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CONTACT INFORMATION

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EARNED DEGREES

B.S.	Mathematics	1982	Columbia Union College, Takoma Park, MD
B.A.	Physics	1982	Columbia Union College, Takoma Park, MD
Ph.D.	Mathematics	1990	University of Maryland, College Park, MD

Ph.D. Thesis Advisor:	John J. Benedetto
Ph.D. Thesis Title:	Wiener Amalgam Spaces in Generalized Harmonic Analysis and Wavelet Theory

EMPLOYMENT HISTORY

2004–present	Professor, School of Math., Georgia Tech
2016–2017	Associate Chair for Faculty, School of Math., Georgia Tech
2011–2016	Associate Chair, School of Math., Georgia Tech
2006–2011	Director of Teaching Effectiveness, School of Math., Georgia Tech
1999–2004	Associate Professor, School of Math., Georgia Tech
1993–1999	Assistant Professor, School of Math., Georgia Tech
1990–1993	National Science Foundation Postdoctoral Research Fellow, MIT
1990–1992	Pure Mathematics Instructor, MIT
1987–1992	Member of Technical Staff, The MITRE Corporation
1985–1989	Teaching Assistant, Mathematics Dept., University of Maryland
1982–1984	Instructor, Mathematical Sciences Dept., Columbia Union College

AWARDS

1. *Class of 1940 Course Survey Teaching Effectiveness Award*, Georgia Tech, 2018.
2. School of Mathematics *Herman Fulmer Prize*, Georgia Tech, 2017.
3. Nominated for the *Outstanding Service* Award, Georgia Tech, 2017.

4. Nominated for the *W. Roane Beard Outstanding Teacher Award*, Georgia Tech, 1999.
5. The MITRE Corporation 1995 Best Paper Award, for *Characterizations of scaling functions: Continuous solutions*.
6. Publication Awards, The MITRE Corporation: 1990, 1993, 1994, 1996.
7. Graduated Summa Cum Laude, Columbia Union College, 1982.
8. Outstanding Contribution to the Mathematics Department, Columbia Union College, 1982.
9. Outstanding Mathematics Student, Columbia Union College, 1982.
10. Merit Scholarship Finalist, 1979.

RESEARCH, SCHOLARSHIP, AND CREATIVE ACTIVITIES

$*$ = Publications authored while at Georgia Tech.
\# = Internet publications posted at the author's Georgia Tech website.
Names of coauthors who were students or postdocs at Georgia Tech are in **bold**.

A. PUBLISHED BOOKS, BOOK CHAPTERS, AND EDITED VOLUMES

A1. Books

#1. C. Heil, "**A Basis Theory Primer,**" electronic manuscript, ©1998, 93 pp., `http://people.math.gatech.edu/~heil/books/`

*2. C. Heil, "**A Basis Theory Primer,**" **Expanded Edition**, Birkhäuser, Boston, 2011 (xxv + 534 pp.).
Supplementary materials by C. Heil:
• Solutions manual, ©2011, 281 pp.

*3. M. D. Weir and J. Haas, with the assistance of C. Heil, "**Thomas' Calculus,**" **13th Edition**, Pearson, Boston, 2014 (xiv + 1032 pp. + appendices).

*4. M. D. Weir and J. Haas, with the assistance of C. Heil, "**Thomas' Calculus: Early Transcendentals,**" **13th Edition**, Pearson, Boston, 2014 (xiv + 1044 pp. + appendices).

*5. M. D. Weir and J. Haas, with the assistance of C. Heil, "**University Calculus: Early Transcendentals,**" **3rd Edition**, Pearson, Boston, 2016 (vii + 912 pp. + appendices).

*#6. C. Heil, "**A Brief Guide to Metrics, Norms, and Inner Products,**" electronic manuscript, ©2016, 64 pp.

*7. J. Haas, C. Heil, and M. D. Weir, "**Thomas' Calculus,**" **14th Edition**, Pearson, Boston, 2018 (xviii + 1048 pp. + appendices).

*8. J. Haas, C. Heil, and M. D. Weir, "**Thomas' Calculus: Early Transcendentals,**" **14th Edition**, Pearson, Boston, 2018 (xviii + 1062 pp. + appendices).

*9. C. Heil, "**Metrics, Norms, Inner Products, and Operator Theory,**" Birkhäuser/Springer, Cham, 2018 (xxi + 359 pp.).

Supplementary materials by C. Heil:

- Solutions manual, ©2018, 273 pp.
- Extra Chapter 8, *Integral Operators*, ©2018, 17 pp.
- Extra online material, ©2018, 103 pp.

*10. J. Haas, C. Heil, P. Bogacki, and M. D. Weir, "**University Calculus: Early Transcendentals,**" **4th Edition**, Pearson, Hoboken, NJ, 2020 (xviii + 938 pp. + appendices).

*11. C. Heil, "**Introduction to Real Analysis,**" Springer, Cham, 2019 (xvii + 400 pp.).

Supplementary materials by C. Heil:

- Online course guide, ©2019, 131 pp.
- Online Chapter 0 (Expanded Notation and Preliminaries), ©2019, 49 pp.
- Online Alternative Chapter 1, ©2019, 62 pp.
- Online Chapter 10 (Abstract Measure Theory), ©2019, 27 pp.
- Online Selected Solutions for Students, ©2019, 39 pp.
- Solutions manual, ©2019, 426 pp.

*12. J. Haas, C. Heil, P. Bogacki, and M. D. Weir, "**Thomas' Calculus,**" **15th Edition**, Pearson, Boston, 2023, xviii + 1058 pp. + appendices.

*13. J. Haas, C. Heil, P. Bogacki, and M. D. Weir, "**Thomas' Calculus: Early Transcendentals,**" **15th Edition**, Pearson, Boston, 2023, xviii + 1058 pp. + appendices.

*14. C. Heil, "**Operator Theory and Functional Analysis,**" Springer, in preparation (currently 281 pp.).

*15. C. Heil, "**A First Course in Real Analysis,**" Springer, in preparation (currently 342 pp.).

*16. C. Heil, "**Measure Theory for Scientists and Engineers,**" Springer, in preparation (currently 403 pp.).

*16. C. Heil, "**Introduction to Real Analysis, Vol. 2: Abstract Measure Theory,**" Springer, in preparation (currently 93 pp.).

A2. Refereed Book Chapters

1. C. Heil, *Wavelets and frames*, in: "Signal Processing, Part I: Signal Processing Theory," L. Auslander, T. Kailath, and S. Mitter, eds., IMA Vol. Math. Appl. **22**, Springer–Verlag, New York (1990), pp. 147–160.
2. J. Benedetto, C. Heil, and D. Walnut, *Uncertainty Principles for time-frequency operators*, in: "Continuous and Discrete Fourier Transforms, Extension Problems and Wiener-Hopf Equations," Oper. Theory Adv. Appl., **58**, I. Gohberg, ed., Birkhäuser, Basel (1992), pp. 1–25.
3. D. Colella and C. Heil, *Dilation equations and the smoothness of compactly supported wavelets*, in: "Wavelets: Mathematics and Applications," J. J. Benedetto and M. W. Frazier, eds., CRC Press, Boca Raton, FL (1994), pp. 163–201.

*4. C. Heil, *Wavelets*, Section 7.13.6 in the CRC Standard Mathematical Tables and Formulae, 30th Edition, D. Zwillinger, ed., CRC Press, Boca Raton, FL (1996), pp. 663–667 (Section 7.15.5 in the 31st Edition, 2003, pp. 723–726).

*5. J. J. Benedetto, C. Heil, and D. F. Walnut, *Gabor systems and the Balian–Low theorem*, in: "Gabor Analysis and Algorithms: Theory and Applications," H. G. Feichtinger and T. Strohmer, eds., Birkhäuser, Boston (1998), pp. 85-122.

*6. C. Heil, *Integral operators, pseudodifferential operators, and Gabor frames*, in: "Advances in Gabor Analysis," H. G. Feichtinger and T. Strohmer, eds., Birkhäuser, Boston (2003), pp. 153–169.

*7. R. Ashino, S. J. Desjardins, C. Heil, M. Nagase, and R. Vaillancourt, *Pseudodifferential operators, microlocal analysis and image restoration*, in: "Advances in Pseudo-Differential Operators," R. Ashino, P. Boggiatto, and M.-W. Wong, eds., Birkhäuser, Boston (2004), pp. 187–202.

*8. C. Heil, *Linear independence of finite Gabor systems*, in: "Harmonic Analysis and Applications," C. Heil, ed., Birkhäuser, Boston (2006), pp. 171–206.

*9. C. Heil, *The Density Theorem and the Homogeneous Approximation Property for Gabor frames*, in: "Representations, Wavelets, and Frames," P. E. T. Jorgensen, K. D. Merrill, and J. A. Packer, eds., Birkhäuser, Boston (2008), pp. 71–102.

*10. C. Heil and G. Kutyniok, *Convolution and Wiener amalgam spaces on the affine group*, in: "Recent Advances in Computational Sciences," P. E. T. Jorgensen et al., eds., World Scientific, Singapore (2008), pp. 209–217.

*11. C. Heil and D. Speegle, *The HRT Conjecture and the Zero Divisor Conjecture for the Heisenberg group*, in: "Excursions in Harmonic Analysis, Volume 3," R. Balan et al., eds., Birkhäuser/Springer, Cham (2015), pp. 159–176.

*12. C. Heil, *Reflections on a Theorem of Boas and Pollard*, in: "Harmonic Analysis and Applications," M. Rassias, ed., Springer, Cham (2021), pp. 173–184.

*13. C. Heil, *Foreword*, in: "New Trends in Applied Harmonic Analysis," Volume 2, A. Aldroubi, C. Cabrelli, S. Jaffard, and U. Molter, eds., Birkhäuser/Springer, 2019, pp. ix–xiii.

*14. C. Heil, *Absolute Continuity and the Banach–Zaretsky Theorem*, in: "Excursions in Harmonic Analysis," Volume 6, M. Hirn et al., eds., Birkhäuser, Cham (2021), pp. 27–51.

A3. Edited Volumes

*1. C. Heil, P. E. T. Jorgensen, and D. R. Larson, Editors, "Wavelets, Frames, and Operator Theory" (College Park, 2003), Contemporary Math., Vol. 345, Amer. MathṠoc., Providence, RI, 2004 (xii + 342 pp.).

*2. C. Heil and D. F. Walnut, Editors, "Fundamental Papers in Wavelet Theory," Princeton University Press, Princeton, NJ, 2006 (xix + 878 pp.).

*3. C. Heil, Editor, "Harmonic Analysis and Applications," In honor of John J. Benedetto, Birkhäuser, Boston, 2006 (xxviii + 374 pp.).

B. REFEREED PUBLICATIONS AND SUBMITTED ARTICLES

B1. Published and Accepted Journal Articles

1. C. E. Heil and D. F. Walnut, *Continuous and discrete wavelet transforms*, SIAM Review, **31** (1989), pp. 628–666.
2. D. Colella and C. Heil, *The characterization of continuous, four-coefficient scaling functions and wavelets*, IEEE Trans. Information Theory, Special Issue on Wavelet Theory and Multiresolution Signal Analysis, **38** (1992), pp. 876–881.
3. D. Colella and C. Heil, *Characterizations of scaling functions: Continuous solutions*, SIAM J. Matrix Anal. Appl., **15** (1994), pp. 496–518.
4. J. J. Benedetto, C. Heil, and D. F. Walnut, *Differentiation and the Balian–Low theorem*, J. Fourier Anal. Appl., **1** (1995), pp. 355–402.

*5. C. Heil, G. Strang, and V. Strela, *Approximation by translates of refinable functions*, Numerische Math., **73** (1996), pp. 75–94.

*6. C. Heil and D. Colella, *Matrix refinement equations: Existence and uniqueness*, J. Fourier Anal. Appl., **2** (1996), pp. 363–377.

*7. C. Heil, J. Ramanathan, and P. Topiwala, *Linear independence of time-frequency translates*, Proc. Amer. Math. Soc., **124** (1996), pp. 2787–2795.

*8. O. Christensen and C. Heil, *Perturbations of Banach frames and atomic decompositions*, Math. Nachr., **185** (1997), pp. 33–47.

*9. C. Heil, J. Ramanathan, and P. Topiwala, *Singular values of compact pseudodifferential operators*, J. Funct. Anal., **150** (1997), pp. 426–452.

*10. C. Cabrelli, C. Heil, and U. Molter, *Accuracy of lattice translates of several multidimensional refinable functions*, J. Approx. Theory, **95** (1998), pp. 5–52.

*11. V. Strela, P. N. Heller, G. Strang, P. Topiwala, and C. Heil, *The application of multiwavelet filterbanks to image processing*, IEEE Trans. Image Proc., **8** (1999), pp. 548–563.

*12. C. Heil, *The Wiener transform on the Besicovitch spaces*, Proc. Amer. Math. Soc., **127** (1999), pp. 2065–2071.

*13. K. Gröchenig and C. Heil, *Modulation spaces and pseudodifferential operators*, Integral Equations Operator Theory, **34** (1999), pp. 439–457.

*14. O. Christensen, B. Deng, and C. Heil, *Density of Gabor frames*, Appl. Comput. Harmon. Anal., **7** (1999), pp. 292–304.

*15. K. Gröchenig, C. Heil, and D. Walnut, *Nonperiodic sampling and the local three squares theorem*, Ark. Mat., **38** (2000), pp. 77–92.

*16. C. Cabrelli, C. Heil, and U. Molter, *Accuracy of several multidimensional refinable distributions*, J. Fourier Anal. Appl., **6** (2000), pp. 483–502.

*17. R. Ashino, C. Heil, M. Nagase, and R. Vaillancourt, *Microlocal filtering with multiwavelets*, Comput. Math. Appl., **41** (2001), pp. 111-133.

*18. K. Gröchenig and C. Heil, *Gabor meets Littlewood–Paley: Gabor expansions in* $L^p(\mathbf{R}^d)$, Studia Math., **146** (2001), pp. 15–33.

*19. R. Ashino, S. J. Desjardins, C. Heil, M. Nagase, and R. Vaillancourt, *Microlocal analysis, smooth frames and denoising in Fourier space*, Asian Information-Science-Life, **1** (2002), pp. 153–160.

*20. K. Gröchenig, D. Han, C. Heil, and G. Kutyniok, *The Balian–Low theorem for symplectic lattices in higher dimensions*, Appl. Comput. Harmon. Anal., **13** (2002), pp. 169–176.

*21. R. Balan, P. G. Casazza, C. Heil, and Z. Landau, *Deficits and excesses of frames*, Adv. Comput. Math., Special Issue on Frames, **18** (2003), pp. 93–116.

*22. K. Gröchenig, C. Heil, and K. Okoudjou, *Gabor analysis in weighted amalgam spaces*, Sampl. Theory Signal Image Process., **1** (2003), pp. 225–259.

*23. R. Balan, P. G. Casazza, C. Heil, and Z. Landau, *Excesses of Gabor frames*, Appl. Comput. Harmon. Anal., **14** (2003), pp. 87–106.

*24. R. Ashino, S. J. Desjardins, C. Heil, M. Nagase, and R. Vaillancourt, *Smooth tight frame wavelets and image analysis in Fourier space*, Comput. Math. Appl., **45** (2003), pp. 1551–1579.

*25. C. Heil and G. Kutyniok, *Density of weighted wavelet frames*, J. Geometric Analysis, **13** (2003), pp. 479–493.

*26. C. A. Cabrelli, C. Heil, and U. M. Molter, *Self-similarity and multiwavelets in higher dimensions*, Memoirs Amer. Math. Soc., Vol. **170**, No. 807 (2004), viii+82 pp.

*27. K. Gröchenig and C. Heil, *Counterexamples for boundedness of pseudodifferential operators*, Osaka J. Math., **41** (2004), pp. 681–691.

*28. Á. Bényi, K. Gröchenig, C. Heil, and K. Okoudjou, *Modulation spaces and a class of bounded multilinear pseudodifferential operators*, J. Operator Theory, **54** (2005), pp. 389–401.

*29. R. Balan, P. G. Casazza, C. Heil, and Z. Landau, *Density, overcompleteness, and localization of frames, I. Theory*, J. Fourier Anal. Appl., **12** (2006), pp. 105–143.

*30. R. Balan, P. G. Casazza, C. Heil, and Z. Landau, *Density, overcompleteness, and localization of frames, II. Gabor systems*, J. Fourier Anal. Appl., **12** (2006), pp. 307–344.

*31. R. Balan, P. G. Casazza, C. Heil, and Z. Landau, *Density, overcompleteness, and localization of frames*, Electron. Res. Announc. Amer. Math. Soc., **12** (2006), pp. 71–86.

*32. C. Heil and A. M. Powell, *Gabor Schauder bases and the Balian–Low Theorem*, J. Math. Physics, **47** (2006), pp. 113506-1–113506-21.

*33. C. Heil, *History and evolution of the Density Theorem for Gabor frames*, J. Fourier Anal. Appl., **13** (2007), pp. 113–166.

*34. C. Heil and G. Kutyniok, *The Homogeneous Approximation Property for wavelet frames*, J. Approx. Theory, **147** (2007), pp. 28–46.

*35. C. Heil and G. Kutyniok, *Density of frames and Schauder bases of windowed exponentials*, Houston J. Math., **34** (2008), pp. 565–600.

*36. C. Heil, Y. Y. Koo, and J. K. Lim, *Duals of frame sequences*, Acta Appl. Math., **107** (2009), pp. 75–90.

*37. **S. Bishop**, C. Heil, Y. Y. Koo, and J. K. Lim, *Invariances of frame sequences under perturbations*, Linear Algebra Appl., **432** (2010), pp. 1501–1514.

*38. A. Aldroubi, C. Cabrelli, C. Heil, **K. Kornelson**, and U. Molter, *Invariance of a shift-invariant space*, J. Fourier Anal. Appl., **16** (2010), pp. 60–75.

*39. C. Heil and A. M. Powell, *Regularity for complete and minimal Gabor systems on a lattice*, Illinois J. Math., **53** (2010), pp. 1077–1094.

*40. **R. Tinaztepe** and C. Heil, *Modulation spaces, BMO, and the Balian–Low Theorem*, Sampl. Theory Signal Image Process., **11** (2012), pp. 25–41.

*41. **G. J. Yoon** and C. Heil, *Duals of weighted exponentials*, Acta Appl. Math., **119** (2012), pp. 97–112.

*42. C. Heil, *WHAT IS ... a frame?*, Notices Amer. Math. Soc., **60** (2013), pp. 748–750. Hungarian translation: Erinto (an electronic mathematics journal), March 2018.

*43. **R. Tinaztepe**, **D. Jacobs**, and C. Heil, *Smoothness of refinable function vectors on* $\mathbf{R}^n$, Int. J. Wavelets Multiresolut. Inf. Process., **15** (2017) 1750051 (16 pages).

*44. C. Heil and **P.-T. Yu**, *Convergence of frame series*, J. Fourier Anal. Appl., to appear (2023), 13 pages.

*45. **Y.-S. Cheng** and C. Heil, *Existence of finite unit-norm tight frames in Banach spaces*, Graduate J. Math., **7** (2022), pp. 17–38.

B2. Conference Presentations with Proceedings (Refereed)

1. C. Heil and D. Walnut, *Gabor and wavelet expansions*, in: "Recent Advances in Fourier Analysis and its Applications" (Il Ciocco, 1989), J. S. Byrnes et al., eds., NATO Adv. Sci. Inst. Ser. C: Math. Phys. Sci. **315**, Kluwer, Dordrecht (1990), pp. 441–454.
2. C. Heil, *Applications of the fast wavelet transform*, in: "Advanced Signal-Processing Algorithms, Architectures, and Implementations" (San Diego, CA, 1990), Proc. SPIE **1348**, F. T. Luk, ed., SPIE, Bellingham, WA (1990), 248-259.
3. C. Heil, *Methods of solving dilation equations*, in: "Probabilistic and Stochastic Methods in Analysis, with Applications" (Il Ciocco, 1991), J. S. Byrnes et al., eds., NATO Adv. Sci. Inst. Ser. C: Math. Phys. Sci. **372**, Kluwer, Dordrecht (1992), pp. 15–45.
4. C. Heil, J. Ramanathan, and P. Topiwala, *Asymptotic singular value decay of time-frequency localization operators*, in: "Wavelet Applications in Signal and Image Processing II" (San Diego, CA, 1994), Proc. SPIE **2303**, A. F. Laine and M. A. Unser, eds., SPIE, Bellingham, WA (1994), pp. 15–24.
5. C. Heil, *Some stability properties of wavelets and scaling functions*, in: "Wavelets and Their Applications" (Il Ciocco, 1992), J. S. Byrnes et al., eds., NATO Adv. Sci. Inst. Ser. C: Math. Phys. Sci. **442**, Kluwer, Dordrecht (1994), pp. 19–38.

*6. C. Heil and D. Colella, *Sobolev regularity for scaling functions via ergodic theory*, in: "Approximation Theory VIII," Vol. 2 (College Station, TX, 1995), C. K. Chui and L. L. Schumaker, eds., World Scientific, Singapore (1995), pp. 151–158.

*7. C. Heil and G. Strang, *Continuity of the joint spectral radius: Application to wavelets*, in: "Linear Algebra for Signal Processing" (Minneapolis, MN, 1992), A. Bojanczyk and G. Cybenko, eds., IMA Vol. Math. Appl. **69**, Springer–Verlag, New York (1995), pp. 51–61.

*8. P. N. Heller, V. Strela, G. Strang, P. Topiwala, C. Heil, and L. S. Hills, *Multiwavelet filter banks for data compression*, in: ISCAS '95, Proc. International Symposium on Circuits and Systems (Seattle, WA, 1995), Vol. 3, IEEE, Piscataway, NJ (1995), pp. 1796–1799.

*9. C. A. Cabrelli, C. Heil, and U. M. Molter, *Polynomial reproduction by refinable functions*, in: "Advances in Wavelets" (Hong Kong, 1997), K.-S. Lau, ed., Springer–Verlag, Singapore (1999), pp. 121–161.

*10. B. Deng and C. Heil, *Density of Gabor Schauder bases*, in: "Wavelet Applications in Signal and Image Processing VIII" (San Diego, CA, 2000), Proc. SPIE **4119**, A. Aldroubi et al., eds., SPIE, Bellingham, WA (2000), pp. 153–164.

*11. C. A. Cabrelli, C. Heil, and U. M. Molter, *Necessary conditions for the existence of multivariate multiscaling functions*, in: "Wavelet Applications in Signal and Image Processing VIII" (San Diego, CA, 2000), Proc. SPIE **4119**, A. Aldroubi et al., eds., SPIE, Bellingham, WA (2000), pp. 395–406.

*12. R. Ashino, C. Heil, M. Nagase, and R. Vaillancourt, *Microlocal analysis and multiwavelets*, in: "Geometry, Analysis and Applications" (Varanasi, India, 2000), R. S. Pathak, ed., World Scientific, Singapore (2001), pp. 293–302.

*13. R. Ashino, C. Heil, M. Nagase, and R. Vaillancourt, *Multiwavelets, pseudodifferential operators and microlocal analysis*, in: Wavelet Analysis and Applications (Guangzhou, China, 1999), D. Deng et al., eds., AMS/IP Stud. Adv. Math., **25**, American Mathematical Society, Providence, RI (2002), pp. 9–20.

*14. R. Ashino, S. J. Desjardins, C. Heil, M. Nagase, and R. Vaillancourt, *Image restoration through microlocal analysis with smooth tight wavelet frames*, in: Theoretical Development and Feasibility of Mathematical Analysis on the Computer (Japanese) (Kyoto, 2002), Sūrikaisekikenkyūsho Kōkyūroku No. 1286 (2002), pp. 101–118.

*15. C. A. Cabrelli, C. Heil, and U. M. Molter, *Multiwavelets in* $\mathbf{R}^n$ *with an arbitrary dilation matrix*, in: "Wavelets and Signal Processing," L. Debnath, ed., Birkhäuser, Boston (2003), pp. 23–39.

*16. C. Heil, *An introduction to weighted Wiener amalgams*, in: "Wavelets and their Applications" (Chennai, January 2002), M. Krishna et al., eds., Allied Publishers, New Delhi (2003), pp. 183–216.

*17. K. Gröchenig and C. Heil, *Modulation spaces as symbol classes for pseudodifferential operators*, in: "Wavelets and their Applications" (Chennai, January 2002), M. Krishna et al., eds., Allied Publishers, New Delhi (2003), pp. 151–169.

*18. R. Balan, P. G. Casazza, C. Heil, and Z. Landau, *Excess of Parseval frames*, in: "Wavelets XI" (San Diego, CA, 2005), Proc. SPIE **5914**, M. Papadakis et al., eds., SPIE, Bellingham, WA (2005), pp. 39–46.

*19. C. Heil and D. R. Larson, *Operator theory and modulation spaces*, in: "Frames and Operator Theory in Analysis and Signal Processing" (San Antonio, 2006), D. R. Larson et al., eds., Contemp. Math., Vol. 451, Amer. Math. Soc., Providence, RI (2008), pp. 137–150.

*20. **S. Bishop**, C. Heil, Y. Y. Koo, and J. K. Lim, *Duals and invariances of frame sequences*, in: "Wavelets XIII" (San Diego, CA, 2009), Proc. SPIE **7446**, V. Goyal et al., eds., SPIE, Bellingham, WA (2009), pp. 74460K1–74460K8.

C. OTHER PUBLICATIONS AND CREATIVE PRODUCTS (Not Refereed)

1. C. E. Heil and D. F. Walnut, *An introduction to wavelet transforms*, The MITRE Corporation, Technical Report MP-88W00038, 1988.
2. C. Heil, *A discrete Zak transform*, Technical Report MTR-89W000128, The MITRE Corporation, 1989.
3. C. Heil and D. Colella, *On the characterization of continuous scaling functions*, The MITRE Corporation, Technical Report WP-91W00476, 1991.

*4. C. Heil, *Existence and accuracy for matrix refinement equations*, Z. Angew. Math. Mech., Special issue on Applied Stochastics and Optimization, **76** (1996), pp. 251–254.

*#5. C. Heil, *Limits for Calc I students*, 4 pp., internet publication, copyright 2001.

*#6. C. Heil, *Writing proofs*, 5 pp., internet publication, copyright 2011.

*#7. C. Heil, Solutions manual to "A Basis Theory Primer (Expanded Edition)," 281 pp., copyright 2011 (available to instructors registered with Birkhäuser).
*#8. C. Heil, *A short review of cardinality*, 7 pp., internet publication, copyright 2017.
*#9. C. Heil, *A brief review of Lebesgue measure and the Lebesgue integral* (13 pages), internet publication, copyright 2017.
*#10. C. Heil, Solutions manual to "Metrics, Norms, Inner Products, and Operator Theory," 273 pp., copyright 2018 (available to instructors registered with Birkhäuser).
*#11. C. Heil, Extra Chapter 8, *Integral Operators*, for "Metrics, Norms, Inner Products, and Operator Theory," 17 pp., copyright 2018.
*#12. C. Heil, Extra online material for "Metrics, Norms, Inner Products, and Operator Theory," 103 pp., copyright 2018.
*#13. C. Heil, *A short review of metrics, norms, and convergence*, 7 pp., internet publication, copyright 2019.
*#14. C. Heil, Extra online Chapter 0, *Expanded Notation and Preliminaries*, for "Introduction to Real Analysis," 49 pp., copyright 2019.
*#15. C. Heil, Online Alternative Chapter 1, *An Introduction to Norms and Banach Spaces*, for "Introduction to Real Analysis," 62 pp., copyright 2019.
*#16. C. Heil, Extra online Chapter 10, *Abstract Measure Theory*, for "Introduction to Real Analysis," 27 pp., copyright 2018.
*#17. C. Heil, Instructor and student guide for "Introduction to Real Analysis," 131 pp., copyright 2019.
*#18. C. Heil, Selected Solutions for Students for "Introduction to Real Analysis," 39 pp., copyright 2019.
*#19. C. Heil, Solutions manual to "Introduction to Real Analysis," 426 pp., copyright 2019 (available to instructors registered with Birkhäuser).

D. PRESENTATIONS (only invited presentations listed)

1–88. Conferences, meetings, and colloquia, 1988–2004.
89. Department Colloquium, U. Maryland, March 2005.
90. Workshop on Sparse Data Representation: The Role of Redundancy in Data Processing, CSCAMM, U. Maryland, May 2005.
91. International Conference on Wavelets and Splines, U. Georgia, May 2005.
92. *Invited main speaker*, Nebraska IMMERSE (Intensive Mathematics: A Mentoring, Education, and Research Summer Experience) Program, U. Nebraska, July 2005.
93. Conference Wavelets XI, SPIE Annual Meeting, San Diego, CA, August 2005.
94. Department Colloquium, U. Toledo, September 2005.
95. Workshop on Time-Frequency Analysis and Nonstationary Filtering, Banff International Research Station, Banff, Canada, September 2005.

96. Special Session on Wavelets, Frames, and Related Expansions, AMS Sectional Meeting, U. Oregon, November 2005.
97. Department Colloquium, Augusta State U., December 2005.
98. Workshop on Recent Progress in Wavelet Analysis and Frame Theory, U. Bremen, Germany, January 2006.
99. Department Colloquium and February Fourier Talks (FFT), U. Maryland, February 2006.
100. FRG Workshop, Vanderbilt U., April 2006. Invited main speaker.
101. Current Trends in Harmonic Analysis and Its Applications: Wavelets and Frames, U. Colorado, May 2006.
102. Informal Regional Functional Analysis Seminar (SUMIRFAS), Texas A&M U., August 2006.
103. Concentration Week on Frames, Banach spaces and Signal Processing, Texas A&M U., August 2006.
104. Summer Time-Frequency Talks (STFT), U. Maryland, June 2007.
105. *Invited address*, MAA SoCal sectional meeting, Santa Ana College, CA, October 2007.
106. Department Colloquium, Augusta State U., October 2007.
107. Special Session on Splines and Wavelets, AMS Sectional Meeting, Middle Tennessee State U., November 2007.
108. Department Colloquium, U. Houston, January 2008.
109. 24th Southeastern Analysis Meeting, Vanderbilt U., March 2008.
110. Department Colloquium, Georgia Southern U., April 2008.
111. Norbert Wiener Center colloquium, U. Maryland, April 2009.
112. *Plenary speaker*, Strobl 09 Conference on Time-Frequency, Strobl, Austria, June 2009.
113. Conference Wavelets XIII, SPIE Optical Engineering + Applications, San Diego, CA, August 2009.
114. Workshop on Optimal Frames and Operator Algebras, San Francisco State U., January 2010.
115. IMAHA 2010, Northern Illinois U., April 2010.
116. Department Colloquium, Northern Illinois U., December 2010.
117. Strobl 11 Conference in honor of Hans Feichtinger, Strobl, Austria, June 2011.
118. Analysis Seminar, U. Houston, November 2011.
119. Special Session on Analysis of Wavelets, Frames, and Fractals, AMS Sectional Meeting, George Washington U., March 2012.
120. Department Colloquium, Vanderbilt U., February 2013.
121. Department Colloquium, Columbus State U., March 2013.
122. Special Session on Wavelets, Frames, and Related Expansions, AMS Sectional Meeting, Washington U., St. Louis, October 2013.
123. Department Colloquium, U. Central Florida, March 2014.

124. *Keynote lecture*, Fifth International Conference on Computational Harmonic Analysis, Vanderbilt U., May 2014.
125. 2014 Conference on Modern Time-Frequency Analysis, Strobl, Austria, June 2014.
126. Special Session on Sampling Theory, AMS Sectional Meeting, Dalhousie University, Halifax, Canada, October 2014.
127. Special Session on Frames, Wavelets, and Their Applications, AMS Sectional Meeting, Michigan State University, March, 2015.
128. Department Colloquium, Kent State U., April 2015.
129. Invited Guest Lecturer, IMA Summer Graduate Student Program on Modern Harmonic Analysis and Applications, U. Maryland, July 2015.
130. Invited Main Speaker, Workshop on the HRT Conjecture, St. Louis University, March 2016.
131. Special Session on Applied Harmonic Analysis, Frame Theory, and Operator Theory, IWOTA 2016, Washington U. St. Louis, July 2016.
132. Special Session on Frame Theory, AMS Sectional Meeting, College of Charleston, Charleston, SC, March 2017.
133. Workshop on Applied Analysis, Kennesaw State U., May 2017.
134. Department Colloquium, Florida International U., May 2017.
135. *Keynote lecture*, CIMPA 2017 Research School, Buenos Aires, Argentina, August, 2017.
136. Analysis Seminar, Clemson U., November 2017.
137. 7th International Conference on Computational Harmonic Analysis, Vanderbilt U., May 2018.
138. Banquet speaker, 2019 MAA-SE Alabama State Dinner, Huntingdon College, Montgomery, AL, March 2019.
139. Codes and Expansions (CodEx) Seminar (virtual), December 2020.
    Recording available at: `https://www.youtube.com/watch?v=dhoqPKFCMbE`
140. Faraway Fourier Talks (virtual), U. Maryland, March 2021.
    Recording available at: `https://www.youtube.com/watch?v=YSwNcVhV18w`
141. (Postponed due to Covid) Invited Lecture, 8th International Conference on Computational Harmonic Analysis (ICCHA 2020), Munich, Germany, September 2020.

E. INDIVIDUAL STUDENT GUIDANCE

E1. Ph.D. Students

1. Demetrio Labate (2000), *Time-frequency analysis of pseudodifferential operators*. Received the **Georgia Tech Sigma Xi Best Ph.D. Thesis award** (one of five institute awards for 2000). Current position: Professor, University of Houston.
2. Denise Jacobs (2001), *Multiwavelets in higher dimensions*. Current position: National Security Agency.

3. Kasso Okoudjou (2003), *Characterization of function spaces and boundedness of bilinear pseudodifferential operators through Gabor frames*. Received the **Georgia Tech Sigma Xi Best Ph.D. Thesis award** (one of five institute awards for 2003). Current position: Professor, Tufts University.
4. Shannon Bishop (2010), *Gabor and wavelet analysis with applications to Schatten class integral operators*. Current position: National Security Agency.
5. Ramazan Tinaztepe (2010), *Modulation spaces, BMO and the Zak transform, and minimizing IPH functions over the unit simplex*. Current position: Assistant Professor, Imam Abdulrahman Bin Faisal University (University of Dammam), Saudi Arabia.
6. Josiah Park (2021). *Interaction energies, lattices, and designs*. Received the **School of Mathematics Top Graduate Student award for 2020**. Nominated for the **Georgia Tech Sigma Xi Best Ph.D. Thesis award** (one of five institute awards for 2021).
7. Yam-Sung Cheng (2021). *Approximate Schauder frames for Banach sequence spaces*. Current position: MontMed, An International medical device company.
8. Victor Bailey (current).
9. Pu-Ting Yu (current).
10. Logan Hart (current).

E2. M.S. Students

1. Sandie Leach (2003), *Density conditions on Gabor frames*.
2. Becky Upchurch (2004).
3. Stacey Touset (2013).

E3. Postdoctoral and Visiting Scholar Mentorship

1. Gitta Kutyniok (Visiting Professor, GA Tech), August–December 2001. Current position: Professor, Technical U. Berlin.
2. Brody Johnson (GA Tech VIGRE Postdoc), August 2002–July 2003. Current position: Associate Professor, St. Louis University.
3. Keri Kornelson (visiting Texas A&M VIGRE Postdoc), January–May 2003. Current position: Associate Professor, U. Oklahoma.
4. Norbert Kaiblinger (Postdoc, Austrian Science Foundation), January–December 2003. Current position: Docent, U. Vienna.
5. Gerard Ascensi (visiting graduate student, U. Barcelona), January–April 2005. Current position: U. Barcelona.
6. Gang Joon Yoon (Visiting Scholar, KIAS), October–December 2006 and March–May 2007. Current position: National Institute for Mathematical Sciences, Daejeon, Korea.

7. Evanthia Carypis (visiting graduate student, U. Torino), August–December 2013. Current position: Postdoc, U. Torino.
8. Michael Northington, NSF IMPACT Postdoc, August 2016–July 2019.
9. Armenak Petrosyan, Hale Visiting Professor, August 2020–present.

SERVICE

A. PROFESSIONAL CONTRIBUTIONS

Editorial Boards

1. *Axioms*, September 2021–present.
2. *Advances in Operator Theory*, January 2017–present.
3. *Applied and Computational Harmonic Analysis*, September 2005–present.
4. *Journal of Fourier Analysis and Applications*, September 1999–present.
5. Book Series "Applied and Numerical Harmonic Analysis," Birkhäuser, September 1995–present.
6. Guest editor (with K. Gröchenig), Special Issue on Modulation Spaces and Time-Frequency Analysis, *Sampling Theory in Signal and Image Processing*, Vol. 5, No. 2 (2006).
7. Guest editor (with J. Stöckler and R.-Q. Jia), Special Issues on Frames, *Applied and Computational Harmonic Analysis*, Vol. 17, Nos. 1, 2 (2004) and Vol. 18, No. 1 (2005).
8. *SIAM Journal on Scientific Computing*, January 1995–December 1998.
9. *PanAmerican Mathematical Journal*, June 1994–June 1996.