Sesión de Pósteres
Congreso Bienal de la Real Sociedad Matemática Española
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Normally ordered forms of powers of differential operators

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Abstract. Gievn a derivation ∂ of a ring, and a central element h in this ring, we can consider the normally ordered forms of the powers $(h\partial)^n$ of the differential operators $h\partial$. For instance,

$$(h\partial)^2 = hh'\partial + h^2\partial^2,$$
$$(h\partial)^3 = h(h')^2\partial + h^2h''\partial + 3h^2h'\partial^2 + h^3\partial^3.$$

It is known that these formulas can be described nicely in terms of sums over increasing trees. Also, they include, either as coefficients or as restricted sums of coefficients, well–known families of combinatorial numbers (namely, the Stirling numbers of both kinds, and the Euler numbers).
We extend this study to the more general operators $(h\partial^d)^n$. In particular, we give a simple combinatorial interpretation for the coefficients of their normally ordered forms. As a byproduct, we obtain new formulas for the *generalized Stirling numbers* $\left\{ {n \atop k} \right\}_{q,d}$ (coefficients of the normally ordered form of $(x^q\partial^d)^n$ in the Weyl algebra):

$$\left\{ {n \atop k} \right\}_{q,d} = \sum_A \frac{\prod_i (d)_{r_i(A)} \cdot \prod_j (q)_{c_j(A)}}{\prod_{i,j}(a_{i,j}!)}$$

where the sum is carried over all triangular arrays $A = (a_{i,j})_{1\le j<i\le n}$ of nonnegative integers, the $r_i(A)$ and $c_j(A)$ being the row sums and column sums of A, and $(x)_k$ standing for the falling factorial.

Trabajo en colaboración con: / Joint work with:
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Keywords: Normal ordering, Stirling numbers, Formal differential operator rings.

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How to induce an hypercyclic and mean ergodic operator from a suitable labelling in the set of finite strings of rational numbers

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Abstract. The main goal of the poster is to show a different approach to some recently solved problems about dynamics of operators between Banach spaces.

Recently, in the works of M. J. Beltrán, J. Bonet, A. Peris and many others, the compatibility of two different type of properties has been studied. On the one hand, there are operators that have "crazy" orbits (dense, frequently-dense,...). On the other hand, there are operators whose orbits are well-behaved in mean terms (some bound holds for the sequence of partial means of any orbit). During the last recent years, there has been a great development in the theory of operators T that satisfy simultaneously conditions of both types: the mean of every orbit is "good" and some orbits are "crazy" (but, remember, the sequence of partial means of the "crazy" orbits is still "good"!)

As one can imagine, depending on the meaning of "good" and "crazy", many questions have been asked in this field and, some of them, have already been answered by providing examples or by showing that such an operator can not exist. Our contribution consists in providing more and new examples to some problems that have already been solved, via a different approach.

We consider the backward shift T between suitably weighted versions of the Banach spaces ℓ^p. Under suitable conditions in the weight it is not hard to show that any orbit for the backward shift is "good". These ideas are not new and they appeared many times in the recent literature of the topic.

However, we propose a different strategy to show the "crazy" condition. We define an "adequate" order in the countable set of finite rational strings $\bigcup_{n=1}^{\infty} \mathbb{Q}^n$ with respect to the weighted norm in ℓ^p. The idea is, essentially, that this "adequate" order induces the construction of an element x in the weighted ℓ^p (remember, the element must have finite norm!) such that every finite string of rational numbers appears in x. At this point, the reader might suspect that x is a good candidate to prove that the orbit $\{x, Tx, T^2x, \dots, \}$ is "crazy"...

Finally, we examine the ideas and limitations that has our proposal for some other problems in the subject.

Keywords: Hypercyclic, mean ergodic, weighted Banach spaces, countability

Vanishing viscosity limit of a Nonlocal viscous Conservation Law

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Abstract. We study a nonlocal regularisation of a scalar conservation law given by a fractional derivative of order between one and two. This nonlocal operator corresponds to a left-sided *Caputo* type fractional derivative integrated form $-\infty$. The main purpose of our work is the study of the vanishing viscosity limit. First, we prove that a classical solution exists for the regularised conservation law following [1] and the global existence using a reverse maximum principle which is obtained from [2]. Finally, we show the convergence of the classical solution of the regularised problem to the entropy solution of the scalar conservation law as the viscosity term vanishes and for this purpose we use the doubling variable technique originally explained in [4].
For completeness, we study the travelling wave problem for genuinely nonlinear fluxes, and show that in the vanishing viscosity limit travelling waves converge to shock waves.

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Keywords: Nonlocal regularisation, Fractional derivative, Vanishing viscosity limits

Sobre la dimensión de Hausdorff de la función no diferenciable de Riemann compleja

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Resumen.
La función no diferenciable de Riemann,

$$R(x) = \sum_{k=1}^{\infty} \frac{\sin \pi k^2 x}{k^2},$$

es un ejemplo clásico de función continua que no es diferenciable en casi ningún punto. Su regularidad fue ampliamente estudiada, y a pesar de que G.H. Hardy y J.E. Littlewood demostraron la no diferenciabilidad en casi todo punto en 1914, la resolución completa del problema no llegó hasta los años 70, cuando J. Gerver mostró que en los puntos restantes la función sí que es diferenciable.

Desde entonces, las propiedades geométricas de la generalización compleja

$$\varphi(x) = \sum_{k=1}^{\infty} \frac{e^{2\pi i k^2 x}}{k^2}$$

y sus variantes han constituido un foco de atención en sí mismo. S. Jaffard analizó su multifractalidad y su espectro de singularidades. En cuanto a la imagen en el plano complejo, J.J. Duistermaat dejó patente su naturaleza autosemejante, mientras que F. Chamizo y A. Córdoba calcularon con éxito la dimensión de Minkowski de los grafos de las partes real e imaginaria, igual a 5/4. En cambio, poco se sabe sobre su dimensión de Hausdorff.

En este trabajo, analizamos una variante dada por

$$\phi(x) = \sum_{k \in \mathbb{Z}} \frac{e^{-4\pi^2 i k^2 x} - 1}{-4\pi^2 k^2},$$

que proviene del análisis de la Vortex Filament Equation y la ecuación de Schrödinger en el contexto del llamado efecto de Talbot. Las ideas de Duistermaat y el aire autosemejante de su imagen en el plano complejo nos llevan a pensar que su dimensión de Hausdorff no sea entera. Demostraremos que esa dimensión es menor o igual que 4/3, y ofreceremos ideas que sugieren que debería ser estrictamente mayor que 1.

Palabras clave: Función no diferenciable de Riemann, dimensión de Hausdorff.

Smooth approxmation without critical points of continuous mappings between Banach spaces

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Abstract. The Morse-Sard theorem states that if $f : \mathbb{R}^n \to \mathbb{R}^m$ is of class C^k, $k = n - m + 1$ then the set of critical values of f has Lebesgue measure zero in $\mathbb{R}^m$. This theorem fails in infinite dimension, although S. Smale proved a version of the theorem for differentibale functions whose derivatives were Fredholm operators. This is a very strong hypothesis that restrics the range of applications drastically. However in many cases it is not important if a function has the Morse-Sard property or not but if it can be approximated by smooth functions with the Morse-Sard property.

In 2004 Azagra and Cepedllo proved that every continous function from l_2 to $\mathbb{R}^m$ can be approximated by a C^∞-function without any critical point. In this talk I will extend this result to show that the same is true if we replace the target space $\mathbb{R}^m$ by l_2.

Theorem: *Let E be one of the classical Banach spaces c_0, ℓ_p or L^p, $1 < p < \infty$. Let F be a Banach space, and assume that there exists a bounded linear operator from E onto F. Then, for every continuous mapping $f : E \to F$ and every continuous function $\varepsilon : E \to (0, \infty)$ there exists a C^k mapping $g : E \to F$ such that $\|f(x) - g(x)\| \leq \varepsilon(x)$ and $Dg(x) : E \to F$ is a surjective linear operator for every $x \in E$. (Here k denotes the order of smoothness of the space E).*

The proof will rely in part on a new result about extractibility of subsets from the space E. Namely that given a closed subset X in E that is locally contained in graphs of continuous functions defined in subspaces of infinite codimension in E (and taking values in their orthonal complements), given an open set U with $X \subseteq U$ and given an open cover $\mathcal{G}$, then there exists a C^∞-diffeomorphism from $E \setminus X$ onto E which is the identity outside U and refines $\mathcal{G}$.

Joint work with:
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Keywords: Banach Spaces, Morse-Sard theorem, approximation, critical points, diffeomorphic extraction

Poisson homogeneous structures for Lorentzian groups

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Abstract. When semiclassical limits of non-commutative spacetimes are considered, a Poisson structure appears as a completely new feature, which is expected to be one of the footprints of quantum gravity effects at the Planck scale. When this spacetime is homogeneous, and thus a Lie group acts on it, the natural compatibility condition between the group action and the Poisson structure is given by a Poisson-Lie group, and in this way the homogeneous spacetime is a Poisson homogeneous space (PHS).

In this poster, Poisson homogeneous spaces (M, π) of a Poisson–Lie group (G, Π) are introduced, where M is given by $M = G/H$ is a homogeneous space and $H \subset G$ is the stabilizer of a point, i.e the Lorentz subgroup. If we denote by $(\mathfrak{g}, \delta)$ the Lie bialgebra associated to (G, Π), the coisotropy condition for the cocommutator δ associated to the Poisson-Lie bracket Π, i.e. $\delta(\mathfrak{h}) \subset \mathfrak{h} \wedge \mathfrak{g}$, where $\mathfrak{h} = \mathrm{Lie}(H)$, is a necessary and sufficient condition for (M, π) to be a Poisson homogeneous space. The particular case when $\delta(\mathfrak{h}) \subset \mathfrak{h} \wedge \mathfrak{h}$ identifies the Poisson subgroup cases, which are less numerous but can be more easily quantized.

Here we present the explicit construction of some PHS on Lorentzian spacetimes. In (2+1) dimensions, Minkowski PHS coming from all possible Drinfel'd double structures of the (2+1) Poincaré Lie algebra are constructed. Also, a PHS for the (3+1)-dimensional AdS group with respect to the so-called κ-Poisson–Lie structure is explicitly given in local AdS coordinates, and it is shown that its Minkowskian limit can be obtained when the cosmological constant parameter vanishes.

Joint work with:
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Palabras clave:
Keywords: Poisson-Lie group, Drinfel'd double, Poisson homogeneous space, Minkowski non-commutative spacetime

Commutators in Finite p-Groups

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Abstract.
In a group G, the set $K(G)$ of commutators need not be a subgroup. In other words, the derived subgroup $G' = \langle K(G) \rangle$ may be strictly larger than $K(G)$. There exist, however, several families of groups in which the equality $G' = K(G)$ is satisfied. In this poster we will discuss this equality and provide different conditions for it to hold.
In particular, for finite nilpotent groups, the study of this property is obviously reduced to finite p-groups, where p is a prime. In this case, Guralnick showed that $G' = K(G)$ whenever G' is abelian and can be generated by 2 elements. We will see that the requirement that G' should be abelian is not necessary. Actually, we will show that all elements of G' arise as commutators from a single suitable element.

Joint work with:
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Keywords: Group Theory, Finite p-Groups, Commutators, Powerful p-groups

The complete classification of empty 4-simplices

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Abstract. A *lattice polytope* is the convex hull of finitely many integer points in $\mathbb{R}^d$. It is *hollow* if its interior contains no integer points and *empty* if its vertices are its only integer points. Empty simplices are essentially equivalent to the *terminal quotient singularities* that appear in the minimal model program of Mori et al. In particular, the classification of empty 3-simplices (established by White in 1964) is sometimes dubbed the *terminal lemma* in the algebraic geometry literature.

In this work we complete the classification of 4-dimensional empty simplices, along the following lines: we first deduce from a general result of Nill and Ziegler (2011) that, in any dimension d, empty simplices can be classified into a finite number of *families*. Here a family consists of all simplices that can be projected to a particular hollow k-polytope Q ($k \leq d$) such that Q does not project to a hollow $(k-1)$-polytope. The members of each family depend on $d-k$ integer parameters.

In particular, the classification of hollow lattice polytopes of dimension ≤ 3 (finished by Averkov, Krümpelmann and Weltge in 2017) allows us to classify the infinite families of empty 4-simplices into:

1. One 3-parameter family, simplices that project to the unit segment.
2. Two 2-parameter families, consisting of simplices that project to the second dilation of a unimodular triangle.
3. Fifty-two 1-parameter families, projecting to certain hollow 3-polytopes.

Then, using convex geometry tools, we upper bound the volume of the "sporadic" empty simplices that do not project to dimension three or less and we enumerate them up to that bound. We thus prove that there are exactly 2641 of them, of determinants ranging between 24 and 419.

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O. Iglesias Valiño and F. Santos, The complete classification of empty 4-simplices, in preparation.

Joint work with: Francisco Santos. Universidad de Cantabria

Keywords: lattice polytope, empty simplex, hollow polytope

Weakly-Eisntein Manifolds: A Classification

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Abstract. Einstein metrics on Riemannian manifolds (M^n, g), i.e., metrics satisfying $\rho = \frac{1}{n}\tau g$, where ρ is the Ricci tensor and τ denotes the scalar curvature, are critical metrics for the Hilbert functional. They are also critical for other curvature functionals like the one given by the L^2-norm of the curvature tensor. However, other non-Einsteinian critical metrics exist. For instance if the Ricci tensor is Codazzi (i.e., its covariant derivative is totally symmetric), a metric is critical for $g \mapsto \int_M \|R\|^2$ if and only if $\check{R} = \frac{1}{n}\|R\|g$, where $\check{R}$ is the symmetric $(0,2)$-tensor field given by $\check{R}_{ij} = R_{iabc}R^{jabc}$. Since any Einstein metric in dimension four satisfies $\check{R} = \frac{1}{n}\|R\|g$, (M, g) is called *weakly-Einstein* if $\check{R} = \frac{1}{n}\|R\|g$, but (M, g) is not Einstein.
The purpose of this communication is to give a classification of locally conformally flat weakly-Einstein manifolds, showing that either (M, g) is locally a product $N_1^m(c) \times N_2^m(-c)$ of equally-dimension manifolds of constant opposite curvature or otherwise (M, g) is locally a warped product $\mathcal{I} \times_f N(c)$ for some specific warping function f and fiber $N(c)$ of constant curvature. Furthermore, a four-dimensional locally conformally flat manifold is weakly-Einstein if and only if the scalar curvature vanishes. As a consequence one can classify weakly-Einstein hypersurfaces in $\mathbb{R}^n$.

Joint work with:
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Keywords: Critical metric, Einstein and weakly-Einstein metrics, Local conformally flatness, Hypersurface.

Singular contact structures

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Abstract. The study of singular symplectic manifolds was initiated by the work of Radko, who classified stable Poisson structures on surfaces. It was observed by Guillemin–Miranda–Pires that stable Poisson structures can be treated as a generalization of symplectic geometry by extending the de Rham complex. Since then, a lot has been done to understand the geometry, dynamics and topology of those manifolds.
We will explore the odd-dimensional case of those manifolds in this poster by extending the notion of contact structure to the singular setting. We plan to give local normal forms and the relation to singular symplectic geometry. We will prove the existence of singular contact structures in dimension 3 and prove the equivalent of Weinstein conjecture in contact geometry in the singular setting, i.e. existence of periodic orbits on compact 3-dimensional b-contact manifolds.

Joint work with:
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Keywords: geometry, contact geometry, symplectic geometry, Jacobi manifolds, Poisson manifolds

On Whitehead's quadratic functor for supermodules

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Abstract. Simson and Tyc gave a generalized version of the Whitehead's quadratic functor $\Gamma(M)$ for a module M, following the traditional presentation as the free algebra generated by M, subject to certain relations. It determines a quadratic map $\gamma\colon M \to \Gamma(M)$, which is universal in the sense that for any other quadratic mapping $f\colon M \to N$, there exists a unique homomorphism of modules $h\colon \Gamma(M) \to N$ such that $h\gamma = f$.
In our work, we generalize this object for supermodules, following an alternative construction much more suitable for working with quadratic maps between supermodules. We explore some of its fundamental properties, and also generalize it to crossed modules of abelian Lie superalgebras, presenting an application to the study of the universal central extension for a perfect crossed module of Lie superalgebras.

Joint work with:
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Keywords: Whitehead's quadratic functor, supermodules, crossed modules of Lie superalgebras, quadratic mappings

Three-Sasakian manifold and the conformal group

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Abstract. We describe several distinguished sets of invariant affine connections on 3-Sasakian homogeneous manifolds. Recall that there exists a one-to-one correspondence between simply connected 3-Sasakian homogeneous manifolds and compact simple Lie algebras. Our description of the affine connections is introduced in a unified approach. The main tool is a classical result by Nomizu. It holds that the spaces of invariant affine connections, metric invariant affine connections, and invariant affine connections with skew-torsion, are parametrized by the same sets for all 3-Sasakian homogeneous manifolds which are not quotient of a unitary group. For studying the exceptional cases, some algebraic models of the tangent spaces are explicitly exhibited. The unique 3-Sasakian homogeneous manifolds admitting nontrivial Einstein with skew-torsion invariant affine connections are those of dimension 7, that is, $\mathbb{S}^7 = \mathrm{Sp}(2)/\mathrm{Sp}(1)$, $\mathbb{R}P^7 = \mathrm{Sp}(2)/\mathrm{Sp}(1) \times \mathbb{Z}_2$ and the Aloff-Wallach space $\mathfrak{W}^7_{1,1} = \mathrm{SU}(3)/\mathrm{U}(1)$. For $\mathbb{S}^7$ and $\mathbb{R}P^7$, the set of such connections is in one to one correspondence with two copies of the conformal linear transformation group of the Euclidean space, while it is strictly bigger for $\mathfrak{W}^7_{1,1}$.

Joint work with:
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Palabras clave:
Keywords: 3-Sasakian manifolds, homogeneous spaces, invariant affine connections, Einstein with skew-torsion connections.

Domination in cylinders

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Abstract. We present a lower bound for the domination number of the Cartesian product of a path and a cycle, that is tight if the length of the cycle is a multiple of five. This bound improves the natural lower bound obtained by using the domination number of the Cartesian product of two paths, that is the best one known so far.
Our strategy is similar to the approach in [1], where the concept of wasted domination was introduced. On the other hand, we use a technique inspired by the construction of cylinders as rotagraphs [2], to design a $(\min, +)$ matrix multiplication algorithm that computes the minimum wasted domination in selected cylinders. With theses tools, we prove that, for $m \geq 20$ and $n \geq 30$:

$$\gamma(P_m \Box C_n) \geq \begin{cases} \left\lceil \frac{n(m+2)+2}{5} \right\rceil & \text{if } n = 32, 33, 37, 38, 42, 43, 47, 48, 53, 58, 63 \\ \left\lceil \frac{n(m+2)}{5} \right\rceil & \text{otherwise} \end{cases}$$

Moreover, if $n \equiv 0 \pmod 5$, then $\gamma(P_m \Box C_n) = \frac{n(m+2)}{5}$.

Joint work with:
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Keywords: Domination number; Cartesian product; cylinder; GPU computing

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Non-Hopf hypersurfaces with constant principal curvatures in complex projective and complex hyperbolic space

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Abstract. A hypersurface in a Riemannian manifold has constant principal curvatures if the eigenvalues of its shape operator are constant maps. The problem of classifying hypersurfaces with constant principal curvatures in real space forms started with B. Segre and É. Cartan who classified hypersurfaces with constant principal curvatures in the Euclidean space and in the real hyperbolic space, respectively. However, the classification in the spheres remains still unknown.
The complex analogue of this problem is also still open. We define the Hopf vector field of a hypersurface in an almost complex manifold by applying the almost complex structure of it to the normal vector field of the hypersurface. Those hypersurfaces whose Hopf vector field is a principal direction are called Hopf. The classification of Hopf hypersurfaces in complex projective spaces and in hyperbolic spaces was achieved by M. Kimura and J. Berndt, respectively.
In this work we classify hypersurfaces with four principal curvatures in the complex projective and hyperbolic spaces whose Hopf vector field has non-trivial projection onto three curvature spaces of dimension one.

Joint work with:
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Keywords: constant principal curvatures, hypersurfaces, complex space forms.

Lie groups related to solutions to the heterotic equations of motion

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Abstract. A model for string theory was proposed in [Candelas-Horowitz-Strominger-Witten, 1985] involving a ten dimensional space $\mathbb{R}^{1,3} \times M^6$, where $\mathbb{R}^{1,3}$ is a Lorentzian spacetime and M^6 is a compact Calabi-Yau manifold. Strominger [Strominger, 1986] generalized the previous construction allowing a background M^6 with a non-zero torsion. This led to a complicated system of PDEs known as the *Strominger system* which is written in terms of the fermionic and bosonic fields relevant in the physical theory. But the system can be reformulated in a geometrical way involving linear connections defined on several bundles over the background M^6.

Several works have been devoted since then to find solutions to this system. In this poster we present compact manifolds providing many solutions to the Strominger system with respect to a 2-parameter family of metric connections $\nabla^{\varepsilon,\rho}$. All our solutions are compact and invariant in the sense that are constructed as quotients of Lie groups. The family $\nabla^{\varepsilon,\rho}$ is a natural extension of the canonical 1-parameter family of Hermitian connections [Gauduchon, 1997] that includes other metric connections that are of interest in the anomaly cancellation condition (for instance the Levi-Civita connection or the so denoted ∇^- connection). Some of the examples solve in addition the most restrictive system of heterotic equations of motion with respect to the Bismut connection. All the results appear in [Otal-Ugarte-Villacampa, 2017].

Concretely, we construct invariant solutions to the Strominger system with respect to the Chern connection ∇^c, with non-flat instanton and positive α' on compact complex solvmanifolds with holomorphically trivial canonical bundle found in [Fino-Otal-Ugarte, 2015]. Furthermore, invariant solutions to the heterotic equations of motion with respect to the Bismut connection ∇^+, non-flat instanton and $\alpha' > 0$ are also obtained.

In the semisimple case we find the first known solutions to the heterotic equations of motion on a compact quotient of SL(2,$\mathbb{C}$). We also provide many invariant solutions to the Strominger system on this manifold recovering the ones obtained in [Fei-Yau, 2015]

Joint work with:
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Keywords: Strominger system, Calabi-Yau manifolds, solvmanifolds, Hermitian connections.

Local Hardy spaces with variable exponents associated to non-negative self-adjoint operators satisfying Gaussian estimates

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Abstract. In this paper we introduce variable exponent local Hardy spaces $h^{p(\cdot)}(\mathbb{R}^n)$ associated with a non-negative self-adjoint operator L. We assume that, for every $t > 0$, the operator e^{-tL} has an integral representation whose kernel satisfies a Gaussian upper bound. We define $h^{p(\cdot)}(\mathbb{R}^n)$ by using an area square integral involving the semigroup $\{e^{-tL}\}_{t>0}$. A molecular characterization of $h^{p(\cdot)}(\mathbb{R}^n)$ is established. As an application of the molecular characterization we prove that $h^{p(\cdot)}(\mathbb{R}^n)$ coincides with the (global) Hardy space $H^{p(\cdot)}(\mathbb{R}^n)$ provided that 0 does not belong to the spectrum of L. Also, we show that $h^{p(\cdot)}(\mathbb{R}^n) = H^{p(\cdot)}_{L+I}(\mathbb{R}^n)$.

Trabajo en colaboración con:
Jorge J. Betancor. Universidad de La Laguna
Estefanía Dalmasso. Universidad Nacional del Litotal (Santa Fe - Argentina)
Lourdes Rodríguez-Mesa. Universidad de La Laguna

Keywords: Hardy spaces, molecules, local, variable exponent.

On the Tjurina number of plane curve singularities

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Abstract. In this Poster I will present some topics and calculations about the Tjurina number of a plane curve singularity. This is part of the main object of study of my Thesis in progress. The principal motivation is a question posed by A. Dimca and G.M. Greuel in 2017 which gives a surprising relation between two of the main invariants of plane curves singularities: Milnor number, of topological nature, and Tjurina number, of analytical nature. I will also present a partial answer to this question in the case of semi-quasihomogeneus singularities (joint work with G. Blanco) which constitute a new hope to achieve a positive answer to Dimca and Greuel's question in the general case.

Keywords: Curve singularities, Tjurina number, Milnor number

Quantitative results for C_p weights

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Abstract. A classical weighted norm inequality between Calderón-Zygmund operators and the Hardy-Littlewood maximal function was proved by Cofiman and Fefferman for weights of class A_∞. Later, the study of the class of weights for which this inequality holds gave place to the class C_p.
We introduce a quantification for weights in this class C_p.This done in the spirit of the standard A_∞ constant. This quantification, allows us to obtain a quantitative version of the Coifman-Fefferman inequality with an explicit dependence on the weight. We also prove a quantitative version of the reverse Hölder-type inequality that characterises the class C_p. As a corollary, we recover the sharp reverse Hölder inequality for the classical A_∞ weights.

Palabras clave: Análisis armónico, desigualdad con peso, operador maximal de Hardy-Littlewood, operador de Calderón-Zygmund.
Keywords: Harmonic analysis, weighted norm inequality, Hardy-Littlewood maximal operator, Calderón-Zygmund operator.

Prescribing Gaussian and geodesic curvature on Disks

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Abstract. In this work we consider the problem of prescribing the Gaussian and geodesic curvature on a disk and its boundary, respectively, via a conformal change of the metric. This leads us to a Liouville-type equation with a nonlinear Neumann boundary condition. We address the question of existence by setting the problem in a variational framework which seems to be completely new in the literature. We are able to find minimizers under symmetry assumptions.

Joint work with:
David Ruiz. University of Granada

Keywords: Prescribed Gaussian curvature problem, variational methods, Moser-Trudinger inequality.

Aplicaciones de códigos no lineales en criptografía

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Resumen. En 1948, Shannon presenta en [1] y [2] el primer trabajo de la Teoría de la Información, en el cual se centra en el problema de la transmisión de información. En el proceso de codificación de la información, el emisor transforma el mensaje en un elemento del código denominado palabra. Aún produciendose alteraciones en la palabra durante su transmisión, el receptor puede recuperar el mensaje original a partir de la palabra recibida. Si bien las formas habituales de codificación utilizadas hoy en día se basan en códigos lineales y utilizan propiedades de álgebra lineal, también existen códigos no lineales tales como los de Kerdock y Preparata. Estos últimos, cuya preimagen mediante la aplicación de Gray los hace $\mathbb{Z}/4\mathbb{Z}$-lineales [3], poseen propiedades que pueden ser utilizadas en otros ámbitos fuera de la Teoría de Códigos [4]. En este poster se presenta una posible aplicación criptográfica de códigos no lineales.

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Palabras clave: Teoría de Códigos, Códigos no lineales, Criptografía

Cellular automata on trees: reversibility and some applications

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Abstract. In this work the notion of linear boolean cellular automata on trees (LBCAT for short) is introduced and the reversibility problem is tackled when the connection topology is defined by means of full binary trees and quadtrees. It is shown that for any number of nodes these automata are reversible and the explicit expressions of the inverse cellular automata are given.
Three applications are presented:

1. A detailed analysis of the pseudorandom properties of the bit sequences generated by both types of LBCAT is given. Specifically, the NIST tests are tested and the quality for cryptographic purposes are derived.

2. A preliminary study as f-reversible processes on graphs of LBCAT defined on full binary trees and quadtrees is presented.

3. Some possible uses in digital imaging processing of LBCAT on quadtrees are shown.

Joint work with:
D. Hernández Serrano. University of Salamanca, Institute of Fundamental Physics and Mathematics, Department of Mathematics.
A. Martín del Rey. University of Salamanca, Institute of Fundamental Physics and Mathematics, Department of Applied Mathematics.

Keywords: Cellular automata. Trees. Reversibility. Pseudorandomness. f-reversible processes on graphs. Digital image processing.

Stability of the volume growth rate under quasi-isometries

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Resumen.

Abstract. Kanai proved the stability under quasi-isometries of numerous global properties (including the volume growth rate) between Riemannian manifolds of bounded geometry. Unfortunately, Kanai's hypotheses are not usually satisfied in the context of Riemann surfaces endowed with the Poincaré metric. In this work we prove the stability of the volume growth rate by quasi-isometries, under hypotheses that many Riemann surfaces (and even Riemannian surfaces with pinched negative curvature) satisfy. Although Kanai just deals with non-bordered Riemannian manifolds, here manifolds with border are allowed. In order to get our results, it is shown that many bordered Riemannian surfaces with pinched negative curvature are bilipschitz equivalent to bordered surfaces with constant negative curvature.

Trabajo en colaboración con: / Joint work with:
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Ana Portilla. St. Louis University (Madrid Campus)
José Manuel Rodríguez. Universidad Carlos III de Madrid

Palabras clave:
Keywords: Volume growth rate, quasi-isometry, Riemann surface, Poincaré metric, negative pinched curvature.

Effective computation of Serre spectral systems

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Abstract. We present methods to compute the Serre spectral system, a generalized version of the Serre spectral sequence, using the effective homology technique.

Joint work with:
Ana Romero. University of La Rioja

Keywords: Effective homology, spectral sequence, fibration, algorithms.

The construction of a spectral sequence arises in a quite natural way from a filtration (indexed over the set $\mathbb{Z}$ of integer numbers) of a chain complex. Recently, Benjamin Matschke proposed a generalization of the notion of spectral sequence, formulating a theory which allows to construct a generalized spectral sequence, or *spectral system*, from filtrations indexed over any partially ordered set (poset). One of the main motivations of Matschke was to describe a mathematical object general enough to unify several spectral sequences which usually one would apply in succession; this is the case of the successive Serre spectral sequences associated with a tower of fibrations. The original motivation causes some posets to assume a particular relevance as sets of indices of a filtration, like $\mathbb{Z}^m$ or, to achieve more generality, the poset of downsets of $\mathbb{Z}^m$.
In previous works, the authors studied how the technique of *effective homolgy* can be employed to produce algorithms computing the Serre spectral system of a tower of m fibrations in the simple case of *trivial* fibrations (for which the total space is the Cartesian product of the base and the fiber). In this poster, we present the extension of our methods to the case of regular fibrations, a generalization which required more refined techniques as well as implementation subtleties. Our new methods are part of a module for the computer algebra system Kenzo.

Norms of inclusions between some classical function spaces

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Abstract. It is well known that an arbitrary analytic (conformally invariant) Besov space B^p of the unit disk is contained in the Bloch space $\mathcal{B}$ of all analytic functions in the disk with bounded invariant derivative. Also, it is well known that the Bloch space is contained in every Bergman space A^p of p-integrable analytic functions with respect to Lebesgue area measure in the disk, where $1 \leq p < \infty$. Moreover, all these inclusions are compact operators.
In this joint work with Dragan Vukotić, we compute the exact values of the norm of the inclusion operator from B^p, $1 < p < \infty$, into the Bloch space. The norm of the inclusion of $\mathcal{B}$ into A^p is a more delicate question: we show that it is exactly one when $1 \leq p \leq 2$ but it blows up as $p \to \infty$. We address the question of precise asymptotic order of the norm for large values of p.

Joint work with:
Dragan Vukotić. Universidad Autónoma de Madrid.

Keywords: Bergman spaces, Bloch space, Besov spaces, extremal problems, norm of inclusions.

On Kransnosel'skii cone fixed point theorem by using more general sets

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Abstract. Let $T : D \subset X \longrightarrow X$ be a mapping between sets, we say that an element $x \in D$ is a fixed point of T if $T(x) = x$. An usual technique followed to find solutions of boundary value problems consists in transforming them into an integral equation. In this way, it is obtained a mapping whose fixed points are in correspondence with solutions to the boundary value problem. Therefore, we deal with fixed point theory results that allow us to prove the existence and localize fixed points of the corresponding mappings.
Some useful fixed point theorems are the ones due to Krasnosel'skii (see 1) and their generalizations (see 2, 4). We have realised that by using Krasnosel'skii classical results is not possible to prove the existence of two solutions with the same norm. However, we have proved some similar results working with more general sets (see 3) and by using them it could be possible to distinguish these solutions.
We will introduce and illustrate some of our results. For example, by working with some simple mappings, we will show how our results enable us to prove the existence of two fixed points with the same norm.

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Joint work with: Rosana Rodríguez-López

Keywords: Krasnosel'skii fixed point theorem, k-set contractions

A new family of mathematical models to simulate malware propagation

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Abstract. The purpose of this work is to introduce a new family of (deterministic) mathematical models to simulate malware spreading. The novelty of these models lies in the fact that a new compartment is considered: the carrier devices (those devices that malware has reached but it is not able to carry out its malicious payload for some reasons: incompatibility of the host's operative system, etc.)
Specifically, two models are proposed:

1. The SCIRS model where susceptible, carrier, infectious and recovered devices are taken into account, with reinfection and vaccination.

2. The SCIRQ model where an extra compartment is considered: the quarantined devices, and only temporal immunity is contemplated.

The dynamics of these models are analyzed determining the equilibrium points and their local and global stabilities. The basic reproductive numbers are derived and, from the study of their explicit expressions, some efficient control measures are stated.

Joint work with:
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Keywords: Malicious code (malware). Mathematical modeling. Computer security. Carriers. Local and global stability. Basic reproductive number.

On fractional Poincaré inequalities

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Abstract. We present some results concerning fractional Poincaré inequalities on domains of quite general metric spaces. Moreover, we study weighted inequalities where the weight is defined in terms of the distance to the boundary of the domain.
More specifically, for a domain Ω in a very general metric space (X, d) endowed with a doubling measure μ and for $1 < p, q < \infty$, we study sufficient conditions for the measure μ and the domain Ω to support inequalities of the following type

$$\int_\Omega |u(x) - u_\Omega|^q d^a(x) d\mu(x) \leq C \left(\int_\Omega \int_{\Omega \cap \{d(x,y) \leq \tau d(x)\}} \frac{|u(x) - u(y)|^p d^b(y) d\mu(y) d\mu(x)}{\mu[B(x, d(x,y))] d(x,y)^{\delta p}} \right)^{\frac{q}{p}},$$

where $d(x)$ denotes the distance of x to the boundary of Ω, u_Ω is the average of u over Ω, $\tau, \delta \in (0, 1)$ and a and b are suitable real numbers.

Joint work with:
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Irene Drelichman. Universidad de Buenos Aires (Argentina)

Keywords: Poincaré-Sobolev inequalities, fractional, metric space, John domain.

A characterization of unitary weighted composition operators on weighted Hardy spaces

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Abstract. In many Banach spaces of analytic functions all the isometries or, at least, the surjective isometries (unitary operators) are known. In the Hilbert spaces there are much more isometries, so a natural question is trying to describe all unitary operators which are, for instance, weighted composition operators.

In this poster we will answer this question in a large family of Hilbert spaces of analytic functions in the unit disk with reproducing kernels. These spaces are called weighted Hardy spaces. This is a joint work with María J. Martín and Dragan Vukotić, part of the author's thesis project.

Trabajo en colaboración con: / Joint work with:
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Keywords: weighted Hardy spaces, reproducing kernels, weighted composition operators, unitary operators

Desarrollos uniformemente convergentes de las funciones de Struve en términos de funciones especiales

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Resumen. Las funciones de Struve son soluciones fundamentales de la ecuación diferencial de Bessel

$$\frac{d^2w}{dz^2} + \frac{1}{z}\frac{dw}{dz} + \left(1 - \frac{\nu^2}{z^2}\right) w = \frac{(z/2)^{\nu-1}}{\sqrt{\pi}\Gamma(\nu + 1/2)}$$

y son útiles en la descripción de fenómenos en mecánica cuántica, aerodinámica, difracción óptica y otras áreas de la física.
La aproximación de estas funciones en términos de funciones elementales es muy conveniente para el análisis de estos fenómenos físicos. Las aproximaciones más utilizadas son los desarrollos de Taylor y asintóticos, válidos para valores pequeños y grandes de $|z|$ respectivamente. Sin embargo, estas aproximaciones no son válidas uniformemente en $|z|$. El objetivo de este trabajo es obtener desarrollos convergentes de las funciones de Struve en términos de funciones elementales que, convenientemente escaladas, son uniformes en una amplia región del plano complejo que contiene valores pequeños y grandes de la variable $|z|$.
El punto de partida es una representación integral. Después, el desarrollo de Taylor de cierto factor del integrando es usado y se intercambia la serie con la integral. Calculamos cotas precisas del error que muestran el carácter uniforme de la aproximación y su velocidad de convergencia. Finalmente, mostramos la precisión de la aproximación por medio de experimentos numéricos.

Trabajo en colaboración con:
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Pedro J. Pagola. Universidad Pública de Navarra

Palabras clave: Funciones de Struve, desarrollos uniformes, desarrollos convergentes.

Stability of p-parabolicity under quasi-isometries

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Resumen.

Abstract. Kanai proved the stability under quasi-isometries of numerous global properties (including existence of Green's function, i.e., non-parabolicity) between Riemannian manifolds of bounded geometry. Unfortunately, Kanai's hypotheses are not usually satisfied in the context of Riemann surfaces endowed with their Poincaré metric. In this work we prove the stability of p-parabolicity (with $1 < p < \infty$) by quasi-isometries, under hypotheses that many Riemann surfaces satisfy. In order to get our results, it is shown that each Riemannian surface with pinched negative curvature is bilipschitz equivalent to a surface with constant negative curvature.

Trabajo en colaboración con: / Joint work with:
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Palabras clave:
Keywords: Green's function, quasi-isometry, Riemann surface, Poincaré metric, negative pinched curvature

BMO functions and Balayage of Carleson measures in the Bessel setting

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Abstract. By $BMO_{\mathrm{o}}(\mathbb{R})$ we denote the space consisting of all those odd and bounded mean oscillation functions on $\mathbb{R}$. We characterize the functions in $BMO_{\mathrm{o}}(\mathbb{R})$ with bounded support as those ones that can be written as a sum of a bounded function on $(0,\infty)$ plus the balayage of a Carleson measure on $(0,\infty)\times(0,\infty)$ with respect to the Poisson semigroup associated with the Bessel operator

$$B_\lambda := -x^{-\lambda}\frac{d}{dx}x^{2\lambda}\frac{d}{dx}x^{-\lambda}, \quad \lambda > 0.$$

This result can be seen as an extension to Bessel setting of a classical result due to Carleson.

Joint work with:
Víctor Almeida. Universidad de La Laguna
Jorge J. Betancor. Universidad de La Laguna
Alejandro J. Castro. Nazarbayev University
Juan C. Fariña. Universidad de La Laguna

Keywords: Bessel operators, BMO functions, Carleson measure, balayage

Uso de Procesos de Difusión para el estudio de Series Temporales

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Resumen. En este trabajo se propone el uso de los procesos de difusión para el estudio y predicción en series temporales de datos. El procedimiento utilizado rompe la serie temporal en su ciclo natural de periodicidad obteniendo así múltiples trayectorias a las que ajustar un proceso de difusión. Previo al ajuste se aplica un procedimiento automatizado de agrupación de las trayectorias, mediante un análisis cluster, y depuración de las trayectorias agrupadas resultantes, mediante el uso de una función de R que permite detectar datos funcionales anómalos en forma o tamaño. La elección del proceso de difusión a ajustar se hará en base a la tendencia de las trayectorias de los datos bajo estudio entre la amplia gama existente como son los procesos Gompertz, lognormal, logístico, de Bertalanffy, etc. Una vez elegido el proceso se estiman los parámetros del mismo mediante máxima verosimilitud en cada uno de los grupos obtenidos de trayectorias, lo cual nos permitirá realizar predicciones mediante las funciones paramétricas estimadas del proceso como son su media, moda, mediana y cuantiles, tanto condicionados como sin condicionar. En particular este procedimiento se ha usado para obtener predicciones sobre series de datos temporales del tráfico de Granada, obtenidos en un proyecto en colaboración con la DGT, mediante un proceso de difusión de tipo mixto Gompertz-lognormal.

Trabajo en colaboración con:
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María Isabel García Arenas. Universidad de Granada
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Palabras clave: modelos estocásticos, procesos de difusión, series temporales

CANTOR PARADOXES AND POSSIBLE WORLDS

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Abstract. The authors illustrate the paradox concerning maximally consistent sets of propositions which is contrary to set theory. It has been shown that Cantor paradoxes do not offer particular advantages for any modal theories. The paradox is not therefore a specific difficulty for modal concepts and also it neither grants advantages or disadvantages for any modal theory. The underlying problem is quite general and affects anyone who intends to use the notion of "worldïn his ontology.

Joint work with:
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H. Gash. Dublin City University

Keywords: Actualism, Cantor theorem, Paradoxes, Possible worlds, Sets

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An extension of Bohr's Equivalence Relation to the Space of Almost Periodic Functions

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Abstract. We introduce an equivalence relation on the classes of almost periodic functions (in the sense of Bohr) of a real or complex variable which is used to refine Bochner's result that characterizes these spaces of functions. In fact, with respect to the topology of uniform convergence, we show that the limit points of the family of translates of an almost periodic function are precisely the functions which are equivalent to it, which leads us to a characterization of almost periodicity.

Keywords: Almost periodic functions · Exponential sums · Bochner's theorem · Fourier series · Dirichlet series

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Raíces de polinomios geométricos

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Resumen. Dados dos cuerpos convexos K, E de $\mathbb{R}^n$ y $\lambda \geq 0$, el volumen de la suma de Minkowski $K + \lambda E$ viene determinado por el polinomio de Steiner: $\mathrm{vol}(K + \lambda E) = \sum_{i=0}^{n} \binom{n}{i} \mathrm{W}_i(K; E)\lambda^i$. Los coeficientes $\mathrm{W}_i(K; E)$ son las denominadas quermassintegrales (relativas) de K respecto de E y, en el caso particular $E = B_n$ (la bola euclídea), involucran funcionales tales como el volumen, el área de superficie o la anchura media.

Si consideramos ahora el volumen de la suma radial $K\widetilde{+}\lambda E = \{x\widetilde{+}\lambda y : x \in K, y \in E\}$, donde $\widetilde{+}$ viene definida por

$$x\widetilde{+}y = \begin{cases} x + y, & \text{si } x \text{ e } y \text{ son proporcionales,} \\ 0, & \text{en caso contrario,} \end{cases}$$

obtenemos el denominado polinomio de Steiner dual, a saber: $\mathrm{vol}(K\widetilde{+}\lambda E) = \sum_{i=0}^{n} \binom{n}{i} \widetilde{\mathrm{W}}_i(K; E)\lambda^i$.

En los últimos años se han estudiado diversas propiedades del conjunto de raíces de los polinomios de Steiner clásico y dual (véanse, por ejemplo [1,2]): estructura, topología, monotonía en la dimensión, relaciones con otros funcionales, etc. Además, en [3], se demostró que el polinomio de Steiner clásico es un caso particular de una familia de polinomios geométricos asociados a una medida sobre la semirrecta real no negativa y se obtuvo que muchas de las propiedades anteriormente citadas seguían siendo ciertas para esta familia más general.

En este trabajo, continuamos con el estudio exhaustivo de las raíces de esta familia de polinomios de Steiner generalizados. Así mismo, se ha iniciado un estudio análogo para el polinomio de Steiner dual (es decir, considerándolo respecto a una medida), centrándonos en las similitudes y diferencias existentes entre las propiedades de las raíces de ambas familias de polinomios.

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