

# Michele Villa

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Born: March 16, 1992—Como, Italy.

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## Current positions

April 2021 *Assistant professor (tenure-track)* at the University of Oulu.  
Sept 2022 *Academy of Finland postdoctoral researcher* at the University of Oulu.

## Field of research

Mathematical analysis. More specifically, geometric measure theory, with focus on quantitative aspects of rectifiability. Also, geometric problems from harmonic analysis, for example boundedness of singular integral operators on non-smooth sets.

## Previous positions

Sep 20-July 21 *Postdoctoral researcher* at the University of Jyväskylä, funded by an Academy of Finland grant with [Tuomas Orponen](#) as PI.  
Mar-Sep 20 *Postdoctoral researcher* at the University of Helsinki, funded by an Academy of Finland grant with Tuomas Orponen as PI.

## Education

Sep 16-June 20 *PhD in Mathematics* at the [Maxwell Institute Graduate School in Analysis and its Applications](#) (MIGSAA). Area of specialisation: geometric measure theory. Supervisor: [Jonas Azzam](#). The external examiner at my difense was [Guy David](#). PhD obtained in June 2020.  
2012-2016 *BSc in Mathematics* at the University of Dundee, Scotland. Degree class: First with Honours.

## Papers and Preprints

14. Azzam J., Mourgoglou M., and Villa M. Quantitative differentiation on uniformly rectifiable sets. Preprint 2022 (available upon request).
13. Dąbrowski D. and Villa M. [Analytic capacity of sets with plenty of big projections and Vitushkin conjecture](#). ArXiv preprint (2022).
12. Chang A., Dąbrowski D., Orponen T. and Villa M. [Structure of sets with nearly maximal Favard length](#). ArXiv preprint (2022).

11. Villa M. [A note on Hausdorff dimension of sets with plenty of big projection](#). ArXiv preprint (2021).
10. Dąbrowski D., Orponen T. and Villa M. [Integrability of orthogonal projections, and applications to Furstenberg sets](#). ArXiv preprint (2021). To appear in *Adv. Math.*
9. Hyde M. and Villa M. [Cone and paraboloid points of arbitrary subsets of Euclidean space](#). ArXiv preprint (2021).
8. Orponen T. and Villa M. [Sub-elliptic boundary value problems in flag domains](#). *Adv. Calc. Var.* To appear. Arxiv preprint (2020).
7. Dąbrowski D. and Villa M. [Necessary condition for the  \$L^2\$  boundedness of the Riesz transform in Heisenberg groups](#). Arxiv preprint (2020).
6. Villa M. [A square function involving the center of mass and rectifiability](#). *Math. Zeitschrift*. To appear. Arxiv preprint (2019).
5. Jaye B., Tolsa X., and Villa M. [A proof of Carleson  \$\epsilon^2\$ -conjecture](#). *Ann. of Math.* Vol. 194, No. 1 (July 2021), pp. 97-161 (65 pages).
4. Villa M. [Higher dimensional Jordan curves](#). Arxiv preprint (2019).
3. Villa M.  [\$\Omega\$ -symmetric measures and related singular integrals](#). *Rev. Mat. Iberoam.* Electronically published on January 18, 2021. doi: 10.4171/rmi/1245 (to appear in print)
2. Azzam J, and Villa, M. [Quantitative comparisons of multiscale geometric properties](#). *Analysis & PDEs*. Vol. 14 (2021), No. 6, 1873–1904.
1. Villa M. [Tangent points of  \$d\$ -lower content regular sets and  \$\beta\$  numbers](#). *J. Lond. Math. Soc.* Vol 101, Issue 2, April 2020, Pg. 530-555.

## Talks

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|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| June 2022    | Workshop talk at the <a href="#">Young research symposium</a> in harmonic analysis. Satellite event of the conference <a href="#">Fourier Analysis At 200</a> . Edinburgh, Scotland. |
| May 2022     | Seminar talk at the <a href="#">Barcelona Analysis seminar</a> . Barcelona, Spain.                                                                                                   |
| Feb. 2022    | Workshop talk at the HIM research trimester on PDEs, Harmonic analysis and geometric measure theory. Bonn, Germany.                                                                  |
| Dec. 2021    | Seminar talk at the Harmonic Analysis seminar of Université Paris-Saclay.                                                                                                            |
| Dec. 2021    | Seminar talk at the <a href="#">Bilbao Analysis and PDEs</a> seminar.                                                                                                                |
| October 2021 | Talk at <a href="#">Rajchman, Zygmund, Marcinkiewicz</a> conference. IM PAN, Warsaw (Poland).                                                                                        |
| August 2021  | Invited speakers at <a href="#">Geometric measure theory and applications</a> in Cortona (Italy).                                                                                    |
| May 2021     | Seminar talk at the Analysis group seminar at Oulu university.                                                                                                                       |
| Oct. 2020    | Seminar talk at the <a href="#">Geometry Seminar</a> of the University of Jyväskylä.                                                                                                 |
| June 2020    | Seminar talk at the <a href="#">Virtual Harmonic Analysis</a> seminar. Online seminar, organised by a network of UK-based mathematicians.                                            |

- Nov. 2019 Seminar talk at the [Analysis seminar](#) of the University of Edinburgh.
- Oct. 2019 *A proof of the Carleson  $\epsilon^2$ -conjecture*. Talk at the workshop on [Geometry and Analysis](#) at IM PAN (Warsaw) in October 2019.
- June 2019  *$\Omega$ -symmetric measures and related singular integrals*. Contributed talk at [BAC2019](#), June 2019.
- June 2019 Contributed talk at the [HAPDE](#) conference in Helsinki (June 2019).
- May 2019 *A family of analyst's travelling salesman theorems*. Seminar talk at the joint [Analysis Seminar](#) of UAB-UB in Barcelona, 20/05/2019.
- May 2017 *Towards a new characterisation of uniform rectifiability*. Talk given at the MIGSAA 2017 symposium.
- April 2017 *Non-tangential behaviour and Carleson measures*. Talk given for the SMSTC (Scottish Mathematical Training Center) course of Harmonic Analysis.
- June 2016 *Classification of three dimensional steady flow*. Talk given at the Topological fluid dynamics seminar at the University of Dundee following VI Arnold's work on the subject.

## Scholarships, awards and other financial support

- Sept 22 - Aug 25 **Academy of Finland postdoctoral grant**. Three years of funding covering wage, travel money and various material. Total funding: 231241 Euros.
- May 2021 **Certificate of Commendation (PhD Thesis Prize)** awarded by the Edinburgh Mathematical Society. This is a bi-yearly prize for the best doctoral theses in pure and applied mathematics in Scotland.
- Apr.-Jul. 2019 Support from X. Tolsa's grant to finance a research stay at UAB (Catalonia), for a total sum of 2000 Euros.
- March 2019 *Dr. Laura Wisewell Travel Scholarships*. A scholarship of £450 awarded to travel to Barcelona for a research visit to X. Tolsa.
- Jan. 2019 *Erasmus + grant*. A grant to fund a four months long visit at UAB, Barcelona, for a total amount of £1550.
- Nov. 2018 *Essay prize*. A yearly award to the best written mathematical essays in the department of mathematics at the University of Edinburgh. The award amounts to £400 for travelling.
- July 2018 *Researcher Development Scholarship*. Travel fund of £800 to participate to the IAS/PCMI program in Park City, Utah.
- July 2018 *IAS/PCMI scholarship*. Scholarship to fund fees, room and board for the Graduate program of IAS/PCMI in Park City, Utah.

## Research Visits, Research Programs

- May 2022 One week long research visit to X. Tolsa, UAB, Barcelona, Spain.
- Spring 2022 [HIM research trimester](#). Research program at the Hausdorff Institute for Mathematics on Harmonic Analysis and Geometric Measure Theory. Bonn, Germany.
- Oct 21-Jan 31 Research visit to Guy David, Université Paris-Saclay.
- Sept. 2019

[Simons Semester](#) at IM PAN (Warsaw) on Geometry and Analysis in function and mapping theory on Euclidean and metric measure spaces. **Invited participant.**

- Summer 2019 *Research visit at UAB, Barcelona.* A four months long (from April to August) research visit at UAB, under the supervision of Xavier Tolsa. Supported by Tolsa ERC grant and an Erasmus + grant.
- July 2018 [IAS/PCMI Research Program in Harmonic Analysis.](#) Park City, Utah (US).

## Conferences, Workshops

- June 2022 [Fourier Analysis at 200.](#) Edinburgh, Scotland.
- June 2022 [Young researcher symposium in harmonic analysis.](#) Edinburgh, Scotland.
- October 2021 [Rajchman, Zygmund, Marcinkiewicz](#) conference. IM PAN, Warsaw (Poland)
- Aug 2021 [Geometric measure theory and applications](#) in Cortona (Italy).
- Oct. 2019 [Workshop on Geometry and Analysis at IM PAN](#) (Warsaw).
- June 2019 [BAC2019.](#) Barcelona Analysis conference.
- June 2019 [Harmonic analysis and PDEs workshop.](#) One-day LMS meeting in Birmingham. 14th of June, 2019.
- June 2019 [Harmonic analysis in non-homogeneous spaces.](#) Workshop in Birmingham, UK. June 2019.
- June 2019 [HAPDE 2019.](#) Harmonic Analysis and PDEs conference. Helsinki, June 2019.
- October 2017 [Harmonic Analysis and Geometric measure Theory.](#) Conference at CIRM, Marseilles, France.
- July 2017 [Neurogeometry.](#) SMI Summer School, Cortona, Italy.
- June 2017 [New trends on Analysis and Geometry in Metric Spaces.](#) CIME-CIRM Course in Levico Terme, Italy.
- Dec. 2016 [Geometric PDEs at Warwick.](#) The week-long workshop aimed at presenting some current research in Geometric analysis and PDEs.
- August 2016 [SMI Summer School](#) (University of Perugia, Italy). SMI is the Italian acronym for Inter-university Mathematical School. This summer school lasts the whole months of August and comprises lectures, exercises classes and mid-term and final exams. Participants need to choose between two courses. My choice was Introduction to PDEs (which covered the Elliptic and Parabolic theory of linear equation, following LC Evans' book), and Differential Geometry (following FW Warner's book).
- Summer 2016 [Topological Fluid Dynamics reading group](#) (University of Dundee). Participant.
- June 2016 [Fourth Scottish PDEs Colloquium.](#) Participant.
- 2014-2015 [1 year academic exchange](#) (University of Hamburg).

## Teaching experience and supervision

- Spring 2022 Supervision of the Master thesis of Paul Le-Breton, visiting from ENS Paris-Saclay.
- Spring 2021 Teaching assistant for *Fourier Analysis* (online). Course for Master/PhD students, two-hours workshops. University of Jyväskylä.
- Spring 2019 Workshops for *Honours Complex Analysis* (HCV, MATH10067, one-hour tutorial plus two-hour presentation skills). University of Edinburgh.

- Autumn 2018 Workshops for *Honours Analysis* (HA, MATH10068, one-hour tutorial plus two-hour presentation skills). University of Edinburgh.
- Spring 2018 Tutorials for Proofs and Problem Solving (PPS, MATH08059, two-hour tutorial).
- Autumn 2017 Tutor for the SMSTC course *Measure and Integration* for first year PhD students. University of Edinburgh and Heriot-Watt University.
- 2015-2016 *MathDoctor, UK*. MathDoctor is an online company which provides online tutoring to students from primary school to university. I mostly teach to A-levels students, IB students and 1st year university students.

## Other past projects

- 2016 *Mathematical theory of Finite Element Methods*. (MIGSAA Taster Project). The project, which was done in group, looked at the theoretical foundations of a finite element method.
- 2015-2016 *Smooth symmetries of vector fields (BSc Dissertation)*. Project supervised by Prof Gunnar Hornig. The work is an investigation on the symmetries of a physical system. This area of research goes back to at least Emmy Noether's theorem, which states that for any physical system which have a continuous symmetry there exists a conservation law, and vice versa. In particular, the project looked at how the theory of the de Rham cohomology provides information on the existence of such symmetries.
- 2014 *Modelling of binocular rivalry*. Summer project with Dr Hiroko Kamei. The aim of the project was to understand some existing models of binocular rivalry. This phenomenon consists in the cyclic switching of firing between the two main neuron bundles (one per eye) of the visual cortex. Such switching is brought about by changing in lighting conditions, object shapes, etc. It is natural to study the phenomenon using bifurcations theory.

## Various other skills and interests

Languages spoken: Italian (native), English (fluent), German (basic).

I have experience in working with the following: CAS Maple, MATLAB/GNU Octave, R, Latex, Python, Linux operating systems.