9th TYAN International Thematic Workshop on Mathematics and 1st TYAN-Humboldt Workshop in Mathematics

October 2nd – 6th, 2023
Universidade de Brasília (UnB)
Brasília, Brazil

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Welcome to

9th TYAN International Thematic Workshop on Mathematics and 1st TYAN-Humboldt Workshop in Mathematics

TYAN International Thematic Workshop on Mathematics and TYAN-Humboldt Workshop in Mathematics

Book of Abstracts

TYAN International Thematic Workshop on Mathematics and TYAN-Humboldt Workshop in Mathematics

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Lucas Cotrim Aguiar
Lucas Matheus de Lima Dal Berto
Samuel Terto de Sousa Rodrigues
Thiago Henrique de Oliveira

Opening Ceremony: Monday, October 02, from 08:00 to 9:00

Paolo Piccione - Chair

Plenary Speakers

Alicia Dickenstein (University of Buenos Aires, Argentina)
Carolina Araujo (IMPA, Brazil)
Celina Figueiredo (Federal University of Rio de Janeiro, Brazil)
Enrique Zuazua (University of Erlangen, Germany)
Gregório Pacelli (Federal University of Ceará, Brazil)
Helge Holden (Norwegian University of Science and Technology, Norway)
Keti Tenenblat (University of Brasília, Brazil)
Liliana Forzani (Universidad Nacional del Litoral, Argentina)
Liliane de Almeida Maia (University of Brasília, Brazil)
Maria Eulalia Vares (Federal University of Rio de Janeiro, Brazil)
Martin Bohner (Missouri University of Science and Technology, USA)
Mina Teicher (University of Miami, USA)
Pavel Shumyatsky (University of Brasília, Brazil)
Pavel Zalesski (University of Brasília, Brazil)
Paolo Piccione (University of São Paulo, Brazil)
Ursula Hamenstädt (University of Bonn, Germany)

Special Sessions

Analysis and Applied Mathematics
Tiago Roux (UERJ)
Carolina Neira (Universidad Nacional de Colombia)
Mayra Soares (UnB)
Maria Soledad Aronna (FGV)
Pierluigi Benevieri (USP)
Antonio Leitão (UFSC)
Gabriela Planas (Unicamp)
Marcio Jorge da Silva (UEL)
Everaldo de Mello Bonotto (USP)

Dynamical Systems

Tiago Pereira da Silva (USP)
Sergey Tikhomirov (PUC-Rio)
Fabio Armando Tal
Sabrina Streipert
Ricardo Martins Miranda
Alexander Arbieto
Tom Cuchta

Geometry, Topology and Discrete Mathematics

Algebra

Panel

Panel 1: Harassment in Academia

Christina Brech (University of São Paulo)
Marcia Barbosa (Federal University of Rio Grande do Sul and MCTI)
Moderator: Alicia Dickenstein (University of Buenos Aires)

Panel 2: TYAN

Franco Cabrerizo (National University of San Martin - (UNSAM, CONICET))
Ferran Valdez (Universidad Autonoma de Mexico)
Pablo Bolaños (Universidad de Costa Rica)
Moderator: Jaqueline Mesquita (University of Brasília)

Panel 3: Mathematics and Industry

José Alberto Cuminato (University of São Paulo - ICMC)
Tiago Pereira da Silva (University of São Paulo - ICMC)
Ana Luiza Amaral (SESI)
Marcio Jorge da Silva (State Univertisty of Londrina)

Posters

- Aryel Kathleen Araújo Silva - Henstock Kurzweil Integral and Applications
- Felipe Gonçalves Netto - Linearized Stability for Neutral Equations with State-Dependent Delays
- Igor Chagas Santos - Equiaffine Structure on frontals
- Janara Ramos Nascimento - Polynomial identities for 3-dimensional Leibniz algebras RR_1 and RR_2

- Maxmilian Barros de Siqueira - A proof of Bochner's Tube Theorem

Social Activities

Welcome Recepion

The welcome reception will take place at the German Embassy on Monday, October 6, from 7pm.

Event address

University of Brasília
Campus Universitário Darcy Ribeiro, Brasília-DF, 70910-900

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General Information

Schedule

	October 02	**October 03**	**October 04**	**October 05**	**October 06**
Chair	*Paolo Piccione*	*Tom Cuchta*	*Martin Bohner*	*Helge Holden*	*Celina Figueiredo*
08:00-09:00	Opening		**Plenary talk 5** Helge Holden *Norwegian University of Science and Technology*	**Plenary Talk 7** Enrique Zuazua *University of Erlangen, Germany*	**Plenary Talk 11** Mina Teicher *University of Miami*
09:00-10:00	**Plenary talk 1** Keti Tenenblat *Universidade de Brasília*	**Plenary Talk 4** Martin Bohner *Missouri University of Science and Technology*	**Plenary Talk 6** Maria Eulalia Vares *Universidade Federal do Rio de Janeiro*	**Plenary Talk 8** Celina Figueiredo *Universidade Federal do Rio de Janeiro*	**Plenary Talk 12** Pavel Zalesski *Universidade de Brasília*
10:00-10:30	**Coffee-Break**	**Coffee-Break**	**Coffee-Break**	**Coffee-Break**	**Coffee-Break**
Chair	*Keti Tenenblat*	*Opportunities for young and mid-career researchers* Representatives of Heidelberg Laureate Forum* FGV – Maria Soledad Aronna IMSA, University of Miami* - Ludmil Katzarkov Representative of Humboldt Foundation* TYAN-Franco Cabrerizo Moderator: Paolo Piccione *Online participation	*Mathematics and Industry* José Alberto Cuminato, USP Tiago Pereira da Silva, USP Ana Luiza Amaral, SESI Moderator: Marcio Jorge, UEL	*Pierluigi Benevieri*	*Mina Teicher*
10:30-11:30	**Plenary Talk 2** Paolo Piccione *Universidade de São Paulo*			**Plenary Talk 9** Liliane de Almeida Maia *Universidade de Brasília*	**Plenary Talk 13** Pavel Shumyatsky *Universidade de Brasília*
11:30-12:30	**Plenary Talk 3** Alicia Dickenstein *Universidad de Buenos Aires*			**Plenary Talk 10** Liliana Forzani *Universidad Nacional del Litoral, Argentina*	**Plenary Talk 14** Carolina Araujo *IMPA*
12:30-14:00	**LUNCH**	**LUNCH**	**LUNCH**		**LUNCH**
14:00-16:00	**Special Sessions**	**TYAN** Pablo Bolaños Franco Cabrerizo Ferran Valdez Moderator: Jaqueline Mesquita	Tour	Barbecue	**Special Sessions**
16:00-16:30	**Coffee-Break**	**Coffee-Break**			**Coffee-Break & Poster Session**
16:30-18:30	***Harassment in Academia*** Marcia Barbosa, MCTI Liliana Forzani, UMALCA Moderator: Alicia Dickenstein, UBA	**Special Sessions**			**Special Sessions**
18:30-19:00					
19:00	**Welcome Reception at the Embassy of Germany**				**Closing**

The 9th TYAN International Thematic Workshop on Mathematics and 1st TYAN-Humboldt Workshop in Mathematics

Map of the University of Brasília

To access the university map, scan the following QR Code or click on the link:
`https://noticias.unb.br/images/mapas_campi_unb.pdf`

Plenary Speakers

Algebraic Geometry Tools In Systems Biology

Alicia Dickenstein
University of Buenos Aires, Argentina

Abstract

In recent years, methods and concepts of algebraic geometry, particularly those of real and computational algebraic geometry, have been used in many applied domains. In this talk, aimed at a broad audience, I will review applications to molecular biology. The goal is to analyze standard models in systems biology to predict dynamic behavior in regions of parameter space without the need for simulations. I will also mention some challenges in the field of real algebraic geometry that arise from these applications.

Partially supported by UBACYT 20020220200166BA and CONICET PIP 20110100580, Argentina.

The Calabi Problem

Carolina Araújo
IMPA, Brazil

Abstract

The Calabi Problem is a formidable problem in the confluence of differential geometry and algebraic geometry. It asks which compact complex manifolds admit a Kähler-Einstein metric. For flat or negatively curved manifolds, the Calabi problem was solved by Yau and Aubin/Yau in the 1970s. They confirmed Calabi's prediction, showing that these manifolds always admit Kähler-Einstein metrics. On the other hand, for positively curved manifolds, called "Fano manifolds", the problem is much more subtle: Fano manifolds may or may not admit Kähler-Einstein metrics. There have been great advances in the Calabi problem for Fano manifolds in the last decade, with surprising and deep connections with birational geometry. In this talk, I will present an overview of the Calabi problem, the recent interactions with birational geometry, and the current state of the art in dimension 3.

The millennium problem of computational intractability

Celina Miraglia Herrera de Figueiredo
Federal University of Rio de Janeiro, Brazil

Abstract

In the year 2000, the Clay Mathematics Institute distinguished seven problems considered central to the progress of mathematics, calling them The Millennium Prize Problems. The solution to each problem corresponds to a prize of one million dollars. One of the seven selected problems is a Theory of Computation problem: is there a question whose answer can be verified quickly but whose answer takes a long time to find? This Millennium Problem, known as P versus NP, is the central problem in the area of Computational Complexity, where we try to classify the difficulty of problems according to the efficiency of possible solutions through computational algorithms.

References

[1] C. M. H. de Figueiredo *Resolver ou Verificar? Uma pergunta que vale um milhão de dólares*, Ciência Hoje, **Novembro** (2011), 42–46.

[2] C. M. H. de Figueiredo, A. A. Melo, D. Sasaki, A. Silva *Revising Johnson's table for the 21st century*, Discrete Applied Mathematics, **323** (2022), 184–200.

This work was supported by the Brazilian agencies Faperj CNE E-26/202.793/2017 and CNPq 407635/2018-1.

Control and Machine Learning

Enrique Zuazua
University of Erlangen, Germany

Abstract

In this lecture we shall present some recent results on the interplay between control and Machine Learning, and more precisely, Supervised Learning, Universal Approximation and Normalizing flows.

We adopt the perspective of the simultaneous or ensemble control of systems of Residual Neural Networks (ResNets). Roughly, each item to be classified corresponds to a different initial datum for the Cauchy problem of the ResNets, leading to an ensemble of solutions to be driven to the corresponding targets, associated to the labels, by means of the same control.

We present a genuinely nonlinear and constructive method, allowing to show that such an ambitious goal can be achieved, estimating the complexity of the control strategies.

This property is rarely fulfilled by the classical dynamical systems in Mechanics and the very nonlinear nature of the activation function governing the ResNet dynamics plays a determinant role. It allows deforming half of the phase space while the other half remains invariant, a property that classical models in mechanics do not fulfill.

The turnpike property is also analyzed in this context, showing that a suitable choice of the cost functional used to train the ResNet leads to more stable and robust dynamics.

(1) B. Geshkovski, E. Zuazua, Turnpike in optimal control of PDEs, ResNets, and beyond, Acta Numerica, 2022, pp. 135-263.

(2) D. Ruiz-Balet, Enrique Zuazua, Neural ODE control for classification, approximation and transport, SIAM Rev., Vol. 65, Iss. 3 (2023)10.1137/21M1411433.

(3) D. Ruiz-Balet, E. Z., Control of neural transport for normalizing flows, Journal de mathématiques pures et appliquées, arXiv:2307.07817.

(4) D. Ruiz-Balet, E. Affili, E. Zuazua, Interpolation and approximation via Momentum ResNets and Neural ODEs, Systems and Control Letters, 162 (2022) 105-182

This work was supported by Alexander von Humboldt-Professorship program, the ModConFlex Marie Curie Action, HORIZON-MSCA-2021-DN-01, the COST Action MAT-DYN-NET CA18232, the Transregio 154 Project "Mathematical Modelling, Simulation and Optimization Using the Example of Gas Networks" of the DFG, grants PID2020-112617GB-C22 and TED2021-131390B-I00 of MINECO (Spain). Madrid Government - UAM Agreement for the Excellence of the University Research Staff in the context of the V PRICIT (Regional Programme of Research and Technological Innovation).

Mathematical Modeling of Traffic Flow – Discrete vs Continuous

Helge Holden
Norwegian University of Science and Technology, Norway
(joint work with **N.H. Risebro**)

Abstract

Vehicular traffic is one of most serious problems facing modern urban life. We will describe some classical models for traffic flow. There are two rather distinct ways to model traffic. On the one hand one can track individual vehicles, often called Follow-the-Leader models (FtL). This leads to systems of ordinary differential equations. However, if traffic is dense, a classical model is the so-called Lighthill–Whitham–Richards model (LWR), which is a nonlinear partial differential equation, more specifically, a hyperbolic conservation law. We study these models and in particular the connection between the discrete (FtL) and the continuous (LWR) when traffic becomes dense. We will also briefly discuss traffic on a network or roads, and traffic on multilane roads.

References

[1] H. Holden, N.H. Risebro *A mathematical model of traffic flow on a network of unidirectional roads*, SIAM J. Math. Anal., **26** (1995), 999–1017.

[2] H. Holden, N.H. Risebro *Continuum limit of Follow-the-Leader models — a short proof*, Disc. Cont. Dyn. Syst., **38** (2018), 715–722.

[3] H. Holden, N.H. Risebro *Follow-the-Leader models can be viewed as a numerical approximation*, Networks & Heterogeneous Media, **13** (2018), 409–421.

[4] H. Holden, N.H. Risebro *Models for dense multilane vehicular traffic*, SIAM J. Math. Anal., **5** (2019), 3694–3713.

[5] R. M. Colombo, H. Holden, and F. Marcellini *On the microscopic modeling of vehicular traffic on general networks*, SIAM J. Appl. Math., **3** (2020), 1377–1391.

This work was supported in part by the Research Council of Norway.

Plenary talk 6:
Tuesday (November, 08), $14:30-15:30$

Classes of Nonlinear PDEs Related to Metrics of Constant Curvature

Keti Tenenblat
University of Brasília, Brazil

Abstract

In this talk, I will survey some aspects relating classes of PDEs with metrics on a 2-dimensional manifold with non zero constant Gaussian curvature. The notion of a differential equation (or system of equations) describing pseudo-spherical surfaces (curvature -1) or spherical surfaces (curvature 1) will be introduced. Such equations have remarkable properties. Each equation is the integrability condition of a linear problem explicitly given. The linear problem may provide solutions for the equation by using Bäcklund type transformations or by applying the inverse scattering method. Moreover, the geometric properties of the surfaces may provide infinitely many conservation laws. Very well known equations such as the sine-Gordon, Korteveg de Vries, Non Linear Schrödinger, Camassa-Holm, short-pulse equation, elliptic sine-Gordon, etc. are examples of large classes of equations related to metrics with non zero constant curvature. Classical and more recent results characterizing and classifying certain types of equations will be mentioned. Examples and illustrations will be included. Some higher dimensions generalizations will be mentioned.

This work was supported by CNPq grant 311916/2021-0.

Abundance vs. Sparsity

Liliana Forzani
Universidad Nacional del Litoral, Argentina
(joint work with **Dennis Cook**)

Abstract

In this talk, we delve into the exploration of regression methodologies, particularly focusing on the paradigm of abundant regressions where a majority of predictors play a crucial role in informing about the response. Contrary to the widely recognized notion of sparse regressions, where limited predictors are of significance, abundant regressions present a rich framework. Our discussion encompasses the asymptotic characteristics of predictive methodologies in abundant linear regressions, emphasizing how these estimators perform commendably in high-dimensional contexts. Additionally, we navigate the intricacies of partial least squares (PLS) regression, examining its asymptotic behavior in scenarios with a diverging sample size and predictor count. Notably, we find that PLS predictions flourish in abundant regressions, achieving optimal asymptotic behavior. However, in contrast, they tend to underperform in sparse regressions. Throughout this presentation, we aim to provide a comprehensive understanding of the strengths and limitations of these methodologies in various regression landscapes.

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[1] Basa, J., Cook, R. D., Forzani, L., & Marcos, M. Asymptotic distribution of one-component partial least squares regression estimators in high dimensions. Canadian Journal of Statistics. 2022.

[2] Cook, R. D,; Forzani, L. Envelopes: A new chapter in partial least squares regression. Invited perspective paper sobre una mirada estadística al uso y propiedades de PLS. Journal of Chemometrics, 2020, 34(10),e3287.

[3] Cook, R.D., Forzani, L. Partial Least Squares Prediction in High-Dimensional Regression. Annals of Statistics, 2019, 47(2), pp. 884–908.

[4] Cook, R.D., Forzani, L. Big data and partial least squares prediction, Canadian Canadian Journal of Statistics, 2018, 46(1), pp. 62–78. Presentado en: Highlights of the Canadian Journal of Statistics - Invited Papers en JSM 2019.

[5] Cook, R. D., Forzani, L., and Rothman, A. J. (2015) Comentarios sobre el trabajo: Tarpey, R. T., Ogden, T., Petkova, E., and Christensen, R. (2014). A paradoxical result in estimating regression coefficients. The American Statistician 67, 249- 260. Ding, P. (2014). Letter to the Editor on Tarpey, et al. (2014). The American Statistician 67, 316. The American Statistician Volume 69, Issue 3.

[6] Cook, R. D., Forzani, L., and Rothman, A. J. (2013). Prediction in abundant high-dimensional linear regression. Electronic Journal of Statistics, 7(1), 3059-3088.

[7] Cook, R. D., Forzani, L., and Rothman, A. J. (2012). Estimating sufficient reductions of the predictors in abundant high-dimensional regressions. Annals of Statistics 40(1), 353-384.

Classification of radial solutions for fully nonlinear equations via a dynamical system

Liliane de Almeida Maia
University of Brasília, Brazil
(joint work with **Gabrielle Nornberg and Filomena Pacella**)

Abstract

In this talk, we present some recent results on existence, nonexistence and regularity of positive radial solutions for a class of nonlinear equations driven by Pucci extremal operators, power nonlinearity and Hardy weight. We classify both regular continuous nondifferentiable and singular solutions defined in radial domains, punctured or not. We also obtain critical threshold exponents for the solvability in the exterior of a ball, as well as uniqueness and symmetry in annuli. Our results are based on the behavior of the trajectories described through suitable dynamical systems on the plane, in addition to energy monotonicity and asymptotic analysis.

References

[1] L. Maia, G. Nornberg, and F. Pacella,*A dynamical system approach to a class of radial weighted fully nonlinear equations*, Comm. Partial Differential Equations, 46**4** (2021), 573–610.

[2] L. Maia, G. Nornberg, and F. Pacella,*Classification of radial solutions for fully nonlinear equations with Hardy potential*, Preprint.

This work was supported by Fapdf and CNPq grant 309866/2020-0.

Phase transition for the contact process on evolving random environments

Maria Eulalia Vares
Federal University of Rio de Janeiro, Brazil

Abstract

Dynamic random environments emerge naturally when considering growth processes with a very large number of interacting components. They also pose new challenges for the investigation of phase transitions. One such example is the classical Harris contact process. In this talk I will be discussing questions in this setup, based mostly on recent papers in collaboration with L. R. Fontes, M. Hilário, T. Mountford, D. Ungaretti, and D. Valesin.

My research is partially supported by CNPq, grant 310734/2021-5, and by FAPERJ, grant E-26/200.442/2023.

THE BEVERTON–HOLT EQUATION

Martin Bohner
Missouri University of Science and Technology, USA
(joint work with **Jaqueline Mesquita and Sabrina Streipert**)

Abstract

In this talk, we will present the Beverton–Holt equation as used in fisheries and other population models, in many different scenarios (discrete case, continuous case, time scales case, quantum case, periodic case, with and without harvesting etc.).

References

[1] Martin Bohner and Rotchana Chieochan. The Beverton-Holt q-difference equation. *J. Biol. Dyn.*, 7(1):86–95, 2013.

[2] Martin Bohner, Fozi M. Dannan, and Sabrina Streipert. A nonautonomous Beverton-Holt equation of higher order. *J. Math. Anal. Appl.*, 457(1):114–133, 2018.

[3] Martin Bohner, Jaqueline Mesquita, and Sabrina Streipert. The Beverton-Holt model on isolated time scales. *Math. Biosci. Eng.*, 19(11):11693–11716, 2022.

[4] Martin Bohner, Stevo Stević, and Howard Warth. The Beverton-Holt difference equation. In *Discrete dynamics and difference equations*, pages 189–193. World Sci. Publ., Hackensack, NJ, 2010.

[5] Martin Bohner and Sabrina Streipert. The Beverton-Holt equation with periodic growth rate. *Int. J. Math. Comput.*, 26(4):1–10, 2015.

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WIMSA - What, Why, How

Mina Teicher
University of Miami, USA

Abstract

The talk is a policy talk in regard to Women in Mathematics.

WIMSA (Advancing Women in math Across the Americas) is an initiative of the university of Miami - the Department of Mathematics and the Institute of Mathematical Sciences of the Americas (IMSA).

In the presentation I'll explain the mission, the conceptual approach, the projects, the expanding, and future plans.

Recent applications of Lie methods to group theory

Pavel Shumyatsky
University of Brasília, Brazil

Abstract

About 35 years ago Efim Zelmanov solved the famous Restricted Burnside Problem (Fields prize 1994). While the problem was about finite groups, a significant part of the solution happened to be Lie-theoretical. Nowadays we know that the tools created in the solution can be applied successfully to other problems in group theory. In the talk I will describe some new results in group theory whose proofs are based on a Lie-theoretical theorem of Zelmanov.

Profinite genus of free products with amalgamation and accessible groups

Pavel Zalesski
University of Brasília, Brazil
(joint work with **Vagner Bessa and Anderson Porto**)

Abstract

In this talk, I shall discuss the profinite genus of finitely generated residually finite accessible groups with a certain natural restriction on one-ended vertex groups in their JSJ-decompositions. Then I shall concentrate on the profinite genus of free products $G_1 *_H G_2$ of such one-ended groups G_1, G_2 with finite amalgamation H.

Bifurcation Phenomena in Geometric Variational Problems

Paolo Piccione
University of São Paulo, Brazil

Abstract

I will provide an overview of classical Bifurcation Theory, followed by an exploration of its contemporary applications in Riemannian Geometry. Topics covered will include minimal and constant mean curvature surfaces, as well as the Yamabe problem.

Special Sessions

Algebra

Elements of almost simple spectrum in representations of Algebraic Groups

Alexandre E. Zalesski
University of Brasilia, Brasilia, Brazil

Abstract

A diagonalizable matrix is said to have an almost simple spectrum if at most one of its eigenvalue multiplicity is greater than 1. This naturally generalizes the class of matrices with simple spectrum whose all eigenvalues are of multiplicity 1.

We study elements of simple algebraic groups having an almost simple spectrum in its irreducible representations. The main question is of finding an upper bound for the multiplicity of an eigenvalue of such matrices in an irreducible representation of the group in question. The main result states that the bound is $n+1$ where n is the rank of the algebraic group in question.

Graded coverings in supergeometry

Elizaveta Vishnyakova
Federal University of Minas Gerais, Belo Horizonte, Brazil

Abstract

In the theory of Lie superalgebras there is a concept of a covering superalgebra. Such algebras are also known under the name loop superalgebras. In geometry there is also the well-known notion of a covering space: a classical example here is the following universal covering: $p : \mathbb{R} \to S^1$, $t \mapsto \exp(it)$. Another examples of this concept are a flat covering and a torsion-free covering in the theory of modules. All these coverings satisfy some common universal properties. Our talk is devoted to the notion of a covering in the super Lie theory and supergeometry.

Subgroup separability of surface braid groups

Igor Lima
University of Brasília, Brazil
(joint work with **Kisnney Almeida (UEFS) and Oscar Ocampo (UFBA)**)

Abstract

A group G is said subgroup separable or locally extended residually finite (LERF) if each finitely generated subgroup H of G is the intersection of finite index subgroups of G. Subgroup separability is a powerful property introduced by M. Hall in 1949, important for group theory and low-dimensional topology, but established either positively or negatively for very few classes of groups. It can be used to show that certain immersions lift to embeddings in a finite cover. It is also known that, for finitely presented groups, subgroup separability implies the generalized word problem is solvable. The purpose of this talk is to determine under which conditions surface braid groups are subgroup separable.

This work was supported by FAPDF (Demanda Espontanea).

RELATIONS, IDENTITIES, GRADINGS ANS ACTIONS IN ALGEBRAS

Irina Sviridova
University of Brasília, Brazil

Abstract

We will discuss interconnections of various types of relations of associative algebras, including polynomial identities (identical relations), and graded identities of graded algebras. PI-theory (the theory of algebras with identical relations) is one of the actively developed area of the modern algebra. Last years, one of the most popular directions of the theory of polynomial identities is also to consider algebras with some additional structures (such as gradings, involutions, actions by automorphisms, etc.), and to study identities of such algebras with the additional signature.

The interconnection of various types of identities with the properties of algebras satisfying them is one of the central question of PI-theory, and is an interesting mathematical question in general.

We will discuss some last results related to this question and concerning some concrete important algebras or general facts of the theory, and their possible consequences and applications.

Normal subgroups in limit groups of prime index

Jhoel Sandoval Gutierrez
University of Mato Grosso do Sul, Campo Grande, Brazil
(joint work with **Thomas Weigel-University of Milano-Bicocca**)

Abstract

Motivated by their study of pro-p limit groups, D.H. Kochloukova and P.A. Zalesski formulated in [1] a question concerning the minimum number of generators $d(N)$ of a normal subgroup N of prime index p in a non-abelian limit group G, being more exact, asked if it is true that $d(N) > d(G)$. In this work we shown that the analogous question for the rational rank has an affirmative answer, being more exact, we show that the rational rank of N is greater than the rational rank of G. From this result one may conclude that the original question of D.H. Kochloukova and P.A. Zalesski has an affirmative answer if the abelianization G^{ab} of G is torsion free and $d(G) = d(G^{ab})$, or if G is a special kind of one-relator group.

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The exponent of the non-abelian q-tensor square and related constructions of p-groups

Nathália Nogueira Gonçalves
University of Brasília, Brazil

Abstract

The group $\nu^q(G)$ is a certain extension of the non-abelian q-tensor square, $G \otimes^q G$, by $G \times G$, where q is a non-negative integer and G is an arbitrary group. In this presentation we obtain bounds for the exponent of these constructions when G belongs to some family of finite p-group. For instance, if G is a powerful p-group we prove that $\exp(G \otimes^q G)$ divides $\exp(G)$ if p is odd or if $p = 2$ and either q is odd or 4 divides q, and $\exp(G \otimes^q G)$ divides $2\exp(G)$ if $p = 2$ and 4 does not divide q. In the potent's family we give a bound for the $\exp(\nu^q(G))$ in terms of the $\exp(G)$. Moreover, we obtain an upper bound for p-groups of maximal class. These bounds extend some existing bounds found in the literature for the particular case $q = 0$.

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Solvable finite group with a nilpotent normal complement subgroup

Mohsen Amiri
Federal University of Amazonas, Brazil

Abstract

Burnside showed that if a Sylow p-subgroup of a group G is in the center of its normalizer then G has a normal p-complement. In this presentation, we show that if a solvable finite group G has a core-free proper subgroup H such that the normalizer of any non-trivial normal subgroup of Fit(H) is equal to H, then H has a nilpotent normal complement K and KZ(Fit(H)) is a Frobenius group.

Torção Generalizada em Grupos

Raimundo de Araújo Bastos Júnior
University of Brasilia, Brasilia, Brazil

Abstract

Nosso objetivo será apresentar os conceitos de *torção generalizada* e *torção generalizada forte*. Investigaremos como tais conceitos se comportam em certas classes de grupos. Essa apresentação foi motivada/baseada nos trabalhos [1, 2, 3, 4].

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Analysis

Decay of solutions for 4D energy-critical nonlinear heat equation

Gabriela Planas
Universidade Estadual de Campinas, São Paulo, Brazil
(joint work with **César Niche (UFRJ) and Leonardo Kosloff (Unicamp)**)

Abstract

In this talk, we address the decay of solutions to the four-dimensional energy-critical nonlinear heat equation in the critical space $\dot{H}^1$. Recently, it was proven that the $\dot{H}^1$ norm of solutions goes to zero when time goes to infinity, but no decay rates were established. By means of the Fourier Splitting Method and using properties arising from the scale invariance, we obtain an algebraic upper bound for the decay rate of solutions.

This work was supported by Fapesp grant 2019/02512-5 and CNPq grant 310274/2021-4.

Control of Biological Systems

Maria Soledad Aronna
Escola de Matemática Aplicada, FGV EMAp, Rio de Janeiro, Brazil
(joint work with **the authors cited below**)

Abstract

In this talk we will describe some models of optimal control in biological systems, such as biological control of insects, vaccine allocation and testing strategies. We will show situations that Optimal Control Theory could successfully solve and we will present and discuss theoretical and numerical challenges for the future of the field.

This work was supported by FAPERJ, CNPq and FGV EMAp.

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Boundary Weak Harnack Estimates and Regularity for Elliptic PDE in Divergence Form

Mayra Soares
University of Brasilia, Brasilia, Brazil
(joint work with **Boyan Sirakov and Fiorella Rendón**)

Abstract

We obtain a global extension of the classical Weak Harnack Inequality which extends and quantifies the Hopf–Oleinik boundary-point lemma, for uniformly elliptic equations in divergence form, under the weakest assumptions on the leading coefficients and on the boundary of the domain. Our main tool is the use of suitable barrier functions, which are solutions of auxiliaries problems and the C^1-estimates up to the boundary.

Among the consequences is a boundary gradient estimate, due to Krylov and well-studied for non-divergence form equations, but completely novel in the divergence framework. Another consequence is a new more general version of the Hopf–Oleinik lemma. Furthermore, we provide an application showing how to use this results in order to deduce a priori upper bounds and multiplicity of solutions for a class of quasilinear elliptic problems with quadratic growth on the gradient.

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Boundary value problems for generalized ordinary differential equations

Everaldo de Mello Bonotto
Universidade de São Paulo, São Paulo, Brazil
(joint work with **M. Federson and C. Mesquita**)

Abstract

In this talk, I will present the existence and uniqueness of solutions for the following boundary value problem concerning generalized ODEs

$$\begin{cases} \dfrac{dx}{d\tau} = D[A(t)x + F(t)], \\ \displaystyle\int_a^b d[K(s)]x(s) = r, \end{cases}$$

for operators taking values in general Banach spaces. Necessary and sufficient conditions will be established not only for the existence of at least one solution, but also for the uniqueness of a solution. Additionally, I will exhibit a result that characterizes the solution to the above BVP in terms of a Green function and the fundamental operator of the corresponding homogeneous problem. The main theorems will be applied to abstract ODEs, as well as to a Volterra-Stieltjes-type integral equation.

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This work was partially supported by Fapesp grant 2020/14075-6 and CNPq grant 310540/2019-4

Pseudodifferential Operators on the Noncommutative Torus

Carolina Neira Jiménez
Universidad Nacional de Colombia, Bogotá, Colombia
(joint work with **C. Lévy and S. Paycha**)

Abstract

Pseudodifferential calculus is a very useful tool in analysis and geometry. On smooth manifolds, this calculus is performed via symbols which are locally defined concepts. On manifolds equipped with certain symmetry (through the action of a Lie group), it is possible to develop a notion of the global symbol of a pseudodifferential operator following [3]. In this talk, we consider such a notion and use it to define a global pseudodifferential calculus on the noncommutative torus, which is a mild noncommutative perturbation of the ordinary torus, and a prototypical object in noncommutative geometry. This is done by using an analogue of the Fourier series representation of a function in the (commutative) torus $C^\infty(\mathbb{T}^n)$ ([2]). Moreover, we will compare such a definition with the one given in [1], where the definition of pseudodifferential operators is given as an analogue to the standard pseudodifferential operators on closed manifolds.

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Curved beam Systems with Partial Thermoelastic Feedback

Marcio A. Jorge da Silva
Universidade Estadual de Londrina, Paraná, Brazil
(joint work with **To Fu Ma**)

Abstract

Curved beams have several applications in physics and engineering. On the mathematical side, the understanding of their stability behavior can provide the response to many questions and help with structural designs, financial support, and avoid catastrophes, for example when building bridges. The presence of damping in these systems can significantly affect their dynamic response and stability characteristics. In this talk, we are particularly interested in damping coming from thermal coupling in the system of curved beams, as one can find e.g. in [4]. More precsily, our results contribute to the theoretical understanding of partially damped systems and give fundamentals of thermoelasticity for research on more complex structural dynamics of problems involving thermoelastic curved beams, see [1, 2, 3]. In particular, a partially damped thermoelastic curved beam system of Bresse type will be approached and the techniques employed allow us to respond a question first introduced in [5].

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This work was supported by CNPq, grant 160954/2022-3.

Extremum Seeking for Infinite-Dimensional Systems: from Delays to PDEs

Tiago Roux Oliveira
State University of Rio de Janeiro (UERJ), Rio de Janeiro, Brazil
(joint work with **Prof. Miroslav Krstic**, UCSD)

Abstract

Exactly a century since its invention and first application, and more than two decades since the proof of its convergence, the extremum seeking control has been recognized as one of the most important model-free real-time optimization tools. However, until recently extremum seeking has been restricted to dynamic systems represented by connections of Ordinary Differential Equations (ODEs) and non-linear convex maps with unknown extremum points. This talk presents the first collection of results on the theory and design of extremum seeking strategies for infinite-dimensional systems governed by Partial Differential Equations (PDEs). The main ideas for the design of the Gradient-Newton methods and the stability analysis for infinite-dimensional systems will be discussed considering a wide class of parabolic and hyperbolic PDEs: delay equations, wave equation and reaction-advection-diffusion models. Moreover, engineering applications are presented, including problems of noncooperative games, neuromuscular electrical stimulation, biological reactors, oil-drilling systems and flow-traffic control for urban mobility.

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This work was supported by CAPES, CNPq, and FAPERJ.

Global bifurcation results for a delay differential system representing a chemostat model

Pierluigi Benevieri
Institute of Mathematics and Statistics, University of São Paulo, São Paulo, Brazil
(joint work with Pablo Amster
Department of Mathematics, University of Buenos Aires)

Abstract

In this talk, we present a global bifurcation result for periodic solutions of the following delayed first order system, depending on a real parameter $\lambda \geq 0$,

$$\begin{cases} s'(t) = Ds^0(t) - Ds(t) - \dfrac{\lambda}{\gamma}\,\mu(s(t))x(t) & t \geq 0 \\ x'(t) = x(t)\big[\lambda\mu(s(t-\tau)) - D\big] & t \geq 0, \end{cases} \tag{1}$$

in which the following conditions hold:

(a) $s^0 : \mathbb{R} \to \mathbb{R}$ is continuous, positive and ω-periodic, where $\omega > 0$ is given,

(b) $\mu : [0, +\infty) \to [0, +\infty)$ is C^2 and verifies $\mu(0) = 0$ and $\mu'(s) > 0$, for any $s \in [0, +\infty)$,

(c) D, γ and the delay τ are positive constants,

System (1) has been studied in [1] and it represents a chemostat model, with a delay. The chemostat is a continuous bioreactor with a constant volume, in which one or more microbial species are cultivated in a liquid medium containing a set of resources with, in particular, a specific nutrient. The maps $s(t)$ and $x(t)$ are, respectively, the densities of the nutrient and of the microbial species at time t. The device receives continuously an input of liquid volume, described by $s^0(t)$, containing a variable concentration of the specific nutrient. It expulses continuously towards the exterior an output of liquid volume containing a mixing of microbial biomass and nutrient. The model described by the system (1) assumes that the consumption of the nutrient has no immediate effects on the microbial growth, but we have a time interval $[t - \tau, t]$ in which the microbial species metabolize(s) the nutrient.

If (s, x) is any solution of (1) such that x vanishes at some t_0, then x turns out to be identically zero. Thus, the first equation in system (1) becomes linear and has a unique ω-periodic solution, which is positive and can be written as

$$v^*(t) = \int_{-\infty}^{t} e^{-D(t-r)} Ds^0(r)\, dr.$$

For a sake of simplicity, assume that $\frac{1}{\omega}\int_0^\omega \mu(v^*(t))\, dt = D$. In [1], the authors prove that

(a) *if $\lambda < 1$ (resp. $\lambda > 1$) and (s, x) is an ω-periodic solution, different from $(v^*, 0)$, then, $x(t) < 0$ (resp. $x(t) > 0$) for all $t \in \mathbb{R}$;*

(b) *if $\lambda = 1$, no ω-periodic solution is different from $(v^*, 0)$.*

Hence, it is quite natural to ask if $(v^*, 0)$ is a bifurcation point for ω-periodic solutions of (1) as well as to investigate the global behaviour of the bifurcating branches of such solutions. Here, we call *ω-triple* an element (λ, s, x) in which (s, x) is an ω-periodic solution of (1) corresponding to λ. Denote by E the Banach space $E := \mathbb{R} \times C^1_\omega \times C^1_\omega$, where

$$C^1_\omega = \{u \in C^1([0, \omega], \mathbb{R}) : u(0) = u(\omega) \text{ and } u'(0) = u'(\omega)\}.$$

Our main result is the following:

There exist in E exactly two connected components $\mathcal{C}_+$ and $\mathcal{C}_-$ of nontrivial ω-triples, which are unbounded, contain $(1, v^*, 0)$ in their closure and are such that every $(\lambda, s, x) \in \mathcal{C}_+$ verifies $\lambda > 1$, $0 < s < v^*$ and $x > 0$, while every $(\lambda, s, x) \in \mathcal{C}_-$ verifies $\lambda < 1$, $s > v^*$ and $x < 0$.

The proof uses, among other tools, the Crandall-Rabinowitz local bifurcation theorem [3] and a concept of degree introduced in [2] for Fredholm maps of index zero between Banach spaces.

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Dynamical Systems

Quasi-Compactness of Transfer Operators on Besov Spaces

Alexander Arbieto
University of Rio de Janeiro, Rio de Janeiro, Brazil
(Joint work with **Daniel Smania**)

Abstract

In this talk, we introduce new Besov spaces using the method of atomic decomposition. We prove that the transfer operator associated to piecewise expanding maps are quasi-compact for potentials on such spaces. As a consequence, we deduce many statistical properties of a large class of such dynamical systems.

This work was supported by CAPES, CNPq, FAPERJ and FAPESP.

Weak conditions implying annular chaos

Fabio Armando Tal
Instituto de Matematica e Estatistica - USP, São Paulo, Brazil
(joint work with **A. Passeggi**))

Abstract

We study homeomorphisms of the open annulus from a topological perspective, introducing simple computable criteria related to mild twist conditions (pair of periodic points with different rotation numbers), which implies the existence of rotational horseshoes and so positive topological entropy. As consequences, we obtain applications in surface dynamics including a final answer to a classical conjecture, showing that the existence of an invariant circloid with nontrivial rotation set implies chaos. Moreover, the quantitative versions of the results can be used for numerical proofs of the existence of chaos, both in the conservative and dissipative setting.

This work was partially supported by Fapesp and CNPq.

Derivation and analysis of discrete population models with delayed growth

Sabrina Streipert
University of Pittsburgh, Pennsylvania, United States
(joint work with **Gail S. K. Wolkowicz**)

Abstract

Discrete delay population models are often considered as a compromise between single-species models and more advanced age-structured population models [4]. This talk is based on a recent work [7], where we provide a procedure for deriving discrete population models for the size of the adult population at the beginning of each breeding cycle and assume only adult individuals reproduce. This derivation technique includes delay to account for the number of breeding cycles a newborn individual remains immature and does not contribute to reproduction. These models include a survival probability (during the delay period) for the immature individuals, since these individuals have to survive to reach maturity and become members of what we consider the adult population. We discuss properties of this class of discrete delay population models and show that there is a critical delay threshold. The population goes extinct if the delay exceeds this threshold. We apply this derivation procedure to two well-known population models, the Beverton–Holt and the Ricker population model. We analyze their dynamics and compare it to existing delay models, focusing on [1, 2, 3, 5, 6].

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Mixing zone in miscible displacement in porous media

Sergey Tikhomirov
Pontifícia Universidade Catolica do Rio de Janeiro, Rio de Janeiro, Brazil
(joint work with **F. Bakharev, A. Enin, A. Groman, Ya. Efendiev, K. Kalinin, A. Kalyuzhnuk, S. Matveenko, D. Pavlov, Yu. Petrova, N. Rastegaev, I. Starkov**)

Abstract

We study the motion of viscous, miscible liquids in porous media. The back front of a polymer slug in the flooding of oil fields with surfactants and polymers is our prototype model.

Injection of a less viscous fluid to a more viscous one leads to the growth of an instability often reffered as viscous fingering. Such a physical mechanism has a negative impact on various flooding schemes in oil fields. The model describing this phenomenon is a system of multi-dimensional PDEs consisting of conservation of mass, incompressibility condition and Darcy's law. The main goal is finding rigorous estimates for the size of the mixing zone containing the instabilities. We are going to present some results of numerical simulations and rigorous estimates of the mixing zone, and compare them to other models frequently used in oil industry [2, 4].

As a practical application of the developed approach, we propose a scheme for a graded viscosity bank [1, 3]. The scheme allows to reduce amount of polymer used in the surfactant-polymer flooding. The main idea is replacing the postflushing polymer slug by a series of smaller slugs with gradually decreasing viscosity.

For further improvements of the estimates on the size of the mixing zone we consider a two-tubes model of the gravity-driven fingering. This model is the simplest model including the transverse liquid flow. For this model for the gravitational fingers we were able to find cascades of travelling waves and prove the relation between model with speed determined by Darcy law and transverse flow equilibrium simplification. Speed of travelling waves could be interpreted as speed of viscous fingers and back front propagation. The result in the simplified model suggests that existing estimates for original multi-dimensional problem could be improved.

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[2] *Bakharev F., Enin A., Groman A., Kalyuzhnyuk A., Matveenko S., Petrova Yu., Starkov I., Tikhomirov S.* Velocity of viscous fingers in miscible displacement: Comparison with analytical models. J. Comput. Appl. Math. 402 (2022), 113808.

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This work was supported by President grant of Russia 075-15-2019-204, Ministry of Science and Education of Russian Federation agreements 075–15–2019–1619, 075-15-2022-287, Russian Science Foundation grant 19-71-30002, Bolsa de Pós-Doutorado Sênior - PDS 2021 "Dynamics of approximations", Projeto Paz and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

Analogues of hypergeometric series

Tom Cuchta
Marshall University, Virginia, United States

Abstract

Recent research on matrix-parameter hypergeometric series will be presented, including some open questions and directions for future research. In particular, norm lower bound estimates, divergence criteria, and differential & difference equations will be discussed.

References

[1] Martin Bohner and Tom Cuchta. The Bessel difference equation. *Proc. Amer. Math. Soc.*, 145(4):1567–1580, 2017.

[2] Martin Bohner and Tom Cuchta. The generalized hypergeometric difference equation. *Demonstr. Math.*, 51(1):62–75, 2018.

[3] Tom Cuchta, David Grow, and Nick Wintz. Divergence criteria for matrix generalized hypergeometric series. *Proc. Amer. Math. Soc.*, 150(3):1235–1240, 2022.

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Geometry, Topology and Discrete Mathematics

A diameter gap for isometric quotients of the unit sphere

Claudio Gorodski
University of São Paulo, São Paulo, Brazil
(Joint work with **C. Lange, A. Lytchak and R. A. E. Mendes**)

Abstract

We will explain our proof of the existence of $\epsilon > 0$ such that every quotient of the unit sphere S^n ($n \geq 2$) by an isometric group action has diameter zero or at least ϵ. The novelty is the independence of ϵ from n. The classification of finite simple groups is used in the proof.

References

[1] C. Gorodski, C. Lange, A. Lytchak, R. A. E. Mendes, *A diameter gap for quotients of the unit sphere*, J. Eur. Math. Soc. (JEMS), **25** (2023), no. 9,3767–3793.

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Exploring Big Mapping Class Groups: A Panoramic Overview

Ferrán Valdez
Centro de Ciencias Matemáticas, UNAM
(joint work with **A. Passeggi**))

Abstract

Discover the world of big mapping class groups, a vibrant and emerging field in geometric topology. These are topological groups associated to surfaces of infinite topological complexity. Join us to delve into their fundamental properties, study tools, and intriguing conjectures.

This work was supported by CONACYT Ciencia Básica CB-2016 283960 and UNAM PAPIIT IN-101422

Bipartite biregular cages: block designs and generalized polygons

Gabriela Araujo-Pardo
Instituto de Matemáticas, Universidad Nacional Autónoma de México
(joint work with **Robert Jajcay, Alejandra Ramos, and Tamás Szőnyi**)

Abstract

A *bipartite biregular* $(m, n; g)$-graph Γ is a bipartite graph of even girth g having the degree set $\{m, n\}$ and satisfying the additional property that the vertices in the same partite set have the same degree. The $(m, n; g)$-*bipartite biregular cages*, was introduced in 2019 by Filipovski, Ramos-Rivera, and Jajcay, they are bipartite biregular $(m, n; g)$-graphs of minimum order. The authors calculate lower bounds on the orders of bipartite biregular $(m, n; g)$-graphs, and call the graphs that attain these bounds *bipartite biregular Moore cages*.

We improve the lower bounds obtained in the above paper. Furthermore, in parallel with the well-known classical results relating the existence of k-regular Moore graphs of even girths $g = 6, 8$ and 12 to the existence of projective planes, generalized quadrangles, and generalized hexagons, we prove that the existence of an $S(2, k, v)$-Steiner system yields the existence of a bipartite biregular $(k, \frac{v-1}{k-1}; 6)$-cage, and, vice versa, the existence of a bipartite biregular $(k, n; 6)$-cage whose order is equal to one of our lower bounds yields the existence of an $S(2, k, 1+n(k-1))$-Steiner system. Moreover, in the special case of Steiner triple systems, we completely solve the problem of determining the orders of $(3, n; 6)$-bipartite biregular cages for all integers $n \geq 4$.

Considering girths higher than 6, we relate the existence of generalized polygons (quadrangles, hexagons and octagons) to the existence of $(n + 1, n^2 + 1; 8)$-, $(n^2 + 1, n^3 + 1; 8)$-, $(n, n + 2; 8)$-, $(n + 1, n^3 + 1; 12)$- and $(n + 1, n^2 + 1; 16)$-bipartite biregular cages, respectively. Using this connection, we also derive improved upper bounds for the orders of other classes of bipartite biregular cages of girths 8, 12, and 14.

References

[1] G. Araujo-Pardo, A. Ramos-Rivera, R. Jajcay, T. Szőnyi, *On a relation between bipartite biregular cages, block designs, and generalized polygons,*, J. Combin. Des. **30**. No.7 (2022) 479-496. https://doi.org/10.1002/jcd.21836

This work was supported by PAPIIT-UNAM-México IN101821.

Geometrical and analytical results for Einstein solitons

José Nazareno Vieira Gomes
Federal University of São Carlos, São Carlos, Brazil

Abstract

In this work we give a lower bound for the scalar curvature of a gradient Einstein soliton under a certain assumption on its potential function. We establish an asymptotic behavior of the potential function on a noncompact gradient shrinking Einstein soliton. As a result, we obtain the finiteness of its fundamental group and its canonical weighted volume and we prove the validity of the weak maximum principle at infinity for a drifted Laplacian. We also prove some geometrical and analytical results for constructing gradient Einstein solitons that are realized as warped metrics, and we give a few explicit examples.

A class of surfaces related to a problem posed by Élie Cartan

Pedro Roitman
University of Brasilia, Brasilia, Brazil
(joint work with **Antonio Martinez**)

Abstract

We will introduce a class of surfaces in Euclidean space motivated by a problem posed by Élie Cartan. This class furnishes what seems to be the first non trivial examples of pairs of noncongruent surfaces in Euclidean space such that, under a diffeomorphism, lines of curvatures are preserved and principal curvatures are switched. We will show how to construct such surfaces using holomorphic data and also discuss how we have used the (Laguerre) space of spheres as a guiding tool to find such surfaces.

Constant Q-curvature metrics

Rayssa Caju
CMM- Universidad de Chile, Chile
(joint work with **J.H. Andrade, J. M do Ó, J. Ratzkin and A. Silva Santos.**)

Abstract

The connections between geometry and partial differential equations have been extensively studied in the last decades. In particular, some problems arising in conformal geometry, such as the classical Yamabe problem, can be reduced to the study of PDEs with critical exponent on manifolds. More recently, the so-called Q- curvature equation, a fourth-order elliptic PDE with critical exponent, is another class of conformal equations that has drawn considerable attention by its relation with a natural concept of curvature. In this talk, I would like to motivate these problems from a geometric and analytic perspective, and discuss some recent developments in the area, in particular regarding the singular Q-curvature problem. The particularity of the sphere is its degeneracy, which makes the linear analysis necessary to construct these metrics particularly challenging.

References

[1] Mazzeo, Rafe, Daniel Pollack, and Karen Uhlenbeck. *Moduli spaces of singular Yamabe metrics.* Journal of the American Mathematical Society 9.2 (1996): 303-344.

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[3] Mazzeo, Rafe, and Frank Pacard. *Constant mean curvature surfaces with Delaunay ends.* Communications in Analysis and Geometry 9.1 (2001): 169-237.

[4] Santos, Almir Silva. *A construction of constant scalar curvature manifolds with Delaunay-type ends.* Annales Henri Poincaré. Vol. 10. SP Birkhäuser Verlag Basel, 2010.

Two or Infinity

Umberto L. Hryniewicz
RWTH Aachen, Germany
(joint work with **Cristofaro-Gardiner, Hutchings and Liu**)

Abstract

In this talk I will report on work establishing a long-standing conjecture in Hamiltonian dynamics stated by Hofer, Wysocki and Zehnder in the late 1990s. Namely, we prove that the Reeb flow of every contact form on a closed 3-manifold admits two or infinitely many periodic orbits, provided that the first Chern class of the associated contact structure is torsion. Three corollaries solving old problems in dynamics are noteworthy: (1) every Finsler metric on a closed surface has two or infinitely many closed geodesics, (2) every star-shaped hypersurface in a linear symplectic 4-space has two or infinitely many closed characteristics, (3) a Reeb flow on the tight three-sphere with a hyperbolic periodic orbit has infinitely many periodic orbits, in particular, a Finsler metric on a closed surface with a hyperbolic closed geodesic has infinitely many closed geodesics. Finally, I will note that our result provides an independent proof of a big achievement in XXth century Dynamical Systems attributed to Bangert and Franks: every Riemannian metric on the two-sphere has infinitely many closed geodesics.

This work was supported by the DFG grant SFB/TRR 191 “Symplectic Structures in Geometry, Algebra and Dynamics”, Projektnummer 281071066-TRR 19.

Posters

Henstock Kurzweil Integral and Applications

Aryel Araújo[1]
University of Brasilia, Brazil

Abstract

In this work, we will investigate the development of some types of integral, such as Henstock-Kurzweil:

A function $f : I \to \mathbb{R}^n$ is said to be *Henstock-Kurzweil-Integrable* on I if there exists a vector $B \in \mathbb{R}^n$ such that for every $\epsilon > 0$, there exists a gauge γ_ϵ on I such that if $\dot{P} := (I_i, t_i)_{i=1}^n$ is any tagged partition of I such that $l(I_i) < \gamma_\epsilon(t_i)$ for $i = 1, ..., n$, then

$$||S(f; \dot{P}) - B|| \leq \epsilon$$

The model proposed by Henstock started from the investigation of an integration process with the objective of reconstructing a derived function, and is responsible for covering a broader class of functions than those present in the Riemann and Lebesgue models, without the need to work with measure theory, as for Lebesgue Integrable functions. At the same time, but completely independent, Jaroslav Kurzweil introduced in 1957 an equivalent concept of integration to investigate continuous dependence results

This type of integration naturally pays more attention to the tags than the more traditional integration concept, so, the definition is constructed by allowing the $\gamma_\epsilon > 0$, used in the definition of the Riemann integral, be any positive function, this allows a wider class of functions to be integrable.

Using this type of integral it is possible to study many important problems in physics with highly oscillating behaviour such as Kapitza's pendulum.

References

[1] Bartle, R. G. A Modern Theory of Integration, *American Mathematical Society.*, 2001.

[1] Under the guidance of Professor Jaqueline Godoy Mesquita

Linearized Stability for Neutral Equations with State-Dependent Delays

Felipe Gonçalves Netto
University of Brasilia, Brazil

Abstract

In this poster, we will present a principle of linearized stability for semiflows generated by neutral functional differential equations with state-dependent delay in the abstract form:

$$x'(t) = g(\partial x_t, x_t).$$

References

[1] H. O. Walther , *Semiflows for neutral equations with state-dependent delays*, Infinite dimensional dynamical systems, Springer, New York, (2013), 211-267.

[2] H. O. Walther , *More on Linearized Stability for Neutral Equations with State-Dependent Delays*, Differential Equations and Dynamical Systems, 19 (2011), 315-333.

Equiaffine Structure on frontals

Igor Chagas Santos
University of São Paulo-ICMC, São Carlos, Brazil

Abstract

In this poster we generalize the idea of equiaffine structure to the case of frontals, in order to define the Blaschke vector field of a frontal. We also investigate the conditions that a frontal needs to satisfy in order to have a Blaschke vector field and provide some examples. Finally, as an application of this theory, we present a version of the fundamental theorem of affine differential geometry for frontals.

Polynomial identities for 3-dimensional Leibniz algebras RR_1 and RR_2

Janara Ramos Nascimento
Federal University of Bahia- Institute of Mathematics and Statistics, Salvador, Brazil
(joint work with **Manuela Souza**)

Abstract

In this work we study polynomial identities in two three-dimensional Leibniz algebras. For RR_1 we display (when there exist) multilinear polynomial identities of degree less than or equal to 3 and for RR_2 we display (when there exist) multilinear polynomial identities of degree less than or equal to 4 over a field $\mathbb{K}$.

References

[1] [V. DRENSKY. *Free algebras and PI-algebras. SpringerVerlarg*, Singapore, 2000.

[2] A. GIAMBRUNOandM.ZAICEV. *Polinomialidentities and asymptotic methods*. American Mathematical Society, USA, 2005.

[3] A. F. MELO JUNIOR. *Identidades polinomiais para as álgebras de leibniz de dimensão menor ou igual a 3*. Dissertação de mestrado, Universidade Federal da Bahia, Instituto de Matemática e Estat´ıstica, 2017.

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This work has been supported by the CAPES– Brasil (CAPES)– Finance Code 001

A proof of Bochner's Tube Theorem

Maxmilian Barros de Siqueira
University of Alagoas, Maceió, Brazil
(joint work with **R. Medrado**)

Abstract

Let ω be a connected open set of $\mathbb{R}^m$ and f be a holomorphic function defined in $\Omega = \omega + i\mathbb{R}^m$. We will prove that f can be approximated by entire functions. In order to do that we will present a version of Baouendi-Treves approximation formula, to be more precise we will express f as a limit of an explicit integral formula. As an application we will proof Bochner's Tube Theorem (we will prove that there exists an holomorphic extension of f defined on the convex hull of Ω). This work follows J. Hounie's paper, published in 2009.

Congratulations

The TYAN - Humboldt organization thanks all speakers and participants!!

Congratulations to everyone involved in the organization!!