CV Markus Faulhuber

Personal Details

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ORCID:	0000-0002-7576-5724
Date of Birth:	23.03.1985
Nationality:	Austria
marital status:	married, 1 kid
Languages:	German (mother tongue), English (business fluent), Norwegian (basic)

Main Area of Research

I am a project leader at the Faculty of Mathematics of the University of Vienna, where I work within the Numerical Harmonic Analysis Group (NuHAG).
My main area of research covers and connects topics in (harmonic) analysis, mathematical physics, signal processing and data science. A special research interest of myself are extremal geometric problems in analysis. This includes the study of optimal sampling strategies and discretization, the study of lattice theta functions or energy minimization and polarization.
My major achievements include, in co-operation with L. Bétermin and S. Steinerberger, an analytic solution on determining optimal sampling strategies for Gaussian Gabor frames. Such systems are, e.g., state of the art in wireless communication (4G/5G standards, WLAN). My results imply the correctness of the long standing conjecture on optimal sampling raised by T. Strohmer and S. Beaver in 2003. Also, the results give an optimality result among optimally charged ionic crystals as studied by M. Born in 1921. Furthermore, my results show connections to the open problem of finding the exact value of Landau's constant in geometric function theory, dating back to 1929.

Academic Qualifications

Feb 2017	Doktor der Naturwissenschaften (Dr.rer.nat. / PhD) in Mathematics, University of Vienna
Apr 2014	Master of Science (MSc) in Mathematics, University of Vienna
Mar 2012	Bachelor of Science (BSc) in Mathematics, University of Vienna

Academic Positions

Oct 2020 - Sep 2022	**Faculty of Mathematics, University of Vienna** Project Leader
Oct 2020 - Sep 2022	**Faculty of Mathematics, University of Vienna** University Assistant ($\sim$ non-tenure-track Assistant Professor)
Apr 2020 - Sep 2020	**Department of Mathematics, RWTH Aachen University** stand-in Professor for Mathematics of Data Science

Aug 2019 - Mar 2020	**Faculty of Mathematics, University of Vienna** University Assistant ($\sim$ non-tenure-track Assistant Professor)
Nov 2018 - Jul 2019	**Faculty of Mathematics, University of Vienna** Erwin-Schrödinger Fellow (Project leader)
Aug 2017 - Oct 2018	**Department of Mathematical Sciences, NTNU Trondheim** Erwin-Schrödinger Fellow (Project leader)
Mar 2017 - Jul 2017	**Faculty of Mathematics, University of Vienna** Research Assistant (PostDoc)
Sep 2014 - Feb 2017	**Faculty of Mathematics, University of Vienna** Research Assistant (PreDoc, 75% employment)
Oct 2012 - Apr 2014	**Faculty of Mathematics, University of Vienna** Student Assistant (master student, 50% employment)

Grants

showing month and year when the grant was awarded

(ongoing)

Mar 2020 **Stand-alone Project**
Austrian Science Fund (FWF), € 610.858,50
48 months, University of Vienna
March 2021 – February 2025
FWF grant P33217, *Inside the Frame Set.*

(finished)

Jun 2020 **1000-Ideas Program**
Austrian Science Fund (FWF), € 150.184,39
24 months, University of Vienna
October 2020 – September 2022
FWF grant TAI6, *Universal Optimality of the Hexagonal Lattice.*

Jun 2017 **Erwin-Schrödinger Fellowship**
Austrian Science Fund (FWF), € 116.417,50
24 months, NTNU Trondheim (15 months) and University of Vienna (9 months)
August 2017 – July 2019.
FWF grant J4100, *A "Weltkonstante" in Time-Frequency Analysis.*

Teaching Experience

Students

PhD

current I. Shafkulovska (in co-supervision with Prof. K. Gröchenig)

Master

current A. Xu

Bachelor

2023 S S. Elgohary (BEd). *Dichteste Kugelpackungen* [*Densest sphere packings*]

M. Katzenschlager (BEd). *Die Unschärferelation* [*The uncertainty principle*]

B. Meyer (BSc). *Time-Frequency Analysis*

2020/21 W	A. Kaiser (BEd). *Gitterpackungen und -überdeckungen und die Methode der diagonalen Verformung* [*Lattice packings and coverings and the method of diagonal distortion*]
	E. Zou (BEd). *An Introduction to Time-Frequency Analysis*
2020 S	B. Rohacky (BEd). *Die Riemannsche Vermutung – Über den Zusammenhang der Primzahlverteilung mit den nicht-trivialen Nullstellen der Zeta-Funktion* [*The Riemann hypothesis – On the connection between the distribution of primes and non-trivial zeros of the zeat function*]
2019/20 W	V. Spanikova (BEd). *Elliptische Kurven und ihre Anwendung in der Kryptographie* [*Elliptic curves and their application in cryptography*]
2019 S	M. Weinhandl (BEd). *Die Lemniskate von Bernoulli und das arithmetisch-geometrische Mittel von Gauß* [*The lemniscate of Bernoulli and the arithmetic-geometric mean of Gauss*]

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Courses The number in brackets (x) stands for x academic units per week.

Oct 2021 - Sep 2022	**Faculty of Mathematics, University of Vienna** University Assistant - Seminar (1+1) *Harmonic Analysis* (SS22) (jointly with Prof. K. Gröchenig) - Exercises (1) *Introduction to mathematical methodology* (SS22) - Exercises (2×1) *Introduction to mathematical methodology* (WS21/22) - Lecture Course (4) *Time-Frequency Analysis* (SS21)
Apr 2020 - Sep 2020	**Department of Mathematics, RWTH Aachen University** Guest Professor - Lecture Course + Problem Session (4+2) *Harmonic Analysis II*
Oct 2019 - Mar 2020	**Faculty of Mathematics, University of Vienna** University Assistant - Tutorials (1) on *Complex Analysis*
Sep 2016 - Feb 2017	**Faculty of Mathematics, University of Vienna** Assistant Lecturer in Mathematics - Problem session (2) to *Linear Algebra for Physicists*
Sep 2014 - Aug 2015	**University of Natural Resources and Life Sciences, Vienna** Assistant Lecturer in Mathematics for various mathematical problem sessions (2-4) at the beginner level (different studies)
Oct 2012 - Jun 2014	**University of Natural Resources and Life Sciences, Vienna** Tutor in Mathematics for various mathematical problem sessions (2-4) at the beginner level (different studies)

Scientific Activities

(* indicates "by invitation")

Apr 21-26, 2024	**MFO, Oberwolfach, Germany** (Workshop*) Applied Harmonic Analysis and Data Science
Jul 2-5, 2023	**University of Cologne, Germany** (Research stay*)
Jun 5-9, 2023	**NTNU Trondheim, Norway** (Conference*) Quantum harmonic analysis meets time-frequency analysis

Nov 30- Dec 2, 2022	**University of Cologne, Germany** (Workshop*) Three days of computational methods for extremal discrete geometry
Jul 17-22, 2022	**RICAM, Linz, Austria** (Conference*) Monte Carlo and Quasi-Monte Carlo Methods in Scientific Computing Talk*: *Optimal sampling strategies in time-frequency analysis*
Jun 19-25, 2022	**BIFEB, Strobl, Austria** (Conference) Applied Harmonic Analysis and Friends Talk: *Gaussian lattice sums and optimal Gabor frames*
Mar 10, 2022	**One World Mathematics Seminar** (Seminar*) Information, Data, and Signals (1W-MINDS) Talk*: *Optimal sampling patterns in the time-frequency plane*
Nov 28- Dec 4, 2021	**MFO, Oberwolfach, Germany** (Workshop*) Applied Harmonic Analysis and Data Science Talk*: *Gaussian lattice sums*
Aug 15, 2021	**Messe Wien, Vienna** (Conference*) DAGA – 47. Jahrestagung für Akustik Talk*: *Einführung in die Zeit-Frequenz Analyse*
Aug 3-5, 2021	**NTNU Trondheim, Norway** (Online conference) Quantum Harmonic Analysis and Applications to Operator Theory
Aug 13, 2020	**RWTH Aachen University, Germany** (Data Science Seminar, online) Talk*: *Inside the Frame Set*
Mar 14, 2020	**TU Vienna, Austria** (Science to Public) *** cancelled due to COVID19 *** International Day of Mathematics Talk: *Die Radon Transformation als Grundlage bildgebender Verfahren in der Medizin*
Jul 8-12, 2019	**University of Bordeaux, France** (Conference*) 13^{th} International Conference on Sampling Theory and Applications Talk*: *The Strohmer and Beaver Conjecture for Gaussian Gabor Frames*
Jun24-26, 2019	**Politecnico di Torino, Italy** (Conference) Aspects of Time-Frequency Analysis
May 25-31,2019	**NTNU Trondheim, Norway** (Research stay)
Apr 1-5, 2019	**University of Heidelberg, Germany** (Research stay + seminar talk*)
Feb 21-22, 2019	**NWC, University of Maryland, USA** (Conference) The February Fourier Talks
Feb 19-21, 2019	**Yale University, New Haven, USA** (Research stay + guest lecture*)
Oct 19, 2018	**NTNU Trondheim, Norway** (Institute's Colloquium*) Forum for matematiske perler (og kuriositeter) Talk*: *The ubiquitous constant and its siblings*
Jun 4-8, 2018	**BIFEB, Strobl, Austria** (Conference) Harmonic Analysis and Applications Talk: *Two Ubiquitous Constants other than E and Pi*
Apr 21-24, 2018	**BIFEB, Strobl, Austria** (Conference*) Quantum Harmonic Analysis and Symplectic Geometry Talk*: *Modular and Hamiltonian Deformation of Gabor Frames*
Mar 19-23, 2018	**ESI, Vienna, Austria** (Workshop*) Mathematical Challenges of Structured Function Systems Talk*: *A "Weltkonstante" in Time-Frequency Analysis*

Jul 5-7, 2017	**Politecnico di Torino, Italy** (Conference) Aspects of Time-Frequency Analysis Talk: *Extremal Problems in Complex and Harmonic Analysis*
Apr 27-29, 2017	**Yale University, New Haven, USA** (Research stay + talk*) *Some Extremal Problems in Analysis and a "Weltkonstante"*
Jun 6-10, 2016	**BIFEB, Strobl, Austria** (Conference) Time-Frequency Analysis and Related Topics Talk: *Optimizing frame bounds for the Gaussian window over separable lattices*
Apr 15-16, 2016	**University of Vienna, Austria** (Workshop) Approximation Theory and Applications Talk: *Optimal Gabor Frame Bounds*
Jan 11-15, 2016	**HIM, Bonn, Germany** (Doctoral School) Advances in Mathematics of Signal Processing Poster: *An optimal Gabor frame set-up*
Aug 16-22, 2015	**MFO, Oberwolfach, Germany** (Workshop*) Applied Harmonic Analysis and Sparse Approximation
Jul 20- Aug 7, 2015	**NWC, University of Maryland, USA** (Doctoral School) Modern Harmonic Analysis and Applications
Feb 19-20, 2015	**NWC, University of Maryland, USA** (Conference) February Fourier Talks 2015 Poster: *A Packing Problem in Time-Frequency Analysis*
Oct 20-24, 2014	**CIRM, Marseille, France** (Doctoral School) Computational Harmonic Analysis - with Applications to Signal and Image Processing
Jun 2-6, 2014	**BIFEB, Strobl, Austria** (Conference) Modern Time-Frequency Analysis Poster: *Geometric Aspects of the Time-Frequency Plane*
Jan 21, 2014	**ISTA, Klosterneuburg, Austria** (Talk*) *Lattice Deformations and Packing Problems*

Review Activities (incl. quick opinions)

Journals

• Adv. Op. Theory • Commun. Math. Phys. • Digit. Signal Process.
• IEEE Trans. Inf. Theory • J. Fourier Anal. Appl. • J. Math. Anal. Appl.
• J. Reine Angew. Math. • N. Y. J. Math. • Results Math. • Stud. Appl. Math.
• Proc. Math. Phys. Eng. Sci.

Science Funds

• SNSF

Other

• NTNU Trondheim (external sensor for master theses)

Awards & Honors

Mar 2018	**Doc Award** awarded by the City of Vienna and the University of Vienna, for one of the 12 most outstanding doctoral theses (among all fields) in the academic year 2016/17

Jan 2018	**Performance Scholarship** awarded by the University of Vienna, §§ 57 - 61 StudFG for the academic year 2016/17: rank 1 in Doktorat Naturwissenschaften
Aug 2015	**Oberwolfach-Leibniz-Graduate-Student** support program of the Mathematisches Forschungsinstitut Oberwolfach (MFO) for young researchers to attend workshops at the MFO
Jan 2015	**Performance Scholarship** awarded by the University of Vienna, §§ 57 - 61 StudFG for the academic year 2013/14
Jan 2014	**Performance Scholarship** awarded by the University of Vienna, §§ 57 - 61 StudFG for the academic year 2012/13

Journal Articles

[1] M. Faulhuber and I. Shafkulovska. Gabor frame bound optimizations. *Applied and Computational Harmonic Analysis*, 67:101574, November 2023.
arXiv preprint: 2204.02917
DOI: 10.1016/j.acha.2023.101574

[2] L. Bétermin, M. Faulhuber. Maximal Theta Functions – Universal Optimality of the Hexagonal Lattice for Madelung-Like Lattice Energies. *Journal d'Analyse Mathématique*,149(1):307-341, April 2023.
arXiv preprint: 2007.15977
DOI: 10.1007/s11854-022-0254-z

[3] M. Faulhuber. Some Curious Results Related to a Conjecture of Strohmer and Beaver. *Analysis and Applications*, 19(5):845-873, September 2021.
arXiv preprint: 1901.00356
DOI: 10.1142/S0219530520500177

[4] L. Bétermin, M. Faulhuber, H. Knüpfer. On the optimality of the rock-salt structure among lattices with charge distributions. *Mathematical Models and Methods in Applied Sciences*, 31(2):293-325 February 2021.
arXiv preprint: 2004.04553
DOI: 10.1142/S021820252150007X

[5] M. Faulhuber. Extremal Determinants of Laplace-Beltrami Operators for Rectangular Tori. *Mathematische Zeitschrift*, 297(1):175-195, February 2021.
arXiv preprint: 1709.06006
DOI: 10.1007/s00209-020-02507-7 (open access)

[6] M. Faulhuber. An Application of Hypergeometric Functions to Heat Kernels on Rectangular Tori and a "Weltkonstante" – Or – How Ramanujan Split Temperatures. *The Ramanujan Journal*, 54(1):1-13, February 2021.
arXiv preprint: 1901.01218
DOI: 10.1007/s11139-019-00224-2 (open access)

[7] M. Faulhuber. On the Parity under Metaplectic Operators and an Extension of a Result of Lyubarskii and Nes. *Results in Mathematics*, 75(8), March 2020.
arXiv preprint: 1901.01220
DOI: 10.1007/s00025-019-1134-4 (open access)

[8] M. Faulhuber, M. de Gosson, D. Rottensteiner. Gaussian Distributions and Phase Space Weyl-Heisenberg Frames. *Applied and Computational Harmonic Analysis*, 48(1):374-394, January 2020.
arXiv preprint: 1708.01551
DOI: 10.1016/j.acha.2018.06.001

[9] M. Faulhuber, S. Steinerberger. An Extremal Property of the Hexagonal Lattice. *Journal of Statistical Physics*, 177(2):285-298, October 2019.
arXiv preprint: 1903.06856
DOI: 10.1007/s10955-019-02368-3

[10] M. Faulhuber. A Short Note on the Frame Set of Odd Functions. *Bulletin of the Australian Mathematical Society*, 98(3):481–493, December 2018.
arXiv preprint: 1710.00753
DOI: 10.1017/S0004972718000746

[11] M. Faulhuber. Minimal Operator Norms via Minimal Theta Functions. *Journal of Fourier Analysis and Applications*, 24(2):545–559, April 2018.
arXiv preprint: 1608.01168
DOI: 10.1007/s00041-017-9526-x (open access)

[12] M. Faulhuber, S. Steinerberger. Optimal Gabor frame bounds for separable lattices and estimates for Jacobi theta functions. *Journal of Mathematical Analysis and Applications*, 445(1):407–422, January 2017.
arXiv preprint: 1601.02972
DOI: 10.1016/j.jmaa.2016.07.074

[13] M. Faulhuber. Gabor frame sets of invariance: a Hamiltonian approach to Gabor frame deformations. *Journal of Pseudo-Differential Operators and Applications*, 7(2):213–235, June 2016.
arXiv preprint: 1509.04603
DOI: 10.1007/s11868-016-0146-z (open access)

Proceedings and Conference Papers

[1] Markus Faulhuber. The Strohmer and Beaver Conjecture for Gaussian Gabor Systems - A Deep Mathematical Problem (?). In procceedings of the *13th international conference on Sampling Theory and Applications (SampTA 2019)*. July 2019.
DOI: 10.1109/SampTA45681.2019.9030963
arXiv preprint: 1905.05051

[2] M. Dörfler, M. Faulhuber. Multi–Window Weaving Frames. In proceedings of the *12th international conference on Sampling Theory and Applications (SampTA 2017)*. July 2017.
DOI: 10.1109/SAMPTA.2017.8024450

Preprints

[1] M. Faulhuber, I. Shafkulovska, I. Zlotnikov. A note on energy minimization in dimension 2, June 2023.
arXiv preprint: 2306.16266

[2] M. Faulhuber, S. Steinerberger. Maximal polarization for periodic configurations on the real line, May 2023.
arXiv preprint: 2305.01532

[3] M. Faulhuber, A. Gumber, and I. Shafkulovska. The AGM of Gauss, Ramanujan's corresponding theory, and spectral bounds of self-adjoint operators. September 2022.
arXiv preprint: 2209.04202

[4] L. Bétermin, M. Faulhuber, S. Steinerberger. A variational principle for Gaussian lattice sums. October 2021.
arXiv preprint: 2110.06008