Joseph FENEUIL

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Research themes: harmonic analysis, elliptic partial differential equations, geometric measure theory.

RESEARCH INTERESTS

▶ **Harmonic analysis applied to elliptic PDE and geometric measure theory:** I am studying the solvability of the Dirichlet, Neumann, and regularity problems for non-smooth coefficients and/or non-smooth boundaries. My work mainly focus on domains which are complement in $\mathbb{R}^n$ of sets of dimension $d < n - 1$.

Key-words are: Sets with higher co-dimensional boundaries, degenerate elliptic PDE, De Giorgi-Nash-Moser estimates, harmonic measure, A^∞-absolute continuity of measure, comparison principle, Green functions, Carleson perturbations.

▶ **Analysis on non-Euclidean spaces (harmonic analysis, geometric analysis, probability):** My main achievement is the proof of the L^p-boundedness of the Riesz transform for $1 < p < 2$ under sub-Gaussian estimates on the heat kernel.

Key-words are: Riesz transform, heat kernel estimates, Littlewood-Paley-Stein functionals, fractal graphs, Riemannian manifolds, doubling spaces, Hardy spaces, Gaffney estimates, Besov spaces, paraproducts, Lie groups.

SCHOLARSHIP

2012-2015 : Ph.D. under the supervision of Emmanuel RUSS at Université Joseph Fourier, Grenoble (France). The memoir is entitled *Harmonic analysis on graphs and Lie groups: Quadratic functionals, Riesz transforms and Besov spaces.*

2012 : Master degree in mathematics (speciality PDE) at Université Lyon 1.

2011 : Agrégation de mathématiques (competitive examination for positions in public education).

2009 : Degree in mathematics at University Rennes 1.

2008-2012 : École Normale Supérieure de Cachan, Britanny Branch.

Professional Experience

2024- : Assistant Professor (Maître de Conférence) at the Université Paris-Saclay, France.

2022-2023 : MSI Fellow at the Australian National University, Canberra, Australia.

2021-2022 : Postdoctoral Fellow at Pisa, Italy, funded by the grant ERC VAREG "Variational approach to the regularity of the free boundaries", supervised by Bozhidar Velichkov.

2021 : Postdoctoral Fellow with the Simons Foundation Localization of Waves Collaboration, at Université de Paris-Saclay, France, supervised by Guy David.

2018-2020 : Non Tenure Track Assistant Professor, Temple University, Philadelphia, USA.

2015-2018 : Dunham Jackson Assistant Professor, University of Minnesota, Minneapolis, USA. Mentor: Svitlana Mayboroda.

2012-2015 : Graduate student in Grenoble, France. Supervisor: Emmanuel Russ.

Teaching

Recent (at the Université Paris-Saclay)

Spring 2024 : Discussions for *Homolomorphic functions* and *Ordinary Differential Equations* for the Magistère (L3).

Spring 2024 : Discussions for *Fourier Analysis for physicists* for the physics degree (L2).

Older

2022-2023 : Functional Analysis (x2), Introductory research course entitled "Regularity theory for uniformly elliptic operators". *Australian National University.*

2018-2020 : Calculus II, Multivariable Calculus, Differential Equation, Linear Algebra. *Temple University, USA.*

2015-2018 : Calculus I (x3), Mathematical Modeling (x2), Introduction to PDE (x1). *University of Minnesota, USA.*

2012-2015 : Calculus I and II, and Fourier Series. *Université Joseph Fourier (now Université Grenoble Alpes), IUT, Department of "Telecommunications and Networks".*

Publications

All my preprints can be found on ArXiv.

Sᴍᴀʟʟ ᴄᴀᴘ In press or accepted

[1] A Green function characterization of uniformly rectifiable sets of any dimension (with L. Lɪ), *Adv. Math.*, accepted. Available at https://arxiv.org/abs/2302.00000.

[2] Green functions and smooth distances (with L. Lɪ and S. Mᴀʏʙᴏʀᴏᴅᴀ), *Math. Ann.*, accepted. Available at https://arxiv.org/abs/2211.05318.

[3] The regularity problem in domains with lower dimensional boundaries (with Z. Dᴀɪ and S. Mᴀʏʙᴏʀᴏᴅᴀ), *J. Funct. Anal.*, accepted under minor modifications. Available at https://arxiv.org/abs/2208.00628.

[4] Carleson perturbations in the regularity problem (with Z. Dᴀɪ and S. Mᴀʏʙᴏʀᴏᴅᴀ), *Rev. Mat. Iberoam.* **39**, no. 6, 2119–2170, 2023.

[5] Elliptic theory in domains with boundaries of mixed dimension (with G. Dᴀᴠɪᴅ and S. Mᴀʏʙᴏʀᴏᴅᴀ), *Astérisque* **442**, vi+139 pp, 2023.

[6] Absolute continuity of the harmonic measure on low dimensional rectifiable sets, *J. Geom. Anal.* **32** , no. 10, Paper No. 247, 36p, 2022.

[7] Green function estimates on complements of low-dimensional uniformly rectifiable sets (with G. Dᴀᴠɪᴅ and S. Mᴀʏʙᴏʀᴏᴅᴀ), *Math. Ann.* **385**, no. 3-4, 1797–1821, 2023.

[8] Generalized Carleson perturbations of elliptic operators and applications (with B. Pᴏɢɢɪ), *Trans. Amer. Math. Soc.* **375**, no. 11, 7553–7599, 2022

[9] A change of variable for Dahlberg-Kenig-Pipher operators, *Proc. Amer. Math. Soc.* **150**, no. 8, 3565–3579, 2022.

[10] Green function with pole at infinity applied to the study of the elliptic measure, *Anal. PDE* **16** no. 2, 545–570, 2023.

[11] The Dirichlet problem in domains with lower dimensional boundaries (with S. Mᴀʏʙᴏʀᴏᴅᴀ and Z. Zɪʜᴜɪ), *Rev. Mat. Iberoam.* **37**, no. 3, 821–910, 2021.

[12] A new elliptic measure in lower dimensional sets (with G. Dᴀᴠɪᴅ and S. Mᴀʏʙᴏʀᴏᴅᴀ), *Acta Math. Sinica, special issue in honor of Carlos Kenig's 65th birthday*, **35**, no 6, 876–902, 2019.

[13] Dahlberg's theorem in higher co-dimension (with G. Dᴀᴠɪᴅ and S. Mᴀʏʙᴏʀᴏᴅᴀ), *J. Funct. Anal.* **276**, no 9, 2731–2820, 2019.

[14] Elliptic theory for sets with higher co-dimensional boundaries (with G. Dᴀᴠɪᴅ and S. Mᴀʏʙᴏʀᴏᴅᴀ). *Mem. Amer. Math. Soc.* **273**, no 1346, 2021.

[15] Algebra properties for Besov spaces on unimodular Lie groups. *Colloq. Math.* **154**, 205–240, 2018.

[16] About the L^2-analyticity of Markov operators on graphs. *Proc. Amer. Math. Soc.* **146**, 1793–1805, 2018.

[17] Harmonic measure on sets of codimension larger than one (with G. Dᴀᴠɪᴅ and S. Mᴀʏʙᴏʀᴏᴅᴀ), *C. R. Math. Acad. Sci. Paris* **355**, no. 4, 406–410, 2017.

[18] Riesz transform for $1 \leq p \leq 2$ without Gaussian heat kernel bound (with L. Chen, T. Coulhon, and E. Russ), *J. Geom. Anal.*, **27**, no 2, 1489–1514, 2017.

[19] Hardy and BMO spaces on graphs, application to Riesz transform, *Pot. Anal.*, **45**, no 1, 1–54, 2016.

[20] Littlewood-Paley functionals on graphs, *Math. Nachr.* **288**, no 11-12, 1254–1285, 2015.

Preprints

[21] An alternative proof of the L^p-regularity problem for Dahlberg-Kenig-Pipher operators on $\mathbb{R}^n_+$, 19 pages, `https://arxiv.org/abs/2310.00645`.

[22] Boundedness of Riesz transform on H^1 under sub-Gaussian estimates, 40 pages, `https://arxiv.org/abs/1505.07001`.

Conference and Seminar presentations

- **May 2024.** 49th Annual Spring Lecture Series, on *Harmonic analysis, partial differential equations, and geometric measure theory*, University of Arkansas, USA.
- **April 2023.** Analysis Seminar, The university of Edinburgh, UK.
- **December 2022.** Annual meeting of the AustMS (Australian Mathematical Society), Sydney, Australia.
- **September 2022.** Analysis and Geometry Seminar, Australian National University, Canberra, Australia.
- **May 2022.** CBMS conference *Analysis, Geometry, and PDEs in a Lower-Dimensional World*, Florida State University, Tallahassee, USA.
- **March 2022.** Analysis and Probability Seminar, Université de Clermont-Ferrand, France.
- **February 2022.** Analysis Seminar, Université de Lille, France.
- **January 2022.** Workshop on *Geometric measure theory and Harmonic analysis*, Hausdorff Institute of Mathematics, Bonn, Germany.
- **November 2020.** Analysis and PDE Seminar (online), University of Minneapolis, USA.
- **January 2020.** Colloquium, University of Alabama, USA.
- **May 2019.** Analysis and PDE Seminar, University of Nantes, France.
- **April 2019.** AMS meeting at Hartford, USA.
- **March 2019.** Analysis Seminar, Temple University, Philadelphia, USA.
- **December 2018.** Analysis Seminar, Temple University, Philadelphia, USA.
- **November 2018.** AMS meeting at Fayetteville, USA.
- **April 2018.** AMS meeting at Boston, USA.
- **October 2017.** Conference on *Harmonic analysis and geometric measure theory,* Marseille, France.
- **June 2017.** Meeting of the ANR *Harmonic Analysis at its Boundaries*, Nantes, France.

- **June 2016.** *10th International Conference on Harmonic Analysis and Partial Differential Equations,* El Escorial, Spain.
- **February 2016.** PDE Seminar, University of Minnesota.
- **October 2014.** Workshop on *Functional calculus and Harmonic analysis of semigroups,* Besançon, France.
- **October 2013.** Meeting of the GDR *Functional Analysis, Harmonic Analysis and Probability*, Lyon, France.
- **October 2013.** Analysis Seminar, Institut Fourier, Grenoble, France.

Other research activities

▶ **Reviews for:** Advances in mathematics, Analysis & PDE, Communications in PDE, Duke Mathematical Journal, Journal of Geometric Analysis, Mathematische Annalen, Nonlinear Analysis, Proceedings of the AMS, Transactions of the AMS. I also regularly write reviews for MathSciNet.

▶ **Co-supervision** of Zanbing DAI's Ph.D. Zanbing DAI is a graduate student at the University of Minnesota under the supervision of Svitlana MAYBORODA, and I was unofficially mentoring him.

Spoken languages and Computer skills

French, mother tongue; **English**, fluent.

Computer skills: LaTeX, Maple, Matlab and Scilab.