BOOK OF ABSTRACTS

BARCELONA MATHEMATICAL DAYS
Triennial Internacional Research Conference of the SCM
4th edition, 2023

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Barcelona, novembre 2023

This booklet contains the abstracts of the talks of the Barcelona Mathematical Days as provided by the respective speakers, grouped according the organization of the conference in plenary talks, thematic sessions and poster session.

Societat Catalana de Matemàtiques

BMD BARCELONA 2023 MATHEMATICAL DAYS

BENVINGUDA

La Societat Catalana de Matemàtiques (SCM) dona la benvinguda als participants de la quarta edició del Barcelona Mathematical Days, el congrés internacional triennal de la SCM nascut el 2014, que es centra en temes de recerca actuals en diverses àrees de les matemàtiques.

Les conferències plenàries i les sessions temàtiques han estat seleccionades pel Comitè Científic d'aquesta edició. Agraïm especialment als organitzadors de les sessions temàtiques i a les universitats catalanes la seva col·laboració en el congrés.

Des de la SCM apreciem la qualitat i el nivell d'internacionalització de les matemàtiques a Catalunya, que pensem que queda reflectida en aquest congrés. Esperem oferir-vos un context adequat per a l'intercanvi matemàtic, tant en les xerrades com en les discussions informals.

Aquest llibretó conté els resums de les xerrades del Barcelona Mathematical Days 2023, aportats pels respectius ponents, agrupats segons l'organització de la jornada en ponències plenàries, sessions temàtiques i sessió de pòsters.

WELCOME

The Catalan Mathematical Society (SCM) welcomes the participants to the fourth edition of the Barcelona Mathematical Days, the triennial international research conference of the SCM, which focuses on current research topics across several areas of Mathematics.

Plenary talks and thematic sessions have been selected by the Scientific Committee for this edition. Special thanks are due to the organizers of the thematic sessions and to the Catalan universities for their collaboration in this conference.

From the SCM we appreciate the quality and level of internationalization of mathematics in Catalonia, which we expect is reflected in this conference. We hope to provide you with a suitable context for mathematical exchange, both in lectures and in informal discussions.

This booklet contains the abstracts of the talks of the Barcelona Mathematical Days 2023, as provided by the respective speakers, grouped according the organization of the conference in plenary talks, thematic sessions and poster session.

SCHEDULE

Thursday

8:30	Registration	
9:15 – 9:30	Opening	
9:30 – 10:30	Plenary Lecture: Claire Voisin	(Prat de la Riba)
10:30 – 11:00	Coffee break	
11:00 – 13:30	Thematic Sessions:	
	Operator Algebras	(Nicolau d'Olwer)
	Analysis and PDEs	(Pi i Sunyer)
	Dynamical Systems	(Pere i Joan Coromines)
13:30 – 15:00	Lunch	
15:00 – 16:00	Plenary Lecture: Stuart White	(Prat de la Riba)
16:00 – 16:30	Coffee break and Poster Session	
16:30 – 19:00	Thematic Sessions:	
	Logic	(Nicolau d'Olwer)
	Discrete Mathematics	(Pi i Sunyer)
	New trends in Algebraic Geometry	(Pere i Joan Coromines)
20:00	Conference dinner	

Friday

9:00 – 10:00	Plenary Lecture: Corinna Ulcigrai	(Prat de la Riba)
10:00 – 10:30	Coffee break and Poster Session	
10:30 – 13:00	Thematic Sessions:	
	Operator Algebras	(Nicolau d'Olwer)
	Analysis and PDEs	(Pi i Sunyer)
	Dynamical Systems	(Pere i Joan Coromines)
13:00 – 14:30	Lunch	
14:30 – 15:30	Plenary Lecture: David Nualart	(Prat de la Riba)
15:30 – 16:00	Coffee break	
16:00 – 18:30	Thematic Sessions:	
	Logic	(Nicolau d'Olwer)
	Discrete Mathematics	(Pi i Sunyer)
	New trends in Algebraic Geometry	(Pere i Joan Coromines)

Societat Catalana de Matemàtiques

BMD BARCELONA 2023 MATHEMATICAL DAYS

PLENARY LECTURES (Prat de la Riba)

Thursday

9:30 – 10:30 **Claire Voisin**: *On a problem of Whitney type in algebraic geometry*

15:00 – 16:00 **Stuart White**: *Simple amenable C^*-algebras*

Friday

9:00 – 10:00 **Corinna Ulcigrai:** *Chaotic properties and deviations phenomena of locally Hamiltonian flows*

14:30 – 15:30 **David Nualart:** *Malliavin Calculus and Normal Approximations*

On a problem of Whitney type in algebraic geometry

Claire Voisin (CNRS, Paris Sorbonne)

Whitney embedding theorem in differential geometry says that a small perturbation f' of a map f between two manifolds of dimensions m and n (hence f' is isotopic, and a fortiori homotopic to f) is an embedding if $n > 2m$ (the Whitney range). I will discuss a related question in complex algebraic geometry: can we write the cohomology class of an algebraic subvariety of a smooth projective variety as a combination with integral coefficients of classes of smooth subvarieties? The question is still open in the Whitney range.

Simple amenable C^*-algebras

Stuart White (University of Oxford)

C^*-algebras are norm closed self-adjoint algebras of bounded operators on Hilbert space, and so arise naturally from unitary representations of groups and group actions, amongst other constructions. Large scale work of many researchers over decades has recently culminated in a definitive classification theorem for simple amenable C^*-algebras of finite topological dimension. In this talk, I'll describe this theorem: which C^*-algebras are classified, and by what data, and how this connects to corresponding theorems in von Neumann algebras. The talk will be illustrated by examples coming from group actions. No prior knowledge of operator algebras will be assumed.

Chaotic properties and deviations phenomena of locally Hamiltonian flows

Corinna Ulcigrai (Universität Zurich)

This talk will focus on locally Hamiltonian flows on surfaces, namely smooth two-dimensional flows which are local solution of Hamiltonian differential equations. We will present a survey of results concerning the chaotic properties, in particular mixing properties, of this class of flows. We will then discuss the deviations phenomena exhibited by ergodic integrals of smooth functions. Recent results on this phenomenon and applications to ergodicity of extensions are based on joint works with K. Fraczek and with P. Berk and F. Trujillo.

Malliavin Calculus and Normal Approximations

David Nualart (University of Kansas)

The purpose of this talk is to make an heuristic introduction to the stochastic calculus of variations, that was introduced by Paul Malliavin in the 70's in order to provide a probabilistic proof of Hörmander's hypoellipticity theorem. We will discuss the application Malliavin calculus, combined with Stein's method for normal approximations, to establish upper bounds for total variation distances in the context of central limit theorems. This methodology will be illustrated by two examples: central limit theorems for stationary sequences and asymptotic behavior of spatial averages of the stochastic heat equation.

Societat Catalana de Matemàtiques

BMD BARCELONA 2023 MATHEMATICAL DAYS

THEMATIC SESSION 1: **Operator algebras** (Nicolau d'Olwer)

Organizers: Francesc Perera, Ramon Antoine

Thursday

11:00 – 11:45 **Shirly Geffen:** *Simplicity of reduced crossed products*

11:00 – 12:35 **Julian Kranz:** *Tracially amenable actions*

12:40 – 13:25 **Andrea Vaccaro:** *Dynamical comparison and Z-stability for crossed products of simple C*-algebras*

Friday

10:30 – 11:15 **Joachim Zacharias:** *Almost elementary dynamical systems and the classification of simple nuclear C*-algebras*

11:20 – 12:05 **Joan Bosa:** *Almost Elementary Dynamical Systems*

12:10 – 12:55 **Kang Li:** *The diagonal dimension for C*-pairs*

Abstracts

Simplicity of reduced crossed products.
Shirly Geffen (University of Münster)

Results from a few years ago of Kennedy and Schafhauser attempt to characterize simplicity of reduced crossed products, under an assumption which they call vanishing obstruction. However, this is a strong condition that often fails, even in cases of finite groups acting on finite dimensional C*-algebras. In this work, we give complete C*-dynamical characterization, of when the crossed product is simple, in the setting of FC-hypercentral groups. This is a large class of amenable groups that, in the finitely-generated setting, is known to coincide with the set of groups with polynomial growth.
This is joint work with Dan Ursu.

Tracially amenable actions

Julian Kranz (University of Oxford)

Tracially amenable actions of groups on C*-algebras are a generalization of amenable actions of groups on C*-algebras where the approximations are required to hold in uniform tracial 2-norm rather than the C*-norm. The advantage of tracial amenability over amenability is that, while it is easier to produce interesting examples of such actions, we still have powerful structural results about the associated crossed products. In particular, crossed products of tracially amenable actions by non-amenable groups turn out to be purely infinite in many cases. I will discuss the general theory of tracially amenable actions, structural results about their crossed products, as well as a link between tracial amenability and equivariant property (SI). This is joint work with E. Gardella, S. Geffen, P. Naryshkin, and A. Vaccaro.

Dynamical comparison and $\mathcal{Z}$-stability for crossed products of simple C*-*algebras.*

Andrea Vaccaro (Universität Münster)

A question that has recently attracted considerable attention among researchers in C*-algebras is whether the crossed product of a stably finite classifiable C*–algebra by an amenable discrete group is $\mathcal{Z}$-stable, the latter being a key property in the framework of classifiable C*–algebras. While conjecturally the answer could always be affirmative, all known arguments rely on certain topological assumptions on the tracial simplex of the algebras considered. We use an adaptation of dynamical comparison from topological dynamics to expand the current knowledge on the topic, verifying in particular the conjecture for certain actions of the integers on C*–algebras whose trace space is a Bauer simplex and whose boundary is not necessarily finite dimensional. We will introduce the notion of diagonal dimension for diagonal pairs of C*–algebras in the sense of Kumjian, and will compare it with the usual nuclear dimension for C*–algebras. For instance, the Jiang-Su algebra $\mathcal{Z}$ admits a diagonal MASA $\mathcal{D}$ such that the diagonal dimension of $(\mathcal{Z}, \mathcal{D})$ is equal to n for any given natural number n even though the nuclear dimension of $\mathcal{Z}$ is equal to 1. We also show that the diagonal dimension of a uniform Roe algebra with respect to the standard diagonal is equal to the asymptotic dimension of its underlying metric space. Finally, we will discuss its relation to the dynamic asymptotic dimension of groupoids introduced by Guentner, Willett and Yu and the tower dimension of topological dynamical systems introduced by Kerr. This is joint work with Hung-Chang Liao and Wilhelm Winter.

Almost elementary dynamical systems and the classification of simple nuclear C-algebras*

Joachim Zacharias (University of Glasgow)

The classification of simple nuclear C*-algebras by K-theory and traces has seen vast progress in the past decades, developing from investigating mostly examples to a systematic, almost complete classification result. It turned out that not all simple nuclear C*-algebras can be classified, but a very large class of algebras can and is characterised by different equivalent regularity properties. Dynamical systems provide a rich source of examples of simple nuclear C*-algebras via the crossed product construction. Necessary and sufficient criteria for when crossed product algebras are classifiable are still lacking. We will review the crossed product construction and introduce almost elementariness, a regularity property for C*-algebras and dynamical systems. For C*-algebras this notion gives a new equivalent characterisation of classifiability, and for dynamical systems the condition appears close to being equivalent to classifiability of its crossed product algebra. It requires simultaneous approximations for the action and the algebra to exist, up to a small remainder.
This is joint work with my coauthors Joan Bosa, Francesc Perera and Jianchao Wu.

Almost Elementary Dynamical Systems

Joan Bosa (Universidad de Zaragoza)

Motivated by recent work on dynamical analogues of the Toms-Winter conjecture, we propose an extension of Kerr's notion of almost finiteness for actions of discrete groups on compact metric spaces to actions on general C*-algebras by generalising the concept of castle. We call such actions almost elementary and study these dynamical systems in different frameworks. For instance, we show that they lead to $\mathcal{Z}$-stable crossed products, if these are simple, and that for actions of the trivial group our condition is a weak form of being tracially AF or having tracial nuclear dimension 0.

The diagonal dimension for C^*-pairs

Kang Li (Friedrich-Alexander-Universität Erlangen-Nürnberg)

We will introduce the notion of diagonal dimension for diagonal pairs of C*-algebras in the sense of Kumjian, and will compare it with the usual nuclear dimension for C*-algebras. For instance, the Jiang-Su algebra Z admits a diagonal MASA D such that the diagonal dimension of (Z,D) is equal to n for any given natural number n even though the nuclear dimension of Z is equal to 1. We also show that the diagonal dimension of a uniform Roe algebra with respect to the standard diagonal is equal to the asymptotic dimension of its underlying metric space. Finally, we will discuss its relation to the dynamic asymptotic dimension of groupoids introduced by Guentner, Willett and Yu and the tower dimension of topological dynamical systems introduced by Kerr. This is joint work with Hung-Chang Liao and Wilhelm Winter.

THEMATIC SESSION 2: **Logic** (Nicolau d'Olwer)

Organizers: Joan Bagaria, Joan Gispert

Thursday	(Algebraic Logic)
16:30 – 17.15	**Tomaso Moraschini:** *Profinite Heyting algebras and the representation problem for Esakia spaces*
17:20 – 18:05	**Sara Ugolini:** *Structural and universal completeness in algebra and logic*
18:10 – 18.55	**Luca Carai:** *Free algebras and coproducts in varieties of Gödel algebras*
Friday	(Set Theory)
16:00 – 16:45	**Juan Carlos Martínez:** *Cardinal sequences in topology*
16:50 – 17:35	**Jeffrey Bergfalk:** *Set theory and condensed mathematics*
17.40 – 18.25	**Alejandro Poveda:** *When 'Almost Always' Implies 'Always': Recent Insights into Compactness Phenomena in Set Theory*

Abstracts

Profinite Heyting algebras and the representation problem for Esakia spaces

Tomaso Moraschini (Universitat de Barcelona)

A poset is said to be "representable" when it is isomorphic to the prime spectrum of a bounded distributive lattice or, equivalently, of a commutative ring with unit. The problem of characterizing the representable posets was raised by Gratzer and Kaplansky in lattice theory and general algebra, respectively.
While it is an immediate consequence of Priestley duality that a a poset is representable precisely when it can be endowed with a topology that turns it into a Priestlety space, the problem of obtaining a more concrete description of the representable posets seems to elude easy solutions. In this talk, we will consider the related problem of describing the posets isomorphic to the prime spectra of Heyting algebras. We call these posets "Esakia representable" because they coincide with the posets that can be endowed with a topology that turns them into Esakia spaces. On the one hand, we characterize the Esakia representable well-ordered trees. On the other hand, we employ the theory of profinite Heyting algebras to obtain a description of the top part of Esakia representable posets. When phrased in purely algebraic terms, our main result takes the form of a description of the varieties of Heyting algebras whose profinite members are profinite completions.
This talk is based on joint work with G. Bezhanishvili, N. Bezhanishvili, and M. Stronkowski.

Structural and universal completeness in algebra and logic

Sara Ugolini (Artificial Intelligence Research Institute - CSIC)

This talk is about the interplay of the notions of derivability and admissibility for the rules of a logic, the latter seen as a substitution-invariant consequence relation among formulas written over some algebraic language. In particular, a rule is admissible in a logic L if every substitution making the premises a theorem of L, also makes the conclusions a theorem of L. For a logic L, being structurally complete then means that all the admissible rules of L are derivable in L, or equivalently, each of its proper extensions admits new theorems. If the logic L is algebraizable with equivalent algebraic semantics a quasivariety Q, the structural completeness of L can be studied algebraically; Q (and so L) is structurally complete if every admissible quasiequation is valid in Q (where a quasiequation is admissible if every substitution making the premises valid in Q, also makes the conclusions valid in Q). Universal completeness moves this same notion to multiple-conclusion rules, or clauses instead of quasiequations. Now, for instance, Classical Logic and Boolean algebras are structurally complete but not universally complete, while Intuitionistic Logic and Heyting algebras are not even structurally complete. The latter are, however, passively structurally complete: all the quasiequations that are passive (i.e., such that there is no substitution making their premises valid) are valid. We will present some bridge theorems between the logical and algebraic notions of structural and universal completeness and their relevant weakenings; in particular, we give new algebraic characterizations of quasivarieties that are passively structurally complete, and actively universally complete. Finally, we show some consequences for varieties of bounded lattices, and for the equivalent algebraic semantics of substructural logics; e.g. we will see that within the large container of substructural logics with weakening, a logic is passively structurally complete if and only if every classical contradiction is explosive in it.
This is joint work with Paolo Aglianò, from the University of Siena (Italy).

Free algebras and coproducts in varieties of Gödel algebras

Luca Carai (University of Milan)

The Gödel-Dummett logic is a point of contact of intuitionistic and fuzzy logic. Indeed, it is obtained by adding the prelinearity axiom $(p \to q) \vee (q \to p)$ to the intuitionistic calculus, but it is also the fuzzy logic with truth values in the real unit interval induced by the minimum t-norm. The algebraic semantics for the propositional Gödel-Dummett logic is provided by Gödel algebras, which are the Heyting algebras validating the prelinearity axiom.
In this talk, we see how to dually describe free Gödel algebras. More precisely, we employ Priestley and Esakia dualities to describe the Esakia dual of the Gödel algebra free over a distributive lattice L in terms of the Priestley dual of L. As a consequence, we obtain a dual description of free Gödel algebras, which allow us to show that any free Gödel algebra is a bi-Heyting algebra. Using similar techniques, we also describe the Esakia duals of coproducts in the variety of Gödel algebras. These results generalize some well-known descriptions of finitely generated free Gödel algebras and coproducts of finite Gödel algebras due to Aguzzoli, D'Antona, Gerla, Grigolia, and Marra. In the last part of the talk, we adapt these dual descriptions to all subvarieties of the varieties of Gödel algebras and of symmetric Gödel algebras.

Cardinal sequences in topology

Juan Carlos Martínez (Universitat de Barcelona)

If X is a topological space and α is an ordinal, we define the α^{th} - Cantor-Bendixson derivative of X by transfinite induction on α as follows:
(a) $X^0 = X$
(b) if $\alpha = \beta$, $X^\alpha =$ set of accumulation points of X^β,
(c) if α is a limit ordinal, $X^\alpha = \{X^\beta : \beta < \alpha\}$.
The Cantor-Bendixson derivatives of a topological space X form a decreasing se- quence, i.e. we have $X^\alpha \supset X^\beta$ if $\alpha < \beta$.
Then, for every ordinal α we define he α^{th} -level of X as $I_\alpha(X) = X^\alpha \setminus X^{\alpha+1}$. So, $I_\alpha(X) =$ the set of isolated points of the subspace $X = X \setminus \{I_\beta(X) : \beta < \alpha\}$.
We say that a topological space X is scattered, if there is an ordinal α such that $X^\alpha = \emptyset$. If X is a scattered space, we define the cardinal sequence of X as the sequence formed by the cardinalities of the infinite Cantor-Bendixson levels of X, i.e.

$$\text{CS}(X) = \langle |I_\alpha(X)| : \alpha < \delta \rangle$$

where δ is the least ordinal γ such that $I_\gamma(X)$ is finite.
Many authors have studied the possible sequences of infinite cardinals that can arise as the cardinal sequence of some scattered space. In this talk we will show some of the most relevant results on this topic

Set theory and condensed mathematics

Jeffrey Bergfalk (Universitat de Barcelona)

Around 2019, Dustin Clausen and Peter Scholze introduced a far-reaching framework for "doing algebra with objects carrying a topology" which they term condensed mathematics. We will briefly review this framework's connections to the field of set theory, both by way of the forcing technique, as well as by way of the infinitary combinatorics which condensed and derived categories not infrequently involve.

When 'Almost Always' Implies 'Always': Recent Insights into Compactness Phenomena in Set Theory

Alejandro Poveda (Harvard University)

In this presentation, we shall be preoccupied with compactness phenomena in set theory. Compactness is the phenomenon by which the local properties of a mathematical structure determine its global behavior. This phenomenon is intrinsic to the very architecture of the mathematical universe and manifests to us in a cornucopia of forms. Over the past fifty years, the study of compactness phenomena has been a cornerstone of research in set theory. This talk will present recent discoveries regarding compactness principles, spanning classical themes like the tree property and stationary reflection, while also forging novel connections with other topics, such as Woodin's HOD Conjecture.

Societat Catalana de Matemàtiques

BMD BARCELONA 2023 MATHEMATICAL DAYS

THEMATIC SESSION 3: **Analysis and PDEs** (Pi i Sunyer)

Organizers: Albert Clop, Daniel Faraco

Thursday

11:00 – 11: 45 **Laura Prat Baiget:** *Removable singularities for solutions of the Heat equation and the fractional Heat equation in time varying domains*

11:50 – 12:35 **Matteo Levi:** *Hardy–Littlewood maximal operators on trees with bounded geometry*

12:40 – 13: 25 **Jan Kristensen:** *Lower semicontinuity via Stoilow factorization*

Friday

10:30 – 11:15 **María Ángeles García-Ferrero:** *The Calderón problem: on reconstruction in different settings*

11:20 – 12:05 **Fran Mengual:** *Sharp nonuniqueness of admissible solutions for the 2D Euler equatio*

12:10 – 12:55 **Tomás Sanz Perela** *A shape optimization problem in relativistic quantum mechanics*

Abstracts

Removable singularities for solutions of the Heat equation and the fractional Heat equation in time varying domains

Laura Prat Baiget (Universitat Autònoma de Barcelona)

The talk will be about removable singularities for solutions of the Heat Equation and the Fractional Heat Equation in time varying domains. In order to talk about removability, some associated capacities will be introduced to study its metric and geometric properties. I will discuss on some results obtained in joint work with X. Tolsa and J. Mateu and also mention some recent achievements of J. Hernández.

Hardy–Littlewood maximal operators on trees with bounded geometry

Matteo Levi (Universitat de Barcelona / Universitat Autònoma de Barcelona)

The centred Hardy–Littlewood maximal operator $\mathcal{M}$ on homogeneous trees is of weak type $(1,1)$ and hence bounded on L^p for every $p > 1$ [CMS, NT]. In this talk we enlarge the view to $\Upsilon_{a,b}$, the family of trees on which the valence of each vertex can oscillate between the values a and b. We will discuss the following unexpected dichotomy concerning trees $\mathfrak{T} \in \Upsilon_{a,b}$: if $b > a^2$ the range of $p \in (1,\infty)$ for which $\mathcal{M}$ is bounded on $L^p(\mathfrak{T})$ cannot depend solely on a and b, but also depends on the locations of the vertices with different valence within $\mathfrak{T}$, while for $a < b \leq a^2$, $\mathcal{M}$ is bounded on $L^p(\mathfrak{T})$ for every $p > \log_a b$, independently of the locations of the vertices. In the latter case, the range of p can be proved to be sharp, meaning that for $p \leq \log_a b$ one can always locate the vertices of $\mathfrak{T}$ in such a way that $\mathcal{M}$ is unbounded $L^p(\mathfrak{T})$. On the other hand, if the vertices of $\mathfrak{T} \in \Upsilon_{a,b}$ with different valence are well distributed one can recover the weak $(1,1)$ boundedness of $\mathcal{M}$ on $\mathfrak{T}$, as in the homogeneous case. Time permitting, a few words will be devoted to the same problem for the uncentred maximal operator.
The talk is based on a joint work with S. Meda, F. Santagati e M. Vallarino.

References:

[CMS] M. Cowling, S. Meda, A. G. Setti, A weak type $(1,1)$ estimate for a maximal operator on a group of isometries of homogeneous trees, *Coll. Math.* **118** (2010), 223–232.

[NT] A. Naor and T. Tao, Random martingales and localization of maximal inequalities, *J. Funct. Anal.* **259** (2010), 731–779.

Lower semicontinuity via Stoilow factorization

Jan Kristensen (University of Oxford)

The variational integrals appearing in problems from Elasticity Theory and Geomet- ric Function Theory often have a growth behaviour that makes it very difficult to establish lower semicontinuity results, and hence prove existence of minimizers, under the natural condition of quasiconvexity as introduced by Morrey in 1952. Instead other conditions have been used, notably polyconvexity, and while this condition allows for the treatment of some realistic models it is known that it is far from be- ing a necessary condition for lower semicontinuity. In this talk we define a slight strengthening of the quasiconvexity condition for functionals defined on two-by-two matrices that we show in important special cases is equivalent to quasiconvexity (in fact even to rank-one convexity). With this condition it is possible to use results from the theory of planar quasiconformal maps to prove lower semicontinuity of the corresponding variational integrals.
This is joint work with Kari Astala (Helsinki), Daniel Faraco (Autonoma Madrid), André Guerra (ETH) and Aleksis Koski (Aalto)

The Calderón problem: on reconstruction in different settings

María Ángeles García-Ferrero (Universitat de Barcelona)

The classical Calderón problem is the inverse problem of determining the conductivity of the interior of a medium from voltage and current measurements on its surface. Closely related, we may consider the inverse problem of determining the potential of a Schrödinger equation from boundary measurements. Nonlocal versions of this problem can be also considered.
In this talk, we will focus on the information needed for the reconstruction. Namely, we will see that unique continuation properties associated to nonlocal operators reduce this information basically to one single, suitably localized, measurement. We will compare this with the local case and we will share some insights regarding the problem for low regular conductivities.

Sharp nonuniqueness of admissible solutions for the 2D Euler equation

Fran Mengual (Max Planck Institute)

A weak solution to the Euler equation is called admissible if it does not increase the energy. These weak solutions coincide with a strong solution as long as the latter exists. In this talk we address the question of what is the threshold regularity at t = 0 for which uniqueness of admissible solutions fails in 2D. We will show, by means of the convex integration method, sharpness of the weak-strong uniqueness principle, as well as sharpness of the Yudovich proof of uniqueness in the class of bounded admissible solutions.

A shape optimization problem in relativistic quantum mechanics

Tomás Sanz-Perela (Universitat de Barcelona)

Dirac operators defined on domains of the Euclidean space are used in relativistic quantum mechanics to describe particles that are confined in a region. A remarkable example is the MIT bag operator, used to model confinement of quarks in hadrons, and a fundamental topic in mathematical physics concerns the analysis of the spectral gap and its associated shape optimization problem. This consists on minimizing the first squared eigenvalue among all domains with prescribed volume, and it is conjectured that the ball is the optimal domain.
In this talk I will describe a recent work —in collaboration with N. Arrizabalaga, A. Mas, and L. Vega — in which we propose an approach towards this open problem. We have studied a family of Dirac operators defined on a domain of the three-dimensional euclidean space and with boundary conditions that depend on a real parameter. This family contains the MIT bag operator (when the parameter is zero), while some well-known operators arise in the limits as the parameter goes to plus or minus infinity. We parametrize the spectrum of the family of operators through a collection of increasing smooth curves, and we study the limit operators.
Thanks to this analysis, we manage to establish (for large values of the parameter) the optimality of the ball for the associated shape optimization problem. This is expected to hold for all the parametrization and thus solve the open problem for the MIT bag operator.

Societat Catalana de Matemàtiques

BMD BARCELONA 2023 MATHEMATICAL DAYS

THEMATIC SESSION 4: **New trends in algebraic geometry**

(Pere i Joan Coromines)

Organizers: Josep Àlvarez Montaner, Simone Marchesi

Thursday

16:30 – 17.15 **Ana-Maria Castravet:** *Higher Fano manifolds*

17:20 – 18:05 **Zsolt Patakfalvi:** *Varieties with nef anti-canonical have surjective Albanese*

18:10 – 18.55 **Eva Elduque:** *Hodge theory of abelian covers of algebraic varieties*

Friday

16:00 – 16:45 **Víctor González Alonso:** *Embedded deformations of curves with maximal variation of Hodge structure*

16:50 – 17:35 **Rita Pardini:** *$\mathbb{Z}_2^k$-covers and explicit compactification of surfaces of general type with $p_g = 0$*

17.40 – 18.25 **Joan Carles Naranjo:** *Cyclic coverings of curves of genus 2*

Abstracts

Higher Fano manifolds

Ana-Maria Castravet (Université Paris-Saclay)

Fano manifolds are complex projective manifolds having positive first Chern class. The positivity condition on the first Chern class has far reaching geometric and arithmetic implications. For instance, Fano manifolds are covered by rational curves, and families of Fano manifolds over one dimensional bases always admit holomorphic sections. In recent years, there has been some effort towards defining suitable higher analogues of the Fano condition. Higher Fano manifolds are expected to enjoy stronger versions of several of the nice properties of Fano manifolds.
In this talk, I will discuss higher Fano manifolds which are defined in terms of positivity of higher Chern characters. After a brief survey of what is currently known, I will present recent joint work with Carolina Araujo, Roya Beheshti, Kelly Jabbusch, Svetlana Makarova, Enrica Mazzon and Nivedita Viswanathan, regarding toric higher Fano manifolds. I will explain a strategy towards proving that projective spaces are the only higher Fano manifolds among smooth projective toric varieties.

Varieties with nef anti-canonical has surjective Albanese

Zsolt Patakfalvi (Ecole Polytechnique Fédérale de Lausanne)

I will present a joint work with Sho Ejiri showing that smooth projective varieties with nef anti-canonical divisor have surjective Albanese morphism. The statement was conjectured in the Kähler setting by Demailly-Peternell-Schneider in 1993, and it was shown in characteristic zero by Zhang in 1996. Our contribution is that it also holds in positive characteristic, and hence over any field. This is the first arbitrary dimensional positive characteristic result on varieties with nef anti-canonical divisor that is not sensitive to wild behavior: wild action of Frobenius on cohomology, wild singularities of the general fibers over the Albanese image, etc. I will also mention a few corollaries and generalizations.

Hodge theory of abelian covers of algebraic varieties

Eva Elduque (Universidad Autónoma de Madrid)

Let $f : U \to G$ be an algebraic map from a smooth complex connected algebraic variety U to a complex semiabelian variety G. Using f to pull back the exponential map of Lie groups, one obtains a cover of U with free abelian deck transformation group which is a complex analytic manifold, although not algebraic in general. The homology groups of these covers generalize the classical Alexander invariants, which arise when U is an affine hypersurface complement and G is an algebraic torus. In this talk, we will talk about work in progress aimed at endowing the homology groups of these covers with canonical mixed Hodge structures.
This is joint work with Moisés Herradón Cueto.

Embedded deformations of curves with maximal variation of Hodge structure

Víctor González Alonso (Leibniz Universität Hannover)

Given a family of complex (smooth projective) manifolds, the dimension of the corresponding subset of the local moduli space gives a first measure of how far it is from being trivial. This can be then refined taking into account how much the Hodge structures of the fibres change, which leads to the notion of maximal (infinitesimal) variation of Hodge structure (IVHS).
In the case of families of curves, results of Lee-Pirola and of myself with Torelli imply in particular that a general deformation of any curve has maximal IVHS. However this is not so clear if one wants the deformation to keep some further structure, such as the gonality of the curve or an embedding into a given surface. For example, it was only recently proved by Favale and Pirola that every smooth plane curve admits a deformation as a plane curve with maximal IVHS, and the question remains open for deformations of curves inside any other surface.
In this talk I will present a joint work in progress with Sara Torelli extending this result to curves in $\mathbb{P}^1 \times \mathbb{P}^1$, which turns out to be surprisingly more involved than the plane case.

$\mathbb{Z}_2^k$-covers and explicit compactification of two components of the moduli space of surfaces of general type with $p_g = 0$

Rita Pardini (Università di Pisa)

We consider two classes of surfaces of general type with $p_g = 0$:

- Campedelli surfaces with fundamental group $\mathbb{Z}_2^3$,
- Burniat surfaces with $K^2 = 6$.

Both are realized as $\mathbb{Z}_2^k$-covers of (a blow-up of) the plane and give rise to connected components of the moduli space of surfaces of general type. We give a complete description of the closure of these components in the KSBA moduli space of stable surfaces. All limit surfaces are obtained as (mostly non-normal) $\mathbb{Z}_2^k$-covers.
This is joint work with Valery Alexeev.

Cyclic coverings of curves of genus 2

Joan Carles Naranjo (Universitat de Barcelona)

We consider unramified cyclic coverings of odd degree d of curves of genus 2. By a result of Lange and Ortega, it is known that the corresponding Prym map P_d has degree 10 for $d = 7$, and Albano and Pirola proved that the generic fibers of P_3 and P_5 are positive dimensional. Moreover, Agostini proved that P_d is generically finite for $d \geq 7$. In this talk I will report on a proof of the generic injectivity for P_d for d prime. Our method is based on the study of the isogeny type of the Prym variety and the computation of the theta dual variety of some distinguished curves.
This is a joint work with A. Ortega and I. Spelta.

Societat Catalana de Matemàtiques

BMD BARCELONA MATHEMATICAL DAYS 2023

THEMATIC SESSION 5: **Dynamical systems** (Pere i Joan Coromines)

Organizers: Inma Baldomà, Anna Florio

Thursday

11:00 – 11:45 **Mercè Ollé:** *The CP problem: what, how and why*

11:50 – 12:35 **Frank Trujillo:** *Inverse problems in analytic KAM theory*

12:40 – 13:25 **Jessica Elisa Massetti:** *Attractive invariant circles through elliptic methods*

Friday

10:30 – 11:15 **Donato Scarcella:** *Asymptotic motions for time-dependent perturbations of Hamiltonian systems having an invariant torus*

11:20 – 12:05 **Chiara Caracciolo:** *Computation of lower-dimensional elliptic tori via invariant torus*

12:10 – 12:55 **Andrea Venturelli:** *On a question of Newtonian mechanics*

Abstracts

The CP problem: what, how and why

Mercè Ollé (Universitat Politècnica de Catalunya)

We consider the problem of the hydrogen atom interacting with a circularly polarized microwave field (also called CP problem). In the context of classical mechanics, we will describe several interesting phenomena concerning the motion of the electron. Usual techniques of Dynamical Systems Theory are applied and the methodology and results discussed.
This is a joint work with E. Barrabés, F. Borondo, A. Delshams, D. Farrelly, J. M. Mondelo, J. R. Pacha and O. Rodríguez

Inverse problems in analytic KAM theory

Frank Trujillo (University of Zurich)

According to classical KAM theory, a sufficiently small perturbation of a non-degenerate integrable Hamiltonian system admits a collection of invariant tori, whose restricted dynamics is conjugated to that of a translation by a Diophantine vector.
In this talk we will discuss the following inverse problem: To what extent are perturbed systems determined by their associated collections of invariant tori?
We'll prove that this collection completely characterizes the perturbed Hamiltonian and show some of the dynamical implications for systems whose collections of invariant tori share certain common features.

Attractive invariant circles through elliptic methods

Jessica Elisa Massetti (Università Roma Tre)

Studying general perturbations of a dissipative twist map depending on two parameters, a frequency ν and a dissipation η, the existence of a Cantor set $\mathcal{C}$ of curves in the (ν, η) plane such that the corresponding equation possesses a Diophantine quasi-periodic invariant circle can be deduced, up to small values of the dissipation, as direct consequence of a normal form Theorem in the spirit of Rüssmann and the "elimination of parameters" technique. These circles are normally hyperbolic as soon as $\eta \neq 0$, which implies that the equation still possesses a circle of this kind for values of the parameters belonging to a neighborhood $\mathcal{V}$ of this set of curves. Obviously, the dynamics on such invariant circles is no more controlled and may be generic, but the normal dynamics is controlled in the sense of their basins of attraction.
As it is expected, by classical graph-transform method we are able to determine a first rough region where the normal hyperbolicity prevails and a circle persists, for a strong enough dissipation $\eta \sim O(\sqrt{\epsilon})$, ϵ being the size of the perturbation. Then, through normal-form techniques, we shall enlarge such regions and determine such a (conic) neighborhood $\mathcal{V}$, up to values of dissipation of the same order as the perturbation, by using the fact that the proximity of the set $\mathcal{C}$ allows, thanks to Rüssmann's translated curve Theorem, to introduce local coordinates of the type (dissipation, translation) similar to the ones introduced by Chenciner in [Che].

References:

[Che] A. Chenciner. Bifurcations de points fixes elliptiques. I. Courbes invariantes. *Inst. Hautes Études Sci. Publ. Math.*, 61:67–127, 1985.

Asymptotic motions for time-dependent perturbations of Hamiltonian systems having an invariant torus

Donato Scarcella (Universitat Politècnica de Catalunya)

Dynamical systems subject to perturbations that decay over time are relevant in the description of many physical models, e.g. when considering the effect of a laser pulse on a molecule, in epidemiological studies, as well as in celestial mechanics. For this reason, in the present talk, we discuss two cases. First, we consider a time-dependent perturbation of a Hamiltonian dynamical system having an invariant torus supporting quasiperiodic solutions. Next, we analyze the case where the orbits associated with the unperturbed system are arbitrary. Assuming the perturbation decays polynomially fast in time in the first case and exponentially fast in the second one, we prove the existence of orbits converging as time tends to infinity to the dynamics associated with the corresponding unperturbed system.
The present work is motivated by the example of the planar three-body problem perturbed by a given comet coming from and going back to infinity asymptotically along a hyperbolic Keplerian orbit, modeled as a time-dependent perturbation.

Computation of lower-dimensional elliptic tori via parametrization method

Chiara Caracciolo (Uppsala University)

In this talk, I will present an algorithm for computing lower dimensional elliptic tori in Hamiltonian systems using the parametrization method. The advantage of such a constructive technique is that it can be used to produce realistic (and, when combined with a computer-assisted proof, even rigorous) results in physical problems. As a difference with respect to previous results based on the normal forms approach, we fix the frequencies that describe the quasi-periodic motion on the torus and those that describe the oscillations in the transverse direction. Finally, I will present an application to the problem of four coupled pendula.
This is joint work with J-L. Figueras and A. Haro.

On a question of Newtonian mechanics asked by Mark Levi

Andrea Venturelli (Université d'Avignon)

In 2003, Mark Levi asked the following question: given a mechanical newtonian system on the plane $\mathbb{R}^2$, governed by a potential U, what can be said on U if we know that each level curve of U can be parametrized so that it is a solution of the associated newtonian system? A classical exemple of a potential satisfying this assumption is a potential with a radial symmetry. It is natural to ask if there are others exemples. We will see that the answer depends on some additional assumptions about U. Specifically, we will see that if U is real analytic then U is necessarily radial. If U is assumed to be smooth and $\mathrm{Crit}(U)$ is supposed to be totally path disconnected, the conclusion is still the same. But without this assumption on the set of critical points, there are exemples of non radial smooths potentials U such that each level curve of U can be parametrized so that it is a solution of the associated newtonian system. This problem is related to en evolution parabolic equation on the set of convex curves on $\mathbb{R}^2$ called inverse curvature flow.
It is a joint work with Philippe Bolle and Marco Mazzucchelli.

Societat Catalana de Matemàtiques

BMD BARCELONA MATHEMATICAL DAYS 2023

THEMATIC SESSION 6: **Discrete Mathematics** (Pi i Sunyer)

Organizer: Kolja Knauer

Thursday

16:30 – 17.15 **Felipe Rincón:** *Tropical Ideals*

17:20 – 18:05 **Vincent Pilaud:** *Unexpected diagonals*

18:10 – 18.55 **Fiona Skerman:** *Is it easier to count communities than find them?*

Friday

16:00 – 16:45 **Amanda Montejano** *Unavoidable patterns in 2-edge colorings of the complete graph*

16:50 – 17:35 **Alexandra Wesolek** *Extremal graphs in the generalized Turán problem*

17.40 – 18.25 **Ignacio García Marco***Sensitivity in Cayley graphs*

Abstracts

Tropical Ideals

Felipe Rincón (Queen Mary University of London)

Tropical ideals are combinatorial objects introduced with the aim of giving tropical geometry a solid algebraic foundation. They can be thought of as combinatorial generalizations of the possible collections of subsets arising as the supports of all polynomials in an ideal. In general, their structure is dictated by a sequence of 'compatible' matroids. In this talk I will introduce and motivate the notion of tropical ideals, and I will discuss work studying some of their main properties and their possible associated varieties.

Unexpected diagonals

Vincent Pilaud (CNRS & LIX, École Polytechnique)

Cellular approximations of diagonals of polytopes are important tools in homotopy theory. Geometrically, they can be constructed via the theory of fiber polytopes, and their projections produce interesting polyhedral subdivisions. This talk will present some unexpected enumerative properties of the diagonals of the associahedron and the permutahedron.
It is based on joint work with Alin Bostan and Frédéric Chyzak (Refined product formulas for Tamari intervals, arXiv:2303.10986) and with Bérénice Delcroix-Oger, Guillaume Laplante-Anfossi and Kurt Stoeckl (Cellular diagonals of permutahedra, arXiv:2308.12119).

Is it easier to count communities than find them?
Fiona Skerman (Uppsala University)

Random graph models with community structure have been extensively studied. For both the problems of detecting and recovering community structure, an interesting landscape of statistical and computational phase transitions has emerged. A natural unanswered question is: might it be possible to infer properties of the community structure (for instance, the number and sizes of communities) even in situations where actually finding those communities is believed to be computationally hard? We show the answer is no. In particular, we consider certain hypothesis testing problems between models with different community structures, and we show in the low-degree polynomial framework that testing between two options is as hard as finding the communities. Our methods give the first computational lower bounds for testing between two different "planted" distributions, whereas previous results have considered testing between a planted distribution and an i.i.d. "null" distribution.
Joint work with Cynthia Rush, Alex Wein and Dana Yang.

Unavoidable patterns in 2-edge colorings of the complete graph
Amanda Montejano (Universidad Nacional Autónoma de México)

We study the color patterns that, for n sufficiently large, are unavoidable in 2-colorings of the edges of a complete graph K_n with respect to $\min\{e(R), e(B)\}$, where $e(R)$ and $e(B)$ are the numbers of red and, respectively, blue edges. More precisely, we completely characterize which patterns are unavoidable depending on the order of magnitude of $\min\{e(R), e(B)\}$ (in terms of n), and show how these patterns evolve from the case without restriction in the coloring, namely that $\min\{e(R), e(B)\} \geq 0$ (given by Ramsey's theorem), to the highest possible restriction, namely that $|e(R) - e(B)| \leq 1$.

Extremal graphs in the generalized Turán problem
Alexandra Wesolek (Technische Universität Berlin)

One of the first results in extremal graph theory is Turán's theorem, which states that the Turán graph $T(n, r)$ maximizes the number of edges in an n-vertex graph that does not contain K_{r+1} as a subgraph. More generally, given two graphs H and F, the generalized Turán number $ex(n, H, F)$ is the largest number of copies of H in an n-vertex F-free graph and such graphs with $ex(n, H, F)$ copies of H are called extremal graphs. For fixed H, $F = K_{r+1}$ and r large enough, we recently showed in a joint work with Morrison, Nir, Norine, and Rzążewski, that the extremal graph for the generalized Turán problem is the Turán graph $T(n, r)$. This talk discusses this result and more broadly, results on generalized Turán numbers.

Sensitivity in Cayley graphs

Ignacio García Marco (Universidad de La Laguna)

In 2019, Huang proved that the sensitivity and the degree of a boolean function are polynomially related, solving an outstanding foundational problem in theoretical computer science: the Sensitivity Conjecture of Nisan and Szegedy. The key point of his argument is the proof that every set of more than half the vertices of the hypercube graph induces a subgraph of high maximum degree. Huang asked whether similar results can be obtained for other highly symmetric graphs. In this work we first prove that this result cannot be extended to general Cayley graphs. We present infinite families of Cayley graphs of groups of unbounded degree that contain induced subgraphs of maximum degree 1 on more than half the vertices.
Second, we propose Coxeter groups as a suitable generalization of the hypercube with respect to Huang's question. We support our proposal with some partial results plus a large amount of computer assisted experiments.
Finally, we provide examples of cube-free Cayley graphs where every induced subgraph on more than half the vertices has high maximum degree. Interestingly, these examples rely on point-line incidence results of projective planes over a finite field.
This is joint work with Kolja Knauer.

POSTERS

Thursday 16:00 – 16:30,
Friday 10:00 – 10:30

Mónica A. Reyes: *A new method to find the spectrum and eigenspaces of the k-token of a cycle.*

Philip Pita Forrier: *Jet transport for General Linear methods.*

Filip Moučka: *Symmetric Cartan calculus.*

Bernat Espigulé: *Zeros of* $\{-1, 0, 1\}$ *Power Series, Connectedness Loci and Peephole Sets.*

Mario González-Sánchez: *Castelnuovo-Mumford regularity of projective monomial curves via sumsets.*

Robert Florido: *Atlas of wandering domains for a Newton family.*

Miquel Ortega: *On the number of monochromatic solutions to multiplicative equations.*

José Lamas Rodríguez: *Parabolic ejection and collision orbits for the restricted planar circular 3-body problem.*

Dídac Gil Rams: *Splitting of separatrices in generalized standard maps.*

Abstracts

A new method to find the spectrum and eigenspaces of the k-token of a cycle.

Cristina Dalfó (UdL), Miquel Angel Fiol (UPC), **Mónica A. Reyes** (UdL), Arnau Messegué

Abstract: The k-token graph $F_k(G)$ of a graph G is the graph whose vertices are the k-subsets of vertices from G, two of which being adjacent whenever their symmetric difference is a pair of adjacent vertices in G. In this poster, we propose a general method to find the spectrum and eigenspaces of the k-token graph $F_k(C_n)$ of a cycle C_n. The method is based on the theory of lift graphs and the recently introduced theory of over-lifts.

Jet transport for General Linear methods.

Philip Pita Forrier (Universitat de Barcelona), Àngel Jorba (Universitat de Barcelona), Joan Gimeno (Universitat de Barcelona)

Abstract: We study how the computational technique called "jet transport" can be applied to the family of numerical integrators known as General Linear methods (GLM), which are a natural generalization of the well-known Linear Multistep (LMM) and Runge-Kutta (RK) methods. Jet transport can be defined as the application of the arithmetic of truncated power series to a numerical integrator in order to obtain the solution of the variational equations (VE); that is,

the linear differential equations that are satisfied by the derivatives of the solution of an initial value problem (IVP). In this context, we prove that: using a GLM the numerical integration of an IVP with jet transport is equivalent to the numerical integration of the VE, we derive the expressions that the higher order coefficients of the jets must satisfy to be a solution of an implicit system, allowing the implementation of implicit General Linear methods and we apply this implementation to study some scenarios in the field of dynamical systems, such as the computation of periodic orbits and the power expansion of Poincaré maps.

Symmetric Cartan calculus.

Filip Moučka (Universitat Autònoma de Barcelona; Czech Technical University in Pragues); Roberto Rubio Nuñez (Universitat Autònoma de Barcelona)

Abstract: We introduce analogues of the exterior derivative, the Lie derivative, and the Lie bracket of vector fields, on the algebra of completely symmetric covariant tensor fields. Then we discuss the basic properties and geometrical interpretation of these objects. Using the correspondence between the Cartan calculus and its symmetric counterpart, we introduce a symmetric version of Poisson geometry and generalized geometry.

Zeros of $\{-1, 0, 1\}$ Power Series, Connectedness Loci and Peephole Sets.

Bernat Espigulé (PhD student at Universitat de Girona), PhD supervisors: Joan Saldaña and David Juher (Differential Equations, Modelling and Applications Group, IMAE, Universitat de Girona).

Abstract: In 1985, Barnsley and Harrington defined a Mandelbrot Set M identified with the set of zeros of $\{-1, 0, 1\}$ power series in the unit disk. In this poster, we reveal the hidden internal structure of M using a novel technique. The result has applications in the geometry of algebraic numbers, and the study of connectedness properties of self-similar sets.

Castelnuovo-Mumford regularity of projective monomial curves via sumsets.

Philippe Gimenez (Universidad de Valladolid); **Mario González-Sánchez** (Universidad de Valladolid)

Abstract: Given $A = \{a_0, \ldots, a_{n-1}\}$ a finite set of $n \geq 4$ non-negative integers that we will assume to be in normal form, i.e., such that $0 = a_0 < a_1 < \cdots < a_{n-1} = d$ and relatively prime, the s-fold sumset of A is the set sA of integers obtained by collecting all the sums of s elements in A. On the other hand, given an infinite field k, one can associate with A the projective monomial curve $\mathcal{C}_A$ parametrized by A:

$$\mathcal{C}_A = \{(v^d : u^{a_1}v^{d-a_1} : \cdots : u^{a_{n-2}}v^{d-a_{n-2}} : u^d)\}$$

where $(u : v)$ covers the whole projective line over k. This allows us to establish a bridge between Additive Number Theory and Commutative Algebra and obtain some results connecting the Castelnuovo-Mumford regularity of $\mathcal{C}_A$ and the behaviour of the sumsets sA.

References:

[GG23] P. Gimenez, M. González-Sánchez. Castelnuovo-Mumford Regularity of Projective Monomial Curves via Sumsets. *Mediterr. J. Math.* **20**, 287 (2023). https://doi.org/10.1007/s00009-023-02482-3

Atlas of wandering domains for a Newton family.

Robert Florido, Núria Fagella (Universitat de Barcelona)

Abstract: Meromorphic maps naturally arise from Newton's root-finding method applied to an entire function F. In the transcendental case, Newton's method may particularly fail to converge to the roots of F if the initial condition lies in a Baker or wandering domain.
Here we present the simplest one-parameter family of transcendental entire functions with zeros, whose Newton's method yields wandering domains. Here we present the simplest one-parameter family of transcendental entire functions with zeros, whose Newton's method yields wandering domains [FF] for an open set of parameters by means of the logarithmic lifting method for periodic Fatou components [Herman].

References:

[FF] R. Florido, N. Fagella: *Dynamics of projectable functions: Towards an atlas of wandering domains for a family of Newton maps*, Preprint arXiv:2309.01411 (2023).

[Herman] *Are there critical points on the boundaries of singular domains*, Commun. Math. Phys., 99, pp 593-612 (1985).

On the number of monochromatic solutions to multiplicative equations.

Lucas Aragão (IMPA), Jonathan Chapman (University of Bristol), **Miquel Ortega** (Universitat Politècnica de Catalunya)

Abstract: Given an r-colouring of the interval $\{2, \dots, N\}$, what is the minimum number of monochromatic solutions of the equation $xy = z$? We prove that it is at least $C_r N^{1/S(r-1)}$, where $S(r)$ is the Schur number for r colours and C_r is a constant. For $r \in \{2, 3, 4\}$, this bound is sharp up to logarithmic factors. For 2-colourings, we establish a stability version of this result. We also obtain results for more general multiplicative equations of the form $x_1^{a_1} \cdots x_k^{a_k} = y$, where $a_1, \dots, a_k$ are positive integers, at least one of which equals 1.

Parabolic ejection and collision orbits for the restricted planar circular 3-body problem.

Marcel Guàrdia, **José Lamas Rodríguez**, Tere M-Seara (Universitat Politècnica de Catalunya)

Abstract: We consider the restricted planar circular three body problem (RPC3BP), which describes the motion of a massless body under the attraction of other two bodies, the primaries, which describe circular orbits around their common center of mass located at the origin. In a suitable system of coordinates, this system is Hamiltonian with two degrees of freedom, whose conserved energy is usually called the Jacobi constant. In such system, we are interested in solutions of the RPC3BP called ejection-collision orbits, i.e., solutions that depart from the big primary at some time t0 and collide with it at some instant t1. In this talk I will explain how to construct arbitrarily large ejection- collision orbits for small values of the mass ratio. To this end, we show that, for small values of the mass ratio and the Jacobi constant, there exist transverse intersections between the stable (unstable) manifold of infinity and the unstable (stable) manifold of collision. Close to such transverse intersections, we prove the existence of a se- quence of ejection-collision orbits that travel arbitrarily far away. More- over, using a similar argument, we prove the existence of a sequence of forward and backward periodic parabolic orbits that travel close to colli- sion too. Finally, we also prove the existence of periodic orbits that travel close to collision and arbitrarily far away.

Splitting of separatrices in generalized standard maps.

Inmaculada Baldomà Barraca (UPC), **Dídac Gil Rams** (CRM), and Pau Martín de la Torre (UPC)

Abstract: We study transversal intersections between the invariant manifolds (stable and unstable) associated to an hyperbolic fixed point for a class of maps. These intersections are known as homoclinic orbits. The existence of these kind of orbits is one of the most celebrated methods to prove the existence of chaotic dynamics in a system. Indeed the Morse-Smale theorem ensures that if there exist transversal intersections between the invariant manifolds of the same invariant object, the system is locally conjugate to a Smale horseshoe with infinite symbols.
The classical Melnikov theory is a first order perturbative theory that, in addition, can be used to measure the intersection angle between the invariant manifolds. However straightforwardly there are cases where the Melnikov function is exponentially small and the associated theory is not true. In these cases, to measure, for example, the intersection angle between the manifolds, becomes a difficult and technical task, since it is a beyond all orders phenomenon. This is the case of the problem we are considering.
We study the splitting of separatrices on generalized standard maps. This generalization includes the already studied maps like *the standard map*, first studied by Lazutkin, or *the perturbed McMillan map*.
More concretely, we are going to study the intersection of the invariant manifolds associated to a fixed point of the discrete dynamical system

$$\begin{cases} x^* = x + y + f(x,h), \\ y^* = y + f(x,h), \end{cases}$$

where h is a small parameter and f depends analytically on $|h| < h_0$, $|x| < \rho_0$, for some fixed $h_0, \rho_0 > 0$. We consider f to be of the form

$$f(x,h) = \sum_{k \geq 0} f_k(x) h^{k+2},$$

with $f_k(x) = \sum_{j=1}^{d_k} f_{k,j} x^j$ and $f_{k,d_k} \neq 0$. In addition some extra condition on the exponents d_k are imposed.
We obtain an asymptotic formula for the *Lazutkin invariant*, value related to the area between two homoclinic points, and its first term depends on a Stokes constant that is generically different from zero. To do so, one of the techniques that we use is the *inner equation* related to our generalized standard maps.

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