CURRICULUM VITAE–October, 2013

Douglas P. Hardin

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EDUCATION

Ph.D, Georgia Institute of Technology, Mathematics, 1985

M.E.E., Stanford University, Electrical Engineering, 1982

B.E.E. (with highest honors), Georgia Institute of Technology, Electrical Engineering, 1980

PROFESSIONAL EXPERIENCE

Professor, Biomedical Informatics, 1/2006 –present

Professor, Mathematics, Vanderbilt University, 6/2005–present

Associate Professor, Mathematics, Vanderbilt University, 7/93–6/2005

Visiting Scholar, University of Dundee (Scotland), 3/2004–4/2004

Visiting Mathematician, Sandia National Laboratory, 1/97–4/97

Mathematician, Iterated Systems, Inc., 1/91-8/91

Assistant Professor, Mathematics, Vanderbilt University, 9/86- 7/93

Instructor, Mathematics, Georgia Tech, 1/86-6/86

Graduate Research Assistant, Mathematics, Georgia Tech, 9/84- 6/85

Graduate Teaching Assistant, Mathematics, Georgia Tech, 9/82-9/84 and 6/85-12/85

Antenna Engineer, Scientific-Atlanta, 6/81-9/81 and 6/82-9/82

Graduate Teaching Assistant, E. E., Stanford University, 9/80- 6/82

RESEARCH INTERESTS

Wavelets; Discrete minimum energy problems; Machine learning and bioinformatics; Inverse Problems

PROFESSIONAL SERVICE AND HONORS

American Mathematical Society

Mathematical Association of America, (former Tennessee State Director for the Southeastern Section of the MAA)

Vanderbilt University Chancellor's Research Award (2005)

Associate Editor, *Mathematics of Computation* (2011-present)

PUBLICATIONS

Books

[1] A. Statnikov, C. F. Aliferis, D. P Hardin, and I. Guyon, *A Gentle Introduction to Support Vector Machines in Biomedicine, Volume 1: Theory and Methods*, World Scientific, 2011.

[2] A. Statnikov, C. F. Aliferis, D. P Hardin, and I. Guyon, *A Gentle Introduction to Support Vector Machines in Biomedicine, Volume 2: Case Studies*, World Scientific, 2013.

Journal Publications

[3] A. V. Bondarenko, D. P. Hardin, and E. B. Saff, *Mesh Ratios for Best-Packing and Limits of Minimal Energy Configurations*, Acta Math. Hungar. (2013), accepted for publication.

[4] A. V. Bondarenko, D. P. Hardin, and E. B. Saff, *Minimal N-Point Diameters and f-Best-Packing Constants in* $\mathbf{R}^d$, Proc. Amer. Math. Soc (2013), accepted for publication.

[5] D. P. Hardin, A. P. Kendall, and E. B. Saff, *Polarization optimality of equally spaced points on the circle for discrete potentials*, Discrete & Computational Geometry **50** (2013), no. 1, 236–243.

[6] M. T. Calef, W. C. Griffiths, C. A. Fichtl, A. E. Schulz, and D. P. Hardin, *Observed Asymptotic Differences in Energies of Stable and Minimal Point Configurations on* S^2 *and the Role of Defects*, J. Math. Phys. **54** (2013), 101901, DOI 10.1063/1.4826345.

[7] E.A. Lima, B.P. Weiss, L. Baratchart, D.P. Hardin, and E.B. Saff, *Fast Inversion of Unidirectional Planar Magnetization Distributions in Geological Samples*, Journal of Geophysical Research - Solid Earth **118** (2013), no. 6, 2723–2752, DOI 10.1002/jgrb.50229.

[8] L. Baratchart, D.P. Hardin, E.A. Lima, E.B. Saff, and B.P. Weiss, *Characterizing Kernels of Operators Related to Thin Plate Magnetizations via Generalizations of Hodge Decompositions*, Inverse Problems **29** (2013), 015004.

[9] D. P. Hardin, E. B. Saff, and J. T. Whitehouse, *Quasi-uniformity of Minimal Weighted Energy Points*, Journal of Complexity **28** (2012), 177-191.

[10] L. Brown, I. Tsamardinos, and D. P. Hardin, *To Feature Space and Back: Identifying Top Weighted Features in Polynomial Support Vector Machines Models*, Intelligent Data Analysis **16** (2012), 551–579.

[11] J. S. Brauchart, D. P. Hardin, and E. B. Saff, *The Next-Order Term for Minimal Riesz and Logarithmic Energy Asymptotics on the Sphere*, Contemp. Math. **578** (2012), 31–61.

[12] J. S. Brauchart, D. P. Hardin, and E. B. Saff, *Discrete Energy Asymptotics on a Riemannian Circle*, Uniform Distribution Theory **7** (2012), 77–108.

[13] J. S. Brauchart, D. P. Hardin, and E. B. Saff, *The Riesz energy of the N-th roots of unity: an asymptotic expansion for large N*, Bull. Lond. Math. Soc. **41** (2009), 621–633.

[14] M. T. Calef and D. P. Hardin, *Riesz s-equilibrium measures on d-rectifiable sets as s approaches d*, Potential Analysis **30** (2009), 385–401.

[15] S. Borodachov, D. P. Hardin, and E. B. Saff, *Asymptotics of Weighted Best-Packing on Rectifiable Sets*, Matematicheskii Sbornik **199** (2009), 1579–1595.

[16] S. Borodachov, D. P. Hardin, and E. B. Saff, *On asymptotics of the weighted Riesz energy for rectifiable sets*, Trans. Amer. Math. Soc. **360** (2008), 1559–1580.

[17] A. Aldroubi, C. Cabrelli, D. P. Hardin, and U. Molter, *Optimal Shift invariant spaces and their Parseval frame generators*, Appl. Comp. Harm. Anal. **23** (2007), 273–283.

[18] J. Brauchart, D. P. Hardin, and E. B. Saff, *The support of the limit distribution of optimal Riesz energy points on sets of revolution in R^3*, J. Math. Phys. **48** (2007), no. 12, 122901.

[19] S. Borodachov, D. P. Hardin, and E. B. Saff, *Asymptotics of Best-Packing on Rectifiable Sets*, Proc. Amer. Math. Soc. **135** (2007), 2369–2380.

[20] D. P. Hardin, E. B. Saff, and H. Stahl, *The support of the logarithmic equilibrium measure on sets of revolution in $\mathbf{R}^3$*, J. Math. Phys. **48** (2007), 022901–022914.

[21] Y. Aphinyanaphongs, C. Aliferis, I. Tsamardinos, A. Statnikov, and D. P. Hardin, *Text Categorization Models For Retrieval of High Quality Articles in Internal Medicine*, J. Am. Med. Inform. Assoc. **12** (2005), 207–216.

[22] D. P. Hardin and E. B. Saff, *Minimal Riesz energy point configurations for rectifiable d-dimensional manifolds*, Adv. Math. **193** (2005), 174–204.

[23] A. Statnikov, C. F. Aliferis, I. Tsamardinos, D. P. Hardin, and S. Levy, *A Comprehensive Evaluation of Multicategory Classification Methods for Microarray Gene Expression Cancer Diagnosis*, Bioinformatics **21** (2005), 631–643.

[24] D. P. Hardin and E. B. Saff, *Discretizing manifolds via minimum energy points*, Notices of the Amer. Math. Soc. **51** (2004), no. 10, 1186–1194.

[25] D. P. Hardin, T. A. Hogan, and Q. Sun, *The matrix-valued Riesz lemma and local orthonormal bases in shift-invariant spaces*, Adv. Comput. Math. **20** (2004), no. 4, 367–384.

[26] D. P. Hardin and D. Hong, *Construction of wavelets and prewavelets over triangulations*, J. Comput. Appl. Math. **155** (2003), no. 1, 91–109.

[27] D. P. Hardin and B. Kessler, *Orthogonal macroelement scaling vectors and wavelets in 1-D*, Arab. J. Sci. Eng. Sect. C Theme Issues **28** (2003), no. 1, 73–88. Invited paper for special issue: Wavelet and fractal methods in science and engineering, Part I.

[28] G. C. Donovan, J. S. Geronimo, and D. P. Hardin, *Squeezable orthogonal bases: accuracy and smoothness*, SIAM J. Numer. Anal. **40** (2002), no. 3, 1077–1099.

[29] K. Attakitmongcol, D. P Hardin, and D. M. Wilkes, *Multiwavelet Prefilters II: Optimal orthogonal prefilters*, IEEE Trans. Image Proc. **10** (2002), 1476–1487.

[30] D. P. Hardin and T. A. Hogan, *Refinable subspaces of a refinable space*, Proc. Amer. Math. Soc. **128** (2000), no. 7, 1941–1950.

[31] G. C. Donovan, J. S. Geronimo, and D. P. Hardin, *Compactly supported, piecewise affine scaling functions on triangulations*, Constr. Approx. **16** (2000), no. 2, 201–219.

[32] T. B. Dinsenbacher and D. P. Hardin, *Multivariate nonhomogeneous refinement equations*, J. Fourier Anal. Appl. **5** (1999), no. 6, 589–597.

[33] G. C. Donovan, J. S. Geronimo, and D. P. Hardin, *Orthogonal polynomials and the construction of piecewise polynomial smooth wavelets*, SIAM J. Math. Anal. **30** (1999), no. 5, 1029–1056 (electronic).

[34] D. P. Hardin and J. A. Marasovich, *Biorthogonal multiwavelets on* $[-1, 1]$, Appl. Comput. Harmon. Anal. **7** (1999), no. 1, 34–53.

[35] D. P. Hardin and D. Roach, *Multiwavelet prefilters I: Orthogonal prefilters preserving approximation order* $p \leq 2$, IEEE Trans. Circ. and Sys. II: Anal. and Dig. Sign. Proc. **45** (1998), no. 8, 1106–1112.

[36] G. C. Donovan, J. S. Geronimo, and D. P. Hardin, *Intertwining multiresolution analyses and the construction of piecewise-polynomial wavelets*, SIAM J. Math. Anal. **27** (1996), no. 6, 1791–1815.

[37] X.-G. Xia, J. S. Geronimo, D. P. Hardin, and B. Suter, *Design of prefilters for discrete multiwavelet transforms*, IEEE Trans. Sig. Proc. **44** (1996), 251–35.

[38] G. C. Donovan, J. S. Geronimo, D. P. Hardin, and P. R. Massopust, *Construction of orthogonal wavelets using fractal interpolation functions*, SIAM J. Math. Anal. **27** (1996), no. 4, 1158–1192.

[39] J. S. Geronimo, D. P. Hardin, and P. R. Massopust, *Fractal functions and wavelet expansions based on several scaling functions*, J. Approx. Theory **78** (1994), no. 3, 373–401.

[40] J. S. Geronimo, D. P. Hardin, and P. R. Massopust, *Fractal Surfaces, Multiresolution Analyses and Wavelet Transforms*, NATO ASI Series F **126** (1994), 275–294.

[41] D. P. Hardin and P. R. Massopust, *Fractal interpolation functions from* $\mathbf{R}^n$ *into* $\mathbf{R}^m$ *and their projections*, Z. Anal. Anwendungen **12** (1993), no. 3, 535–548.

[42] J. S. Geronimo and D. P. Hardin, *Fractal interpolation surfaces and a related* 2*-D multiresolution analysis*, J. Math. Anal. Appl. **176** (1993), no. 2, 561–586.

[43] D. P. Hardin, B. Kessler, and P. R. Massopust, *Multiresolution analyses based on fractal functions*, J. Approx. Theory **71** (1992), no. 1, 104–120.

[44] A. Deliu, J. S. Geronimo, R. Shonkwiler, and D. P. Hardin, *Dimensions associated with recurrent self-similar sets*, Math. Proc. Cambridge Philos. Soc. **110** (1991), no. 2, 327–336.

[45] G. S. Strang and D. P. Hardin, *A thousand points of light*, College Mathematics Journal **21** (1991), no. 2, 327–336.

[46] D. P. Hardin, P. Takáč, and G. Webb, *Dispersion population models discrete in time and continuous in space*, J. Math. Biol. **28** (1990), no. 1, 406 –409.

[47] M. F. Barnsley and D. P. Hardin, *A Mandelbrot set whose boundary is piecewise smooth*, Trans. Amer. Math. Soc. **315** (1989), no. 2, 641–659.

[48] M. F. Barnsley, J. Elton, D. P. Hardin, and P. Massopust, *Hidden variable fractal interpolation functions*, SIAM J. Math. Anal. **20** (1989), no. 5, 1218–1242.

[49] J. S. Geronimo and D. P. Hardin, *An exact formula for the measure dimensions associated with a class of piecewise linear maps*, Constr. Approx. **5** (1989), no. 1, 89–98. Fractal approximation.

[50] M. F. Barnsley, J. Elton, and D. P. Hardin, *Recurrent iterated function systems*, Constr. Approx. **5** (1989), no. 1, 3–31.

[51] D. P. Hardin, P. Takáč, and G. Webb, *A comparison of dispersal strategies for survival of spatially heterogeneous populations*, SIAM J. Appl. Math. **48** (1988), no. 6, 1396–1423.

[52] D. P. Hardin, P. Takáč, and G. F. Webb, *Asymptotic properties of a continuous-space discrete-time population model in a random environment*, J. Math. Biol. **26** (1988), no. 4, 361–374.

[53] D. P. Hardin and P. R. Massopust, *The capacity for a class of fractal functions*, Comm. Math. Phys. **105** (1986), no. 3, 455–460.

[54] M. F. Barnsley, V. Ervin, D. P. Hardin, and J. Lancaster, *Solution of an inverse problem for fractals and other sets*, Proc. Nat. Acad. Sci. U.S.A. **83** (1986), no. 7, 1975–1977.

Submitted

[55] T. Erdélyi, D.P. Hardin, and E.B. Saff, *Inverse Bernstein Inequalities and min-max-min problems on the unit circle*, Mathematika (2013), submitted.

[56] S. Borodachov, D. P. Hardin, and E.B. Saff, *Low Complexity Methods for Discretizing Manifolds via Riesz Energy Minimization*, Foundations of Computational Mathematics (2013), submitted.

Publications in Refereed Conference Proceedings and Edited Volumes

[57] J. Brauchart, D. P. Hardin, and E. B. Saff, *Riesz Energy and Sets of Revolution in R^3*, Contemporary Mathematics **481** (2009), 47–57.

[58] A. Statnikov, D. P. Hardin, and C. F. Aliferis, *Using SVM Weight-Based Methods to Identify Causally Relevant and Non-Causally Relevant Variables*, Twentieth Annual Conference on Neural Information Processing Systems (Vancouver, Canada, August Dec. 4), Proceedings of the 20th Annual Conference on Neural Information Processing Systems, 2006.

[59] T. N. T. Goodman and D. P. Hardin, *Refinable shift-invariant spaces of spline functions* (H. Daehlen, K. Morken, and L. L. Schumaker, eds.), Nashboro Press, Brentwood, 2005, pp. 179–197.

[60] T. N. T. Goodman and D. P. Hardin, *Refinable multivariate spline functions* (K. Jetter, M. Buhmann, W. Haussmann, R. Schaback, and J. Stöckler, eds.), Studies in Computational Mathematics, vol. 12, Elsevier, 2006, pp. 55–84.

[61] D. P. Hardin, I. Tsamardinos, and C. Aliferis, *A Theoretical Characterization of SVM-Based Feature Selection*, Twenty-first International Conference on Machine Learning (ICML) (Banff, Alberta, Canada, 2004), ACM International Proceedings Series, Vol. 69, 2004, pp. 48–55.

[62] D. P. Hardin, *Orthogonal piecewise polynomial wavelets*, International Conference on Wavelets and its Applications (Chennai, India, anuary 4), Wavelets and Their Applications (M. Krishna, R. Radha, and S. Thangavelu, eds.), Allied Publishers Pvt. Ltd, 2003, pp. 171–182.

[63] A. Aldroubi, C. Cabrelli, D. P. Hardin, U. Molter, and A. Rodado, *Determining sets of shift invariant spaces*, International Conference on Wavelets and its Applications (Chennai, India, January 4), Wavelets and Their Applications (M. Krishna, R. Radha, and S. Thangavelu, eds.), Allied Publishers Pvt. Ltd, 2003, pp. 171–182.

[64] C. F. Aliferis, D. P. Hardin, and P. Massion, *Machine Learning Models For Lung Cancer Classification Using Array Comparative Genomic Hybridization*, American Medical Informatics Association (AMIA) Annual Symposium (San Antonio, TX, 2002), Proceedings of the 2002 American Medical Informatics Association (AMIA) Annual Symposium, 2002, pp. 7–11.

[65] C. F. Aliferis, I. Tsamardinos, P. Massion, A. Statnikov, N. Fananapazir, and D. P. Hardin, *Machine Learning Models For Classification Of Lung Cancer and Selection of Genomic Markers Using Array Gene Expression Data*, 16th International Florida Artificial Intelligence Research Society (FLAIRS) Conference (St. Augustine, FL, 2003), Proceedings of the 16th International Florida Artificial Intelligence Research Society (FLAIRS) Conference, 2003, pp. 67–71.

[66] C. F. Aliferis, I. Tsamardinos, P. Massion, A. Statnikov, and D. P. Hardin, *Why Classification Models Using Array Gene Expression Data Perform So Well: A Preliminary Investigation Of Explanatory Factors*, 2003 International Conference on Mathematics and Engineering Techniques in Medicine and Biological Sciences (METMBS) (Las Vegas, Nev., 2003), Proceedings of the 2003 International Conference on Mathematics and Engineering Techniques in Medicine and Biological Sciences, 2003, pp. 47–53.

[67] D. P. Hardin, *Wavelets are piecewise fractal interpolation functions*, Fractals in multimedia (Minneapolis, MN, 2001), 2002, pp. 121–135.

[68] D. Bruff and D. P. Hardin, *Squeezable bases and semi-regular multiresolutions*, Wavelet analysis (Hong Kong, 2001), 2002, pp. 9–22.

[69] D. P. Hardin and T. A. Hogan, *Constructing orthogonal refinable function vectors with prescribed approximation order and smoothness*, Wavelet analysis and applications (Guangzhou, 1999), 2002, pp. 139–148.

[70] K. Attakitmongcol, D. P. Hardin, and D. M. Wilkes, *Optimal prefilters for the multiwavelet filter banks*, IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP) , Salt Lake City, 2001, 2001.

[71] G. Donovan, J. S. Geronimo, and D. P. Hardin, *Construction of orthogonal multiwavelets using fractal interpolation functions*, Self-similar systems (Dubna, 1998), 1999, pp. 71–78.

[72] G. C. Donovan, J. S. Geronimo, and D. P. Hardin, *Orthogonal multiwavelet constructions: 101 things to do with a hat function*, Advances in wavelets (Hong Kong, 1997), 1999, pp. 187–197.

[73] T. B. Dinsenbacher and D. P. Hardin, *Nonhomogeneous refinement equations*, Wavelets, multiwavelets, and their applications (San Diego, CA, 1997), 1998, pp. 117–127.

[74] G. C. Donovan, J. S. Geronimo, and D. P. Hardin, *A class of orthogonal multiresolution analyses in* $2D$, Mathematical methods for curves and surfaces (Ulvik, 1994), 1995, pp. 99–110.

[75] J. S. Geronimo, D. P. Hardin, and P. R. Massopust, *An application of Coxeter groups to the construction of wavelet bases in* $\mathbf{R}^n$, Fourier analysis (Orono, ME, 1992), 1994, pp. 187–196.

PUBLICATIONS-unrefereed

Conference Proceedings

[76] D. P. Hardin and E. B. Saff, *Asymptotics of Minimal Energy and Maximal Polarization Configurations I*, Oberwolfach Report **40** (2012), 2448–2450.

[77] D. P. Hardin and E. B. Saff, *Asymptotics of Minimal Energy and Maximal Polarization Configurations II*, Oberwolfach Report **40** (2012), 2451–2453.

[78] J. S. Geronimo and D. P. Hardin, *Squeezable bases and orthogonal wavelets on irregular grids*, Wavelet applications in signal and image processing IX, (San Diego, CA 2001), 2001, pp. 263–270.

[79] T. Dinsenbacher, G. Rhode, D. P. Hardin, A. Aldroubi, and B. Dawant, *Multiscale nonrigid data registration with automatic point selection*, Wavelet applications in signal and image processing VIII, (San Diego, CA 2000, 2000, pp. 1076–1083.

[80] D. P. Hardin and D. Roach, *Semi-orthogonal wavelets for elliptic variational problems*, Proc. Tangier 98 International Wavelet Conference on Multiscale Methods, INRIA, 1998, pp. 6.

[81] G. C. Donovan, J. S. Geronimo, and D. P. Hardin, *Squeezable orthogonal bases and adaptive least squares*, Wavelet applications in signal and image processing V, (San Diego, CA 1997), 1997, pp. 48–54.

[82] G. C. Donovan, J. S. Geronimo, D. P. Hardin, and B. Kessler, *Construction of two-dimensional multiwavelets on a triangulation*, Wavelet applications in signal and image processing IV, (Denver, CO, 1996), 1996, pp. 98–108.

[83] G. C. Donovan, J. S. Geronimo, and D. P. Hardin, *Constructing orthogonal spline wavelets*, Proceedings of Advances in Scientific Computing & Modeling, 1996, pp. 134–138.

[84] G. C. Donovan, J. S. Geronimo, and D. P. Hardin, *C^0 spline wavelets with arbitrary approximation order*, Wavelet applications in signal and image processing, III (San Diego, CA, 1995), 1995, pp. 376–380.

[85] G. C. Donovan, J. S. Geronimo, and D. P. Hardin, *Fractal Functions, Splines, Intertwining Multiresolution Analysis, and Wavelets*, Wavelet applications in signal and image processing, III (San Diego, CA, 1994), 1994, pp. 238–243.

[86] G. S. Strang and D. P. Hardin, *A thousand points of light*, Proceedings of the 1990 Conference on Technology in Collegiate Mathematics Contributed Papers, 1991, pp. 4.

[87] D. P. Hardin and J. V. Herod, *Solutions for model Boltzmann equations proposed by Ziff*, Differential equations (Birmingham, Ala., 1983), 1984, pp. 285–291.

[88] J. R. Jones and D. P. Hardin, *A dual-ported, dual-polarized Spherical Near-Field probe*, Proc. Ant. App. Symp., 1983, pp. 15.

[89] J. R. Jones and D. P. Hardin, *A dual-ported, dual-polarized Spherical Near-Field probe*, Proc. AMTA, 1983, pp. 14.

IN PREPARATION

[90] D. Bruff, B. Atkinson, J. S. Geronimo, and D. P. Hardin, *Wavelets centered on a knot sequence*, in preparation.

Grant information

DMS-1412428 "Discrete Energy and Polarization Problems on Manifolds", Pending, amount requested: $487,116 role in project co-PI

DMS-1418046 "Collaborative Research: Robust computation of ultra-weak moments from scanning magnetic microscopy, Pending, amount requested: $383,705 role in project: PI

DMS-1363146 "Constructive Functions 2014 Conference and School", period of award: 2/1/2014–1/31/2015 $32,200 (direct costs: $32,200, indirect costs: $0), role in project: Principal Investigator

Vanderbilt International Office grant, "Computational Mathematics of Scanning Magnetic Microscopy", period of award: 5/2013–7/2015, $6,850 (direct costs: $6,850, indirect costs: $0) Principal Investigator

DMS-1109266: "Optimal Weighted and Constrained Energy Configurations and Applications" source: NSF, period of award: 07/01/2011–06/30/2014, amount $249,077 (direct costs: $163,479, indirect costs: $85,598), role in project: Principal Investigator

DMS-0962939: "Conference on Optimal Configurations on the Sphere and Other Manifolds", source: NSF, period of award: 04/01/2010–03/30/2010, amount $25,500 (direct costs: $25,500, indirect costs $0), role in project: Principle Investigator

DMS-0934630: "CMG Collaborative Research: Imaging Magnetization Distributions in Geological Samples", source: NSF, period of award: 09/01/0908/30/13, amount: $218,000 (direct costs $140,645, indirect costs $77,355), role in project: co-Principal Investigator (PrincipaI Investigator: E.B. Saff)

DMS-0808093: "Discrete Potential Theory and Perturbations of Ground State Configurations", source: NSF, period of award: 06/01/0805/30/12, amount: $300,000 (direct costs: $195,440, indirect costs: $104,560 , role in project: Principle Investigator

"Clinical Proteomic Technology Assessment for Cancer", source: NIH, duration: 9/28/06–8/31/11, amount: $ 5,102,889, PI: D. Liebler, co-Investigator: D. Hardin U24 CA126479

"Ordered Distributions and Wavelets on Two-Dimensional Manifolds ", source: NSF, duration: 07/15/05–06/31/08, amount: $100,000, PI: D. P. Hardin, DMS-0505756

"Minimal Energy Problems on Manifolds", source: NSF, duration:06/01/05–05/31/06, amount: $200,000, PI: E. Saff, co-PI: D. Hardin, DMS-0532154

"Computational Equipment for Approximation Theory, Control Theory, and Graph Theory, source: NSF, duration: 9/2002-9/2004 (with one-year extension), amount: $40,000, PI: D. Hardin, co-PIs: M. Ellingham, M. Horn, E. Saff, and L. Schumaker, DMS-0215442

"Linked Knowledge Model for Excellence in Bioinformatics, Source: NIH, duration 9/02-8/04, role: co-Investigator, Amt: $442,270

"Orthogonal Multiwavelet Constructions", PI: D. P. Hardin, Total Amt. $65,000, duration: 6/95–5/98, Source: NSF

"Computational Equipment for Analysis, Graph Theory, and Applied Mathematics", PI: D. Hardin, co-Investigators: J. Ahner, M. Ellingham, M. Horn, and L. Schumaker, Total Amt. $88,048, duration: 8/96–9/97, Source: NSF

"Applications of Wavelets to Seismic Imaging", PI: D. P. Hardin, Total Amt. $98,824, duration: 5/96–9/97, Source: Sandia National Laboratory

"Applications of Wavelets to Seismic Imaging", PI: D. P. Hardin, co-Investigators: T. Hogan, Total Amt. $49,875, duration 12/97–8/98 Source: Sandia National Laboratory

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CONFERENCE AND WORKSHOP ORGANIZATION

Optimal Configurations on the Sphere and Other Manifolds in conjunction with Shanks Lecture given by Noam Elkies (May17-20, 2010), Vanderbilt University, Organizers: H. Cohn, D. Hardin, E. Saff, and S. Torquato;

Mini-symposia: Approximation and point distribution on the sphere; 6th International Congress on Industrial and Applied Mathematics (ICIAM) held in Zurich in July 16–20, 2007;

Mini-Workshop: Geometric Measure Theoretic Approaches to Potentials on Fractals and Manifolds; (April 8–14, 2007, Mathematisches Forschungsinstitut Oberwolfach), Organizers: P. Grabner, D. Hardin, and E. Saff, M. Zähle;

Wavelets and Multiwavelets, Special Session of AMS Southeastern Sectional Meeting (March 18–19, 2005, Western Kentucky University);

Wavelets, Frames, and Sampling, Special Session of AMS Southeastern Sectional Meeting (October, 2004, Vanderbilt University);

Second International Conference on Computational Harmonic Analysis (local organizing committee, May, 2004 Vanderbilt University);

Computational Analysis on the Sphere Workshop (December, 2003 Vanderbilt University);

International Conference on Advances in Constructive Approximation (May, 2003 Vanderbilt University);

Wavelet Applications in Signal and Image Processing VIII—X , Program Committee (San Diego, Annual Meeting of SPIE, years 1997–2002)

INVITED LECTURES

Analysis Symposium, Indiana University-Purdue University Fort Wayne, November 8, 2013, "Energy minimization, packing, and lattices: Kissing in eight dimensions"

Amer. Math. Soc. Southeastern Sectional Meeting, University of Mississippi, Oxford, MS March 1-3, 2013, "The next-order term for optimal Riesz and logarithmic asymptotics on the sphere"

AMS Special Session on Discrete Geometry and Algebraic Combinatorics, Joint Mathematics Meetings, San Diego, CA, January 9-12, 2013, "Asymptotics of discrete minimum energy problems"

Bridging the Gap Workshop on Mathematics in the Geosciences, Princeton University, Oct. 1–2, 2012, "Inverse Problems for Scanning Magnetic Microscopy"

Oberwolfach Workshop Optimal and Near Optimal Configurations on Lattices and Manifolds, Oberwolfach, Germany, August 20-24, 2012, "Asymptotics of discrete minimum energy problems II: gaining weight", one-hour talk

IANS-Miniworkshop, Stuttgart University, Stuttgart, Germany, August 18, 2012, "Low complexity discrete minimum energy problems with varying weights"

CityU-Vanderbilt Workshop on Applied Mathematics, City University of Hong Kong, Hong Kong, China, May 15, 2012, "Low complexity discrete minimum energy problems with varying weights"

AMS Western Regional Meeting, Honolulu, Hawaii, March 3–4, 2012, "Lightening the load: Low complexity discrete minimum energy problems"

SIAM SE Sectional Meeting, Huntsville, Alabama, March 24–25, 2012, "Discretizing with minimum energy"

Workshop on Sphere Arrangements, Fields Institute, November 15-18, 2011, "Discretizing Compact Manifolds with Minimum Energy: The attraction of working with the repulsive", one-hour talk

International Conference on Applied Harmonic Analysis and Multiscale Computing, University of Alberta, Edmonton, Canada July 25-28, 2011, "Wavelets Centered On a Knot Sequence"

International Conference on Computational Harmonic Analysis 4, City University of Hong Kong, Hong Kong, China, May 23-27, 2011, "Discretizing Compact Manifolds with Minimum Energy: The attraction of working with the repulsive", one-hour plenary talk

International Symposium on Approximation Theory, Vanderbilt University, May 17-20, 2011, "Quasi-uniformity of Minimal Weighted Energy Points on Compact Metric Spaces"

SIMtech Mini-Workshop: On minimum energy problems, University of Stuttgart, January 24, 2011, "Quasi-uniformity of Minimal Weighted Energy Points on Compact Metric Spaces"

Conference: Optimal configurations on the sphere and other manifolds, Vanderbilt University, May, 2010, "Potential theory and the asymptotics of ground state configurations"

Colloquium, Middle Tennessee State University, April 5, 2010, "Packings, Potentials, and Poppy Seed Bagels"

Colloquium, City University of Hong Kong, March 17, 2010, "Asymptotics of optimal configurations on the sphere: from Smale's Problem 7 to best packing"

Colloquium, Hong Kong Polytechnic University, March 12, 2010, "Asymptotic properties of optimal point configurations on the sphere and other manifolds"

Colloquium, Chinese University of Hong Kong, March 5, 2010, "From transfinite diameter to best-packing: the asymptotics of ground state configurations"

Analysis Seminar, Georgia Institute of Technology, October 23, 2009, "From transfinite diameter to order-density to best-packing: the asymptotics of ground state configurations"

Workshop on Fractals and Tilings, Strobl, Austria, July 7, 2009, "Riesz s-equilibrium measures on fractal sets"

Colloquium, Technische Universität Graz (Austria), July 3, 2009, "Discrete minimum energy problems"

Analysis and Topology Seminar, University of Jena (Germany), May 10, 2009 "Discrete minimum energy problems on fractal sets"

University of Iowa Fractal Workshop, University of Iowa, June 28-29, 2008 "Packing and Discrete Minimum Energy Problems on Fractal Sets"

Los Alamos National Laboratory, Center for Nonlinear Studies Analysis Seminar, June 26, 2008, "Ground State Configurations on Surfaces: Hexagons and Zeta Functions"

Western States Mathematical Physics Annual Meeting, California Institute of Technology, February 18–19, 2008 (1-hour talk), "Discrete Minimum Energy Problems"

Banff International Research Station (BIRS) Workshop: Modern Approaches for Asymptotics of Polynomials, November 11–16, 2007, (1-hour talk), "Asymptotics for Discrete Minimum Energy Problems"

Mini-symposia on Approximation and point distribution on the sphere; 6th International Congress on Industrial and Applied Mathematics (ICIAM) (Zurich) July 16-20, 2007, "Minimum energy configurations on the sphere"

Amer. Math. Soc. Southeastern Section Meeting, Middle Tennessee State University, Murfreesboro, TN, November 3–4, 2007, Special Session on Wavelets and Splines, "Nonuniform wavelets on triangulations"

SIAM SE Section Meeting, University of Memphis, Memphis, TN, May 4–5, 2007, Special Session on Wavelets and Frames, "Wavelets Centered on a Knot Sequence"

MFO MiniWorkshop on Geometric Measure Theoretic Approaches to Potentials on Fractals and Manifolds; (April 8 14, 2007, Mathematisches Forschungsinstitut Oberwolfach), Discrete Minimal Energy Problems Parts 1 and 2.

AMS-MAA Joint Meeting New Orleans, LA, January 5–8, 2007, Special Session on Wavelets and Frames, "Wavelets Centered on a Knot Sequence"

Abi-TUMath and Abi-TUPhys Easter Academy, Novacella, Italy, April 18–21, 2006, Principal Invited Lecturer, "Minimum Energy Configurations on Manifolds"

Amer. Math. Soc. Southeastern Section Meeting, April 2, 2006, "The support of the logarithmic equilibrium measure on sets of revolution in $\mathbf{R}^3$"

Annual MAA Alabama State Meeting, Dothan, AL, February 11, 2005, main speaker, "Packings, Potentials, and Poppy Seeds"

"Discretizing manifolds via minimum energy points", Analysis and Applications, Special Session of AMS Southeastern Sectional Meeting (March 18–19, 2005, Western Kentucky University);

Wavelet Theory and Applications: New Directions and Challenges, National University of Singapore, Singapore, August 10–14, 2004, "Discretizing manifolds via minimum energy points"

Computational Analysis on the Sphere Workshop, Vanderbilt University, Dec 5, 2003, "Discrete minimal energy problems on d-rectifiable manifolds"

Analysis Seminar, Georgia Tech, Atlanta, GA Nov 12, 2003, "Discrete minimum energy problems on d-manifolds"

SPIE International Symposium on Optical Science, Engineering, and Instrumentation, San Diego, California, August 5, 2003, "Macroelement multiwavelets on triangulations "

BIRS Workshop on Wavelets and their Applications, Banff, CA, June 7, 2003, "Squeezable bases and orthogonal wavelets on irregular grids"

AMS-MAA Joint Meeting Baltimore, MD, January 16, 2003, Special Session on Wavelets and Frames, "Wavelets on Triangulations: Orthogonal refinable macroelements"

Colloquium, Department of Applied Mathematics, University of Waterloo, Waterloo, CA, Dec 17, 2002, "An introduction to multiwavelets and their applications"

IDR South Carolina Marathon, University of South Carolina, Columbia SC, Nov 12, 2002, "Wavelets on Triangulations: Orthogonal refinable macroelements"

SIAM Southeastern Atlantic Section Annual Meeting, April, 19, 2002, "Piecewise Polynomial Wavelets", (principal invited speaker)

Seminar, Sandia National Laboratory, April, 10, 2002, "Support Vector Machines and Lung Cancer Classification using array Comparative Genomic Hybridization"

Colloquium, University of New Mexico, April 9, 2002, "Squeezable Bases and Wavelets on Irregular Grids"

SPIE International Symposium on Optical Science, Engineering, and Instrumentation, San Diego, California, July 30—August 3, 2001, "Squeezable Bases"

International Conference of Computational Harmonic Analysis, City University of Hong Kong, Hong Kong, June 4–8, 2001, "Local Orthogonal Bases"

IMA Minisymposium on Fractals in Multimedia, Institute for Mathematics and its Applications, University of Minnesota, January 17-19, 2001, "From fractal interpolation functions to wavelets: The HD problem for refinable functions" (1 hour invited talk)

AMS regional meeting, Birmingham AL, November 11-12, 2000, "Bits and Pieces: The Humpty Dumpty Problem for Refinable Vectors"

Singapore International Workshop on Wavelets and Fractals, Singapore, May 29-June 2, 2000, "Bits and Pieces: The Humpty Dumpty Problem for Refinable Vectors, parts I and II" (principal invited speaker—2 one hour talks)

Georgia Tech Wavelet Workshop, Atlanta, April 20-21, 2000, "Bits and Pieces: The Humpty Dumpty Problem for Refinable Vectors"

International Conference on Wavelet Analysis and Its Applications, Zhongshan University, Guangzhou, P. R. China, November 15–30, 1999, "The refinable subspaces of a refinable space" (principal invited speaker)

SPIE Annual Meeting, Special Session on Wavelets and their Applications, San Diego, July, 18–23, 1999, "Orthogonal Squeezable bases"

Special Session on Wavelet Analysis and Multiresolution Methods, Central Section Regional Meeting of the AMS, University of Illinois, Urbana-Champaign,Illinois, March 18-21, 1999,"Squeezable bases: Approximation order and regularity"

Introduction to Wavelets, 3 hour workshop given at the Southeastern Regional meeting of the MAA, March 1999, Rhodes College, Memphis, TN

Midwest Regional Approximation Theory Conference, Madison Wisconsin, May 29–June 2, 1998 "Squeezable bases: Approximation order and regularity"

Special Session on Multiwavelets and PDEs, AMS Regional Meeting, Albuquerque, NM, November 8–9, 1997, "Squeezable multiresolution analyses"

Special Session on Analysis with Wavelets, AMS Regional Meeting, Milwaukee, WI, October 24–26, 1997, "Refinable subspaces of a refinable space"

Seminar Talk, Analysis Seminar, Georgia Tech, Atlanta GA, October 15, 1997, "Local refinable shift-invariant spaces"

Special Session on Wavelets, International Conference on Curves and Surfaces, Lillehammer, Norway, July 3–7, 1997, "Orthogonal piecewise polynomial wavelets of arbitrary approximation order"

Colloquium Talk, Sandia National Laboratory, Albuquerque, NM, May 21–23, 1997 "Spline multiwavelets"

Hong Kong Workshop on Wavelets, Chinese University of Hong Kong, May 5–9, 1997, "101 things to do with a hat function"

Conference on Theory and Applications of Multiwavelets, Sam Houston State University, Huntsville, Texas, March 20–22, (principal invited speaker: 1 hour talk), "Multiwavelet constructions"

Special Session on Wavelets, Multiwavelets, and Applications of Joint AMS/MAA Winter Meeting, San Diego, January 11, 1997, "Biorthogonal Multiwavelets"

Program on Spline Functions and the Theory of Wavelets, Centre de recherches mathematiques, Universite de Montreal, March 18–21, 1996, "Using fractal interpolation functions to construct wavelets"

Colloquium Talk, National Institute of Health, Bethesda, MD November 9, 1995, "Orthogonal shift-invariant bases"

Wavelet Session, International Conference on Scientific Computing and Modelling, Eastern Illinois University, Charleston, IL, October 12, 1995, "Orthogonal Multiwavelet Constructions"

AMS/SIAM Summer Seminar on Real Number Algorithms, Park City, UT, August 8, 1995

Third U.S. National Conference on Computational Mechanics Dallas, Texas, June 1995

Fractals and Wavelet Seminar, Georgia Tech, Atlanta, GA, February 1995

Colloquium talk at Sandia National Laboratory, Albuquerque, NM, February, 1995

Special Session on Wavelet Galerkin Methods in Computational Mechanics, 31st Annual Technical Meeting of the Society for Engineering Science, College Station, TX, October, 1994

The Fourteenth IMACS World Congress on Computation and Applied Mathematics, Atlanta, GA, July 1994

The Third International Conference on Mathematical Methods in Computer Aided Geometric Design, Ulvik, Norway, June 1994, "Intertwining multiresolution analyses and spline wavelets", (principal invited speaker: 1 hour talk)

Special Session on Wavelets of Joint AMS/MAA Winter Meeting, Cinncinnati, OH, 1994

Fractals and Wavelet Seminar, Georgia Tech, Atlanta, GA, January 1994

MIT Spring Wavelet Seminar, MIT, Cambridge, MA, March, 1993, "Fractal interpolation functions and wavelets" (1 hour talk)

Conference on Technology in The Classroom, Georgia Tech., Atlanta, GA, 1992, "A thousand points of light"

International Workshop on Analysis and its Applications, University of Maine, Orono, ME, 1992.

Conference on Technology in the Classroom, Georgia Tech., Atlanta, GA, 1991.

SIAM Conference on Applications of Dynamical Systems, Orlando, FL, 1990.

Conference on Mathematical Biology, Georgia Tech., Atlanta, GA, 1989.

CONTRIBUTED TALKS

Constructive Functions Tech-04, Georgia Institute of Technology, Atlanta, Georgia, November 7–9, 2004 "Minimal Riesz energy point configurations for rectifiable d-dimensional manifolds"

MAA Southeastern Section Regional Meeting, Montgomery, Alabama, March 30-31, 2001 "Orthogonal Spline Wavelets"

SPIE Annual Meeting, Special Session on Wavelets and their Applications, San Diego, July, 21–24, 1998, "Squeezable Wavelets"

SPIE Annual Meeting, Special Session on Wavelets and their Applications, San Diego, July, 30–August, 1, 1997, "Local orthogonal squeezable bases"

Southeast Approximation Theory Conference, Athens, GA, April 11–12, 1997, "101 things to do with a hat function"

Mathematical Imaging: Wavelet Applications in Signal and Image Processing, SPIE Annual Meeting, Denver, August 6–9, 1996, "Orthogonal Multiwavelets on a Triangulation"

SPIE International Symposium on Optical Science, Engineering, and Instrumentation, San Diego, California, July 13–14, 1995.

American Mathematical Society Southeastern Section Meeting, University of Central Florida, Orlando, Florida, March, 1995.

Eighth International Conference on Approximation Theory, Texas A&M University, College Station, Texas, January, 1995.

Joint AMS/MAA Winter Meeting, Sante Fe, TX January 1993

Joint AMS/MAA Winter Meeting, Baltimore, MD January 1992

Southeast Conference on Mathematical Biology, Clemson University, Clemson, SC 1988

STUDENTS SUPERVISED

Undergraduate Research Supervised

Amos Kendall, "Optimal polarization configurations on the circle", summer, 2012

Will Knowles (Duke undergraduate), "Low complexity minimal energy computations", summer, 2012

Mackenzie Atkinson, "Computing minimal energy configurations", 2012-13 academic year

Vanderbilt Undergraduate Summer Research Program

Noah Clemons, "Multiwavelet algorithms", 2003.

Aimee Cunningham, "Clustering algorithms for biomedical data", (co-supervised with A. Aldroubi), 2001.

Urmila Malvadkar, "Age-structured patch models for perennial plants", 1994.

Undergraduate Honors Theses

Martin King, "Generalized Gauss Sums", 1992.

PhD Students

Justin Fitzpatrick (2010) "The Geometry of Optimal and Near-Optimal Riesz Energy Configurations" initial position: Lecturer, Vanderbilt University

Laura Brown, (jointly directed by D. Hardin and I. Tsamardinos), (PhD: Biomedical Informatics), "Novel methods for variable selection in non-faithful domains, understanding support vector machines, learning regions of Bayesian networks, and prediction under manipulation" (2009) initial (and current) position: Assistant Professor, Michigan Technological University

Matthew Calef, "Theoretical and computational Investigations of minimal energy problems" (2009) initial position: postdoctoral researcher, Los Alamos National Laboratory; current position: staff scientist (2011), Los Alamos National Laboratory

Sergiy Borodachov, (chair: E. Saff, co-chair D. Hardin), "Asymptotic properties of minimal energy points on rectifiable sets" (2006), initial position: postdoctoral fellow, Georgia Institute of Technology, current position: Assistant Professor, Towson University

Derek Bruff, Thesis: "Wavelets on nonuniform knot sequences" (2003), initial position: Assistant Professor (prefector), Harvard University, current position: Derek Bruff Assistant Director, CFT; Senior Lecturer, Mathematics, Vanderbilt University

Kitti Attakitmongcol, "Multiwavelet Prefilters: Optimal Orthogonal Prefilters" (PhD EE, jointly directed by D. Hardin and M. Wilkes) (1999), current position: Assistant Professor, Electrical Engineering, Suranaree University of Technology

Thomas Dinsenbacher, "Nonhomogeneous Refinement Equations" (1999).

Bruce Kessler, Thesis: "Construction of Orthogonal Compactly-Supported Scaling Functions and Multiwavelets on Arbitrary Meshes" (1997), current position: Professor and Assistant Dean, Western Kentucky University.

David Roach, Thesis: "Multiwavelet Prefilters:Orthogonal Prefilters Preserving Approximation Order $p \leq 3$" (1997), current position: Associate Professor, Murray State University.

Jeffrey Marasovich, Thesis: "Biorthogonal Multiwavelets" (1996), current position: Nat. Sec. Agency

December 11, 2013