday	**Sep 1**	**(afternoon session)**
17:30 - 18:00	A. Vitolo	
18:00 - 18:30	W. Neves	
18:30 - 19:00	F. Leoni	
Friday	**Sep 2**	**(morning session)**
09:00 - 09:30	A. Quaas	
09:30 - 10:00	F. Pacella	
10:00 - 10:30	E. Pimentel	
11:00 - 11:30	E. Valdinoci	
11:30 - 12:00	H. Berestycki	

Abstracts

(1) **The principal eigenvalue and the maximum principle for degenerate elliptic operators. Italo Capuzzo-Dolcetta.**

Abstract: I will report on research in collaboration with Berestycki, Porretta and Rossi [1] and with Birindelli and Camilli [2]. An extended notion of principal eigenvalue is introduced in [1] in the general framework of fully nonlinear degenerate elliptic operators; the positivity of this number is shown to be equivalent to the validity of the maximum principle (or sign propagation property). Under stronger ellipticity conditions we proposed in [2] some finite differences schemes to compute this number by means of Collatz-Wielandt type formula. It is worth to point out that numerical approaches to the computation of eigenvalues are usually based on finite elements approximations of the classical Rayleigh- Ritz formula, therefore requiring divergence structure of the operator which is not required in our approach.

[1] H. Berestycki, A. Porretta, L. Rossi, ICD, Maximum Principle and generalized principal eigenvalue for degenerate elliptic operators, JMPA 2014

[2] I. Birindelli, F. Camilli, ICD, On the approximation of the principal eigenvalue for a class of nonlinear elliptic operators, submitted.

(2) **Inhomogeneous Hopf Lemma and Applications. Diego Moreira.**

Abstract: In this talk, we discuss a inhomogeneous version for the Hopf Lemma for Fully nonlinear and Quasilinear PDEs. As a consequence, we obtain several regularities results up to the boundary for these equations and related free boundary problems.

(3) **Thresholds of solvability for the p-Laplace equation with first order terms. Alessio Porretta.**

Abstract: We will deal with the p-Laplace equation with first order terms having super linear growth, possibly below or above the threshold often called natural growth. Several issues will be discussed which are linked one another, such as gradient estimates, boundary barriers and maximal solutions, as well as the role played by so-called nonlinear additive eigenvalues for the existence of solutions to the Dirichlet problem.

(4) **A priori bounds for elliptic inequalities via regularity estimates. Boyan Sirakov.**

Abstract: We show how basic estimates from elliptic regularity theory, such as growth lemmas and half-Harnack inequalities, can be used to obtain new and optimal a priori bounds for positive sub- and super-solutions of nonlinear elliptic equations.

We prove new boundary versions of these regularity estimates, which play an important role in the proofs of the a priori bounds, and are of importance in themselves.

We apply the a priori bounds in order to study the existence and multiplicity of solutions of the Dirichlet problem for a general class of elliptic operators in which the first and the second order terms have the same scaling with respect to dilations.

(5) **Eigenvalues and maximum principle for very degenerate operators. Isabeau Birindelli.**

Abstract: Let Ω denote a bounded smooth domain of $\mathbb{R}^N$ and let $P_k^-(M)$ denote the sum of the k smallest eigenvalues of the symmetric matrix M. We shall study properties of the solutions of the Dirichlet problem $P_k^-(D^2u) + \mu u = f(x)$ in Ω with zero boundary conditions. In particular we shall study the validity or lack of validity of the maximum principle, with the construction of various explicit examples and counter examples. Some regularity results will be proven and many open questions will be raised. This is an ongoing work with G. Galise and H. Ishii.

(6) **Entire subsolutions of degenerate elliptic equations related to mean partial curvatures. Antonio Vitolo.**

Abstract: In this talk we report on recent results on recent results on the exis- tence of entire viscosity subsolutions of equations considered by Harvey and Lawson and deriving from geometrical problems about mean partial curvatures. The topics is naturally connected with the nowadays classical Keller-Osserman condition and the existence of boundary blow-up solutions. In fact the results presented here extend those ones obtained independently by Osserman and Keller in the mid-twentieth, and have been established in the framework of a joint program with I. Capuzzo Dolcetta and F. Leoni.

(7) **Strong Traces for Conservations Laws. *Wladimir Neves*, Evgeniy Panov, and Jean Silva.**

Abstract: In this talk, we present some results about strong traces for scalar conservation laws, where the flux function is assumed non-homogeneous with low regularity in the spatial variable.

(8) **Homogeneous solutions of fully nonlinear elliptic equations in planar cones and applications. Fabiana Leoni.**

Abstract: We present recent results about explicit homogeneous solutions of homogeneous extremal Pucci's equations posed in planar cones. By applying comparison arguments with these explicit barrier functions, we obtain several results about solutions of general fully nonlinear uniformly elliptic equations, from monotonicity properties of solu- tions, to Liouville type non-existence results and behavior of possible nodal eigenfunctions.

(9) **Continuous viscosity solutions for nonlocal Dirichlet problems with coercive gradient terms. Alexander Quaas.**

Abstract: In this paper we study existence of solutions of nonlocal Dirichlet problems that include a coercive gradient term, whose scaling strictly dominates the one of the integro-differential operator. For such problems the stronger effect of the gradient term may give rise to solutions not attaining the boundary data or discontinuous solutions on the boundary. Our main result states that under suitable conditions over the right-hand side and boundary data, there is a (unique) Hlder continuous viscosity solution attaining the boundary data in the classical sense. This result is accomplished by the construction of suitable barriers which, as a byproduct, lead to regularity results up to the boundary for the solution.

(10) **Fully nonlinear elliptic equations: symmetry and spectral properties. Filomena Pacella.**

Abstract: We will present some recent symmetry results for viscosity solutions of a class of fully nonlinear uniformly elliptic equations. Some interesting consequences for the eigenvalues of the related operators in symmetric domains will be discussed.

(11) **Geometric boundary regularity for fully nonlinear elliptic equations. Edgard Almeida Pimentel.**

Abstract: In [Ann. of Math. (2) 130 (1989), no. 1, 189-213], Luis Caffarelli developed his famous $W^{2,p}$ regularity theory for convex fully nonlinear operators, with continuous coefficients. The question on whether these estimates could be established for general non-convex equations challenged the community for nearly thirty years, when Nadirashvili and Vladut built up counterexamples. In this talk, we obtain $W^{2,p}$ boundary estimates for solutions of fully nonlinear elliptic equations under certain assumptions on the asymptotic behavior of the operator F at the ends of $\mathcal{S}(n)$. This analysis rests upon the recession function of F, a notion coming from the theory of free boundary problems which is formally defined by $F^{\infty}(M) = \infty^{-1}F(\infty M)$. Our arguments are based on compactness methods and techniques from the so-called geometric tangential analysis. As an application, we investigate the regularity of solutions in p-BMO spaces.

(12) **Interior and boundary properties of nonlocal minimal surfaces. Enrico Valdinoci.**

Abstract: We consider a geometric variational problem driven by the minimization of a nonlocal perimeter functional. The surfaces obtained in this way arise as limit interfaces of long-range phase transitions and find natural applications, for instance, in image processing and geometric motions. Some interior regularity results will be presented, together with quantitative flatness and energy estimates that are valid for minimizers and, more generally, for stable solutions. We also discuss the (quite unexpected) boundary behavior of these nonlocal minimal surfaces. These results were obtained in collaboration with Luis Caffarelli, Eleonora Cinti, Serena Dipierro, Alessio Figalli, Ovidiu Savin and Joaquim Serra.

(13) **Spreading speed for reaction-diffusion equations in non-homogeneous media. Henri Berestycki.**

Abstract: In this talk I report on joint work with Grgoire Nadin. I will present general results about the spreading speed for Fisher-KPP type reaction-diffusion equations. We consider initial data with compact support and the (directional) spreading speed is roughly the velocity at which level sets move in every direction. This speed is known in the homogeneous and periodic cases. The general non-homogeneous framework, when the equation depends on space and time variables, is quite involved. I will show that this speed is linked to new notions of generalized eigenvalues of linear elliptic (non-homogenous) operators in unbounded domains. This allows us to derive general bounds and to determine the spreading speed for several new frameworks.

12 Minicourse

(1) **Continuous solutions of the Euler equations constructed via convex integration. Camillo De Lellis**

Abstract: A well-known conjecture of Lars Onsager asserts the existence of Hölder continuous solutions of the Euler equations which do not preserve the energy. In a joint work with László Székelyhidi we have shown that continuous solutions of this sort can be constructed via an iteration mechanism which resembles the one of Nash for C^1 isometric embeddings of Riemannian manifolds. Such methods have been pushed by us, Phil Isett and Tristan Buckmaster to reach almost the regularity threshold conjectured by Onsager. Although I will not be able to give all the details of the proofs, the goal of this minicourse is to give the most relevant ideas and the most relevant estimates behind them.