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Abstracts

Alex Amenta

A new version of Rubio de Francia extrapolation for Banach function spaces

Abstract:

We show the following extrapolation theorem: if a sublinear operator T is bounded on $L^p(w)$ for some $p > p_0 \geqslant 1$ and all $w \in A_{p/p_0}$, then T extends to a bounded linear operator on the weighted Bochner space $L^p(w; X)$ for all p_0-convex Banach function spaces X with UMD p_0-concavification X^{p_0}. When $p_0 = 1$ this is due to Rubio de Francia, but the $p_0 > 1$ case - which is not too difficult - seems to be either forgotten or overlooked. Consequences include Littlewood–Paley–Rubio de Francia-type estimates for 2-concave spaces X with UMD 2-concavification (first proven by Potapov–Sukochev–Xu by an ad-hoc argument), and $L^p(\mathbb{R}; X)$-boundedness of variational Carleson operators (extrapolating the recent weighted estimates of Di Plinio-Do-Uraltsev). Joint work with Emiel Lorist and Mark Veraar (TU Delft)

Odysseas Bakas

A conjecture of Pichorides on the constant in the reverse Litltlewood-Paley inequality.

Abstract:

It is well-known that for every $1 < p < \infty$ there are constants $A_p, B_p > 0$ such that

$$A_p \|f\|_{L^p(\mathbb{T})} \leqslant \|S(f)\|_{L^p(\mathbb{T})} \leqslant B_p \|f\|_{L^p(\mathbb{T})},$$

where S denotes the classical Littlewood-Paley square function on $\mathbb{T}$.

In [2], Bourgain determined the behaviour of B_p as $p \to 1^+$ and as $p \to \infty$. In [1], Bourgain showed that $A_p \sim 1$ as $p \to 1^+$. *The behaviour of A_p as $p \to \infty$ is an open problem.* A classical result due to Zygmund shows that the best we can expect is $(A_p)^{-1} \sim p^{1/2}$ as $p \to \infty$. In [3], Pichorides

showed that $(A_p)^{-1} \lesssim p \log p$ as $p \to \infty$ and moreover, he conjectured that $(A_p)^{-1} \sim p^{1/2}$ as $p \to \infty$.

In this talk, we will present the elegant argument of Pichorides and if time permits, we will briefly discuss about the aforementioned result of Zygmund and the probabilistic tools used by Bourgain in [2].

References:

[1] J. Bourgain, *On square functions on the trigonometric system*, Bull. Soc. Math. Belg. Sér. B, **37** (1985), no. 1, 20–26.

[2] J. Bourgain, *On the behavior of the constant in the Littlewood-Paley inequality*, Geometric aspects of functional analysis (1987–88), Lecture Notes in Math., **1376**, Springer, Berlin (1989), no. 1, 202–208.

[3] S. K. Pichorides, *A note on the Littlewood-Paley square function inequality*, Colloq. Math., **60/61** (1991), no. 2, 687–691.

David Beltran

Pointwise control: from the sharp maximal function to sparse operators.

Abstract:

A classical way to prove $L^p(w)$ boundedness of singular integrals T, where $w \in A_p$ and $1 < p < \infty$, is via the sharp maximal function pointwise estimate

$$M^{\#}(Tf)(x) \lesssim (M(f^r)(x))^{1/r}, \tag{†}$$

which holds for any $1 < r < \infty$. Weighted estimates follow then from those for $M^{\#}$ and M; here M denotes the Hardy–Littlewood maximal function. The inequality (†) has subsequently been refined in recent years, leading to the theory of sparse operators; see for instance [6, 3, 5, 7, 8, 4].

In my talk, I would like to present some inequalities in [2, 9] of the type (†) when T is a pseudodifferential operator associated to a symbol in *certain* Hormander symbol classes $S^m_{\rho,\delta}$. The question is to explore if sparse domination may be obtained in this case.

More generally, we may ask the more difficult question of obtaining pointwise control for *any* symbol class $S^m_{\rho,\delta}$. In the recent work [1], I obtained weighted L^2 inequalities for such objects in full generality. Trying to understand these objects from a *pointwise* point of view should require a novelty with respect to the recent techniques involving sparse operators, and could open a new framework to understand pointwise inequalities for oscillatory objects.

References:

[1] D. Beltrán, *Control of pseudo-differential operators by maximal functions via weighted inequalities*, Preprint arXiv:1608.06571.

[2] S. Chanillo, A. Torchinsky, *Sharp function and weighted Lp estimates for a class of pseudodifferential operators* Ark. Mat. **24** (1986), no. 1, 1–25.

[3] J. Conde-Alonso, G. Rey, *A pointwise estimate for positive dyadic shifts and some applications*, Mathematische Annalen, **365** (2016), no. 3-4, 1111–1135.

[4] A. Culiuc, F. Di Plinio, Y. Ou, *Uniform sparse domination of singular integrals via dyadic shifts*, Preprint available at arXiv:1610.01958. To appear in Math. Res. Lett.

[5] M. T. Lacey, *An elementary proof of the A_2 Bound*, Preprint arXiv:1501.05818.

[6] A. K. Lerner, *A pointwise estimate for the local sharp maximal function with applications to singular integrals*, Bull. Lond. Math. Soc., **42** (2010), no. 1, 843–856.

[7] A. K. Lerner, *On an estimate of Calderón-Zygmund operators by dyadic positive operators*, J. Anal. Math. **121** (2013), 141–161.

[8] A. K. Lerner, *On pointwise estimates involving sparse operators*, New York J. Math. **22** (2016), 341–349.

[9] N. Michalowski, D. J. Rule, W. Staubach, *Weighted L^p boundedness of pseudodifferential operators and applications*, Canad. Math. Bull., **57** (2012), no. 3, 555–570.

Gianmarco Brocchi

Extremizers for Strichartz estimates for perturbed Schrdinger equations.

Abstract:

This talk is based on the paper "On Extremizers for Strichartz estimates for higher order Schrdinger equations" by Diogo Oliveira e Silva and Ren Quilodrn, where they study the Fourier extension operator on the perturbed paraboloid in $\mathbb{R}^3$:

$$\Sigma_\phi = \{(y, |y|^2 + \phi(y)), y \in \mathbb{R}^2\}$$

with a sufficiently smooth convex function ϕ. The study of sharp Fourier extension relies on careful analysis of convolution of measures on hypersurfaces. We will focus on a new comparison principle for such convolutions that allows to control the effect of perturbations. If time allows we will describe the behavior of extremizing sequences using concentration-compactness techniques.

José Manuel Conde-Alonso

Calderón-Zygmund operators on nonhomogeneous spaces and weights.

Abstract:

The A_2 conjecture for a Calderón-Zygmund operator T states that the inequality (which is sharp in the dependence on the weight)

$$\|Tf\|_{L^2(w)} \lesssim [w]_{A_2} \|f\|_{L^2(w)}$$

holds true and was solved in the general case by Hytönen. Later, Lerner gave a second, easier proof whose main ingredient is the domination of a Calderón-Zygmund operator by simpler, dyadic objects called sparse operators. After that, the topic has evolved fast and multilinear extensions, other kinds of operators, or different contexts, allow such an approach to quantitative bounds of Calderón-Zygmund operators with weights.

We will focus on a context in which the picture is still not completely clear: non doubling measures. We consider Calderón-Zygmund operators defined with respect to a Radon measure μ by

$$Tf(x) \sim \int_{\mathbb{R}^d} K(x,y)f(y)d\mu(y),$$

with kernels $K(x,y)$ such that $|K(x,y)| \lesssim |x-y|^{-n}$ and $\mu(B(x,r)) \lesssim r^n$, $0 < n \leqslant d$. Pointwise and norm estimates in the spirit of Lerner's domination are possible for Calderón-Zygmund operators and A_2 weights in this context, as shown in [1] and [2]. However, Tolsa showed in [3] that the A_2 is not the 'correct' class of weights for this particular class of singular integrals. On the other hand, the aforementioned [1] and [2] are not best possible (compared to their classical counterparts). We will make a brief exposition of the problem and the available tools to tackle these two questions.

References:

[1] J.M. Conde-Alonso, J. Parcet, *Nondoubling Caldern-Zygmund theory -a dyadic approach-*, available at https://arxiv.org/pdf/1604.03711.pdf

[2] A. Volberg, P. Zorin-Kranich, *Sparse domination on non-homogeneous spaces with an application to A_p weights*, available at https://arxiv.org/pdf/1606.03340.pdf

[3] X. Tolsa, *Weighted norm inequalities for Caldern-Zygmund operators without doubling conditions*, Publ. Mat. **51** (2007), no. 2, 397-456.

Polona Durcik

Power-type cancellation for the simplex Hilbert transform

Abstract:

We prove L_p bounds for the truncated simplex Hilbert transform which grow with a power less than one of the truncation range in the logarithmic scale.

Marco Fraccaroli

On distributions with the $\mathrm{GL}_2(\mathbb{R})$ *dilation symmetry.*

Abstract:

In this talk we will discuss some classification results about $\mathrm{GL}_n^+(\mathbb{R})$-homogeneous tempered distributions on $\mathbb{R}^{n\times n}$.

For $\alpha \in \mathbb{C}$, we say that $\Lambda \in \mathcal{S}'(\mathbb{R}^{n\times n})$ is $\mathrm{GL}_n^+(\mathbb{R})$-homogeneous of degree α if for every $A \in \mathrm{GL}_n(\mathbb{R})$, $\det A > 0$, and every $\varphi \in \mathcal{S}(\mathbb{R}^{n\times n})$

$$\Lambda(D_A^\alpha \varphi) = \Lambda(\varphi),$$

where

$$D_A^\alpha \varphi(V) = \frac{1}{|\det A|^{\alpha+n}} \varphi(A^{-1}V).$$

In dimension $n = 1$, the degree of homogeneity is known to uniquely identify the tempered distributions. The aim of the talk is to present a classification result for the case $n = 2$.

Our interest arose from the multilinear singular integral form with determinantal kernel which generalize the Hilbert transform, namely

$$\Lambda(f,g,h) = \mathrm{p.\,v.} \int_{(\mathbb{R}^2)^3} \frac{1}{\det \begin{pmatrix} 1 & 1 & 1 \\ x & y & z \end{pmatrix}} f(x)g(y)h(z)\delta(x+y+z)\,\mathrm{d}x\,\mathrm{d}y\,\mathrm{d}z,$$

studied in the papers

- P. Gressman, D. He, V. Kovač, B. Street, C. Thiele, P.L. Yung, *On a trilinear singular integral form with determinantal kernel.* arXiv:1510.01069v1 [math.CA] (2015);

- S.I. Valdimarsson, *A multilinear generalisation of the Hilbert transform and fractional integration.* Revista Matemática Iberoamericana **28** (2012), no. 1, 25-55.

An easy consequence of our classification theorem is that the form defined above is identified by its invariance properties.

Kevin Hughes

Efficient congruencing and ℓ^2 decoupling for the parabola

Abstract:

Joeun Jung

Hankel-Schoenberg transforms and the radial Fourier transforms

Abstract:

We discuss the Hankel-Schoenberg transforms defined by

$$\int_0^\infty \Omega_\lambda(rt)d\nu(t) = \int_0^\infty \Gamma(\lambda+1)\left(\frac{rt}{2}\right)^{-\lambda} J_\lambda(rt)\, d\nu(t),$$

where ν is a finite positive Borel measure and J_λ denotes the Bessel function of order $\lambda \geqslant -1/2$, and their connections to the radial Fourier transforms by considering the problem of dimension walks. In addition, we construct the extended Euclid's hat function by investigating the Fourier transforms of the squares of the kernel Ω_λ.

References:

[1] L. Grafakos and G. Teschl, *On Fourier transforms of radial functions and distributions*, J. Fourier Anal. Appl., **19** (2013), pp. 167–170.

[2] R. Schaback, *The missing Wendland functions*, Adv. Comput. Math., **34** (2011), pp. 67–81.

[3] H. Wendland, *Scattered Data Approximation*, Cambridge University Press, Cambridge (2005)

Vjekoslav Kovač

Bressan's mixing problem

Abstract:

We will present an open problem on mixing flows [1] and the partial results from [2] and [3]. The authors of the latter paper have discovered interesting connections with the theory of singular integrals. We will discuss some particular cases and toy models of the problem, together will possible approaches to their resolution.

References

[1] A. Bressan, *Prize offered for the solution of a problem on mixing flows* (2006), available at `https://www.math.psu.edu/bressan/PSPDF/prize1.pdf`.

[2] G. Crippa, C. De Lellis, *Estimates and regularity results for the DiPerna-Lions flow*, J. Reine Angew. Math. **616** (2008), 15–46.

[3] M. Hadžić, A. Seeger, C. K. Smart, B. Street, *Singular integrals and a problem on mixing flows* (2016), available at `arXiv:1612.03431`.

Kangwei Li

Introduction of the Nazarov-Treil-Volberg conjecture

Abstract:

In this talk, I will introduce the Nazarov-Treil-Volberg conjecture. To be precise, I will talk about the characterization of two weight inequalities for singular integral operators. I will mainly focus on the literature, in the end, I will talk about my recent work in this problem.

References:

[1] T. Hytönen, *The two-weight inequality for the Hilbert transform with general measures*, preprint, arxiv:1312.0843.

[2] M. Lacey, *Two Weight Inequality for the Hilbert Transform: A Real Variable Characterization*, II, Duke Math. J. **163** (2014), no. 15 , 2821–2840.

[3] M. Lacey, E. Sawyer, C.-Y. Shen and I. Uriarte-Tuero, *Two Weight Inequality for the Hilbert Transform: A Real Variable Characterization*, I, Duke Math. J. **163** (2014), no. 15, 2795-2820

[4] F. Nazarov, S. Treil and A. volberg, *Two weight estimate for the Hilbert transform and corona decomposition for non-doubling measures*, unpublished manuscript, arxiv:1003.1596

Jose Madrid Padilla

On Maximal Operators

Abstract:

In this talk we will discuss many open questions regarding the boundedness and continuity of maximal operators (classical and fractional) on Sobolev spaces and on spaces of functions of bounded variation.

References:

[1] J. M. Aldaz and J. Prez Lzaro, *Functions of bounded variation, the derivative of the one dimensional maximal function, and applications to inequalities*, Trans. Amer. Math. Soc., **359** (2007), no. 5, 2443?2461.

[2] E. Carneiro and J. Madrid, *Derivative bounds for fractional maximal functions*, to appear in Trans. Amer. Math. Soc. ,http://dx.doi.org/10.1090/tran/6844.

[3] E. Carneiro, J. Madrid, L. Pierce, *Endpoint Sobolev and BV Continuity for Maximal*, preprint.

[4] J. Kinnunen, *The Hardy-Littlewood maximal function of a Sobolev function*, Israel J. Math., **100** (1997), 117–124.

[5] J. Kinnunen and E. Saksman, Regularity of the fractional maximal function, Bull. London Math. Soc., **35** (2003), no. 4, 529–535.

[6] H. Luiro, *Continuity of the maximal operator in Sobolev spaces*, Proc. Amer. Math. Soc., **135** (2007), no. 1, 243–251.

[7] H. Tanaka, *A remark on the derivative of the one-dimensional Hardy-Littlewood maximal function*, Bull. Austral. Math. Soc., **65** (2002), no. 2, 253–258.

Yves Meyer

Poisson summation formulae and the wave equation with a finitely supported measure as initial velocity

Abstract:

New Poisson summation formulae have been recently discovered by Nir Lev and Alexander Olevskii since 2013. But some other examples were concealed in an old paper by Andrew Guinand dating from 1959. This was observed by the second author in 2016. In the present contribution a third approach is proposed. Guinand's work follows from some simple observations on solutions of the wave equation on the three dimensional torus. If the initial velocity is a Dirac mass at the origin, the solution is Guinand's distribution. Using this new approach one can construct a large family of initial velocities which give rise to crystalline measures generalizing Guinand's solution.

Diogo Oliveira e Silva

A discrete, variational, nonlinear Hausdorff–Young inequality.

Abstract:

Following the works of Lyons [1, 2] and Oberlin, Seeger, Tao, Thiele and Wright [3], we relate the variation of certain discrete curves on the Lie group SU(1,1) to the corresponding variation of their linearized versions on the Lie algebra. Combining this with a discrete variational Menshov–Paley–Zygmund theorem, we establish a variational Hausdorff–Young inequality for a discrete version of the nonlinear Fourier transform on SU(1,1).

References:

[1] T. Lyons, *Differential equations driven by rough signals. I. An extension of an inequality of L. C. Young*, Math. Res. Lett., **1** (1994), no. 4, 451–464.

[2] T. Lyons, *Differential equations driven by rough signals*, Rev. Mat. Iberoam., **14** (1998), no. 2, 215-310.

[3] R. Oberlin, A. Seeger, T. Tao, C. Thiele and J. Wright, *A variation norm Carleson theorem*, J. Eur. Math. Soc., **14** (2012), no. 2, 421–464.

João Pedro Gonçalves Ramos

Equivalence of some root uncertainty principles and rearrangement inequalities

Abstract:

Let $\widehat{f}(\xi) = \int_{\mathbb{R}} f(x)e^{2\pi i x\xi}\mathrm{d}x$ be the Fourier transform on the real line, and, for every L^1, real and even function on the real line, consider the number

$$A(f) := \inf\{r \geqslant 0; f(x) \geqslant 0, \forall x \geqslant r\}.$$

Inspired by recent bounds on $\mathcal{A} := \inf_{f \text{ as above}} A(f)A(\widehat{f})$ and the classical uncertainty principles in harmonic analysis, we prove the equivalence (in)equalities

$$\mathcal{A} = \mathcal{A}_{\mathcal{S}} = \mathcal{A}_{bl} \geqslant \mathcal{A}_d > 0,476\mathcal{A},$$

where $\mathcal{A}_{\mathcal{S}}$ and $\mathcal{A}_{bl}$ stand for, respectively, the infimum of $A(f)A(\widehat{f})$ taken over the intersection of the function space above with Schwartz functions and functions with compact support.

The last number we define aside as a *discrete* analogue of the ones above. That is, if $f : \mathbb{T} \to \mathbb{R}$ is also even and integrable, with $\widehat{f} \in \ell^1(\mathbb{Z})$, then

$$
\begin{aligned}
Z(f) &= \inf\{1/2 \geqslant r \geqslant 0; f(x) \geqslant 0, \forall x \geqslant r\} \\
Z(\widehat{f}) &= \inf\{n \geqslant 0; \widehat{f}(k) \geqslant 0, \forall k \geqslant n\}.
\end{aligned}
$$

We define then $\mathcal{A}_d := \inf_{g \text{ as above}} Z(g)Z(\widehat{g})$. We currently conjecture that actually $\mathcal{A}_d = \mathcal{A}$.

The talk is going to be focused mainly on rearrangement techniques and how one can actually use them to derive contradictions in this context. We will try to show how concentration of negative mass of an extremizer should be related to its approximability by Schwartz functions, and sketch on how to conclude that this concentration has to be total, at least in a small neighbourhood of the origin.

Mateus Sousa

Regularity of maximal operators

Abstract:

The aim of this talk is to discuss the boundedness of the derivative of the hardy-littlewood maximal function of $W^{1,1}$ functions, i.e., given a function $f \in W^{1,1}$, do we a have

$$\|\nabla Mf\|_1 \leqslant C\|\nabla f\|_1,$$

where Mf is the maximal function? Bounds like this were proven in the one dimensional case by Tanaka [4] and Kurka [1] for the noncentered and centered maximal functions respectively, and until very recently nothing was known in higher dimensions. We will focus on two recent results by Saari

[3] and Luiro [2] which are in the direction of obtaining bounds in arbitrary dimensions.

References:

[1] O. Kurka, *On the variation of the Hardy-Littlewood maximal function*, Ann. Acad. Sci. Fenn. Math., **40** (2015), no. 1, 109–133.

[2] H. Luiro, *The variation of the maximal function of a radial function*, preprint at https://arxiv.org/abs/1702.00669

[3] O. Saari, *Poincaré inequalities for the maximal function*, preprint at https://arxiv.org/abs/1605.05176

[4] H. Tanaka, *A remark on the derivative of the one-dimensional Hardy-Littlewood maximal function*, Bull. Austral. Math. Soc. **65** (2002), no. 2, 253–258.

Christoph Thiele

The triangular Hilbert integral, progress and approach to the open problem

Abstract:

The triangular Hilbert integral is a singular integral depending on three functions in the plane. With Vjeko Kovac and Pavel Zorin Kranich we recently proved Lp bounds for a discrete model of the the triangular Hilbert transform, when one of the three functions takes a special form such as elementary tensor structure. I will report on this progress and also metion some thoughts about possible further progress.

Gennady Uraltsev

Extensions of outer measure space theory for time-frequency-scale analysis.

Abstract:

In this talk we will cover some recent developments in encoding results from Time-Frequency-Scale Analysis and Time-Scale Analysis using outer measure L^p spaces. After some basic definitions about the dyadic phase plane we will cover the construction of iterated outer measure spaces and prove boundedness of associated embedding maps extending and encoding the seminal paper by Do Thiele and "A modulation invariant Carleson embedding theorem outside local L^2" of Di Plinio and Ou.

These embedding theorems are the crucial elements for proving boundedness of the Bilinear Hilbert Transform, (Variational Carleson's operators). It seems that they are sufficient to prove Uniform BHT bounds if coupled with a strong enough paraproduct (single tree) estimate.

We will conclude by talking about the relation of embedding maps and outer measure spaces to sparse domination results as in "Domination of multilinear singular integrals by positive sparse forms" by Culiuc, Di Plinio, Ou and "Positive Sparse Domination of Variational Carleson Operators" by Di Plinio, Do, U.

Marco Vitturi

Maximal Fourier Restriction theorems.

Abstract:

We discuss a recent result of Mller, Ricci and Wright regarding maximal restriction theorems.
Most results in restriction theory typically take the form of a-priori inequalities, and thus the Fourier restriction Rf of $f \in L^p$ is in principle only defined in an operator-theoretic sense. However, in keeping with the original spirit of the restriction question, it makes sense to ask what's the pointwise relation between Rf and $\hat{f}$. In particular, one might ask whether one can recover a.e. Rf by taking limits of averages of $\hat{f}$. Mller, Ricci and Wright prove that, for restriction to planar curves in $\mathbb{R}^2$, this is the case: for any $f \in L^p$, $1 \leqslant p < 8/7$, a.e. point of the curve with non-vanishing curvature is a Lebesgue point for $\hat{f}$.

The result is open to a number of improvements (notice $8/7 < 4/3$, the critical exponent) and generalizations.

References:

[1] D. Müller, F. Ricci, J. Wright, *A maximal restriction theorem and Lebesgue points of functions in* $\mathcal{F}(L^p)$, 2016, arXiv:1612.04880.

Michal Warchalski

The uniform bounds for the Walsh model of the bilinear Hilbert transform

Abstract:

We discuss a novel proof of the uniform bounds for the Walsh model of the bilinear Hilbert transform in the local L^1 range that is based on a work of Oberlin and Thiele. The new approach makes a use of the theory of iterated outer measure spaces that was developed by Uraltsev and an embedding theorem proven by Di Plinio and Ou.

First of all we reduce the problem to bounding a space-localised form by appropriate outer measure L^p norms. These bounds depend on an improved frequency localised estimate (paraproduct). The bounds for the full form follow then from the embedding theorem proven by Di Plinio and Ou.

The talk is based on a work with G. Uraltsev. Transferring this approach to the continuous setting is in progress. The work of Di Plinio and Ou provides an applicable embedding theorem for this setting.

Pavel Zorin-Kranich

Using Lipschitz regularity

Abstract:

A well-known conjecture of Zygmund states that the Lebesgue density theorem holds along a Lipschitz vector field v in the sense that at a.e. point x of a measurable set A instead of having balls mostly contained in A we can have line segments in direction $v(x)$ mostly contained in A. Lipschitz regularity is necessary due to examples related to Besicovitch sets.

This motivates a number of related questions, but until recently it has been unknown how to use Lipschitz regularity in any of them.