

CURRICULUM VITAE

Pencho Petrushev

January 2018

Graduate Education: Sofia University, Bulgaria

Doc. of Sci. in Mathematics (Second Doctoral Degree) 1983

Ph.D. 1977 in Mathematics; Thesis Advisor: Vasil A. Popov

Undergraduate Education: Sofia University, Bulgaria

B.S. June 1972 in Mathematics

Professional Employment (Permanent Positions):

2009 - present	Director	Interdisciplinary Math. Institute, USC
1996 - present	Professor	Department of Mathematics, USC
1986 - 1996	Professor	Inst. of Math., Bulg. Acad. of Sciences
1982 - 1986	Senior Research Fellow	Inst. of Math., Bulg. Acad. of Sciences
1977 - 1982	Research Fellow	Inst. of Math., Bulg. Acad. of Sciences

Awards and Honors:

The 2010 USC Educational Foundation Award for Research in Science, Mathematics, and Engineering

The 1989 Bulgarian Mathematical Science Award “N. Obreshkov”, awarded by the Bulgarian Academy of Sciences and Sofia University

Editorial Boards:

Constructive Approximation - 2004 – present

SIAM Journal on Mathematical Analysis - 2010 – present

Journal of Fourier Analysis and Applications - 2012 – present

Foundations of Computational Mathematics - 2014 – present

Transactions of Mathematics and Its Applications - 2016 – present

Analysis in Theory and Applications - 1990 – present

Serdica Mathematical Journal - 2004 – present

Mathematics - Open Access Journal - 2012 - present

Doctoral Students: at USC

Borislav Karaivanov, Thesis Title: “Nonlinear piecewise polynomial approximation: Theory and Algorithms”, completed in December 2001

Kyungwon Park, Thesis Title: “Bivariate Rational Approximation and Anisotropic Franklin Bases”, completed in May 2004

Master Students: at USC.

Xiang Yu, Department of Computer Science, USC
Thesis Title: “Client-server system for progressive image transmission based on Adaptive wavelet bases”, completed in May 2001

Wendy Newcomb, Department of Mathematics, USC
Thesis Title: “Fast Evaluation of Band Limited Functions at Scattered Points on the Sphere”, completed in April 2015

Jared Szi, Department of Mathematics, USC
Thesis Title: “Chebyshev Inversion of the Radon Transform”, completed in April 2016

David Hughey, Department of Mathematics, USC
Thesis Title: “Nonequispaced Fast Fourier Transform”, completed in August 2017

Grant Support (last 10 years):

NSF: grant DMS-1714369
Title: Nonlinear approximation in geometric, harmonic and anisotropic settings with applications
PI: P. Petrushev
August 16, 2017 - August 15, 2020; \$162,941

NGA/DOD: HM01771210004
Title: Highly Effective Compression and Evaluation of Geodetic Quantities
PI: P. Petrushev
August 15, 2012 - August 14, 2017; \$750,000

NEH: PR-50207-15
Title: AEO-Light 2.0: An Open Source Application for Image-Based Digital Reproduction of Optical Film Sound
PI: G. Wilsbacher, Co-PI: P. Petrushev
January 1, 2015 - December 31, 2016; \$222,146

NSF: DMS-1211528

Title: Representation and Approximation of Functions in Nonclassical and Anisotropic Settings with Applications

PI: P. Petrushev

June 1, 2012 - May 31, 2015, extended till May 31, 2016; \$170,011

NEH: PR50122

Title: An Open Source Application for Image-Based Digital Reproduction of Optical Film Sound

PI: G. Wilsbacher, Co-PIs: P. Petrushev, M. Cooper, B. Karaivanov

May 2011 - May 2014; \$362,500

NIH/NIDCD: R01DC007640

Title: Efficacy of Laryngeal High-Speed Videoendoscopy

PI: D. Deliyski, Co-PI: P. Petrushev

February 1, 2007 - February 1, 2014 (extended); \$3,078,774

NIH/NIDCD: 5R01DC7640

Title: Throat Clearing, Coughing, and Alternative Behaviors

PI: Bonilha Heather (Medical University of South Carolina)

Subcontract PI: D. Deliyski, Co-PI: P. Petrushev

October 1, 2010 - June 30, 2011, \$14,097

NSF: DMS 0709046

Title: Highly efficient methods for surface and solid sphere studies

PI: Pencho Petrushev

July 15, 2007 - September 30, 2010; \$143,907

DARPA/DSA: HM1582-07-2-3036

Title: Highly Effective Geospatial Representation and Analysis

PI: Pencho Petrushev

October 10, 2007 - April 10, 2009; \$271,385

Cyprus University Research Grant

Title: Decomposition of Weighted Smoothness Spaces and Applications

PIs: George Kyriazis, Pencho Petrushev

September 2007 - August 2009; 17,400 CYP (approximately \$40,000)

Conference Organizing or Program Committees:

Nine international Approximation Theory Conferences in Bulgaria

Invited Conference Talks (last 10 years):

- Conference on Time-Frequency, STROBL09, Strobl, Austria, June 15 - 20, 2009
- International workshop “Nonlinear and Adaptive Approximation” at Castle Reisenburg (Günzburg), Germany, September 30 - October 3, 2009
- Workshop “Topics in Several Complex Variables and Geometry” University of Cyprus, Nicosia, November 22, 2009
- Oberwolfach Workshop: Wavelet and Multiscale Methods, August 1-7, 2010
- Conference: “From Abstract to Computational Harmonic Analysis” Strobl, Austria, June 13 - 19, 2011
- Conference: “New Trends in Approximation Theory” Ein Gedi, Israel, January 4 - 7, 2012
- Workshop: “New perspectives in Approximation theory and Applications” Laboratoire Jacques-Louis Lions, Université Pierre et Marie Curie, Paris, June 15, 2012
- Workshop: “Applied Coorbit Theory” Erwin Schrödinger Institute (Univ. Vienna), Austria, September 17 - 21, 2012
- Numerical Methods for PDEs: On Occasion of Raytcho Lazarov’s 70th Birthday Texas A&M University, College Station, January 25-26, 2013
- Oberwolfach Workshop ”Multiscale and High-Dimensional Problems”, July 28th - August 3rd, 2013
- International Conference Constructive Theory of Functions - 2013, Sozopol, Bulgaria, June 9 - 15, 2013
- 8th Internat. Conference ”Curves and Surfaces”, Paris, June 12-18, 2014
Invited plenary talk (opening talk of conference)
- International Conference Mathematics Days in Sofia, Sofia, Bulgaria, July 7-10, 2014; Invited plenary talk
- Foundations of Computational Mathematics conference, FoCM 2014 - Montevideo, Uruguay, December 11 - 20, 2014; Invited plenary talk

- International Conference on Multivariate Approximation, Giessen, Schloss Rauschholzhausen, Germany, 31 March - 5 April 2016
- International Conference Constructive Theory of Functions - 2016, Sozopol, Bulgaria, June 11 - 17, 2016; Invited plenary talk
- Conference: Multiscale and High-Dimensional Problems Oberwolfach, March 26 - April 1, 2017
- Conference in Cyprus: Contemporary Aspects of Analysis Protaras, Cyprus, May 1-5, 2017; Invited speaker
- FoCM 2017 - Foundations of Computational Mathematics Conference Barcelona, July 10-19, 2017; Keynote speaker
- Fourth Aachen Conference on Computational Engineering Science (AC.CES) July 27-28, 2017; Invited speaker
- International Conference: New perspectives in the theory of function spaces and their applications (NPFSA-2017) Bedlewo, Poland, September 17-23, 2017; Invited speaker

Colloquia and Invited Seminar Talks (last 10 years):

- Department of Mathematics and Statistics, University of Cyprus, Analysis Seminar, Thursday, June 5, 2008
- Institute of Mathematics and Informatics, Bulgarian Academy of Sciences, Mathematical Modelling Seminar, Wednesday, July 23, 2008
- Institute of Mathematics and Informatics, Bulgarian Academy of Sciences Mathematical Modelling Seminar, Wednesday, November 26, 2008
- Department of Mathematical Sciences, Aalborg University, Denmark, March 12, 2009
- Institute of Mathematics and Informatics, Bulgarian Academy of Sciences, Mathematical Modeling Seminar, July 22, 2009
- Colloquium talk given at the Department of Mathematics, USC, November 18, 2010
- Analysis Seminar, Tel Aviv University, June 18, 2013
- Beijing Normal University, Function spaces seminar, April 14, 2014
- Beijing Normal University, General seminar, April 18, 2014
- University of Linköping, Sweden, Analysis seminar, September 24, 2014

Service on Professional Panels:

Member of the Vasil A. Popov Prize Selection Committee, since 1994 (Chair, 2004–2016)

Membership: American Mathematical Society, SIAM, Bulgarian Mathematical Society

Research Areas:

General: Approximation Theory, Harmonic Analysis, Numerical Analysis

Specific:

1. Spaces of distributions such as Hardy, Besov and Triebel-Lizorkin spaces in harmonic, nonclassical, anisotropic and geometric settings
2. Construction of bases and frames (needlets) for Besov and Triebel-Lizorkin spaces in nonclassical and geometric settings
3. Nonlinear approximation from rational functions, splines, frames, ridge functions and more general dictionaries
4. Nonlinear n -term approximation of harmonic functions from linear combinations of shifts of the fundamental solution of the Laplace equation (Newtonian kernel)
5. Application of spherical needlets to approximation and fast evaluation of quantities represented in high degree surface or solid spherical harmonics
6. Reproduction of sound from optical sound tracks of digital scans of motion picture films

Publications: 104 (1 book, 98 articles in print and 5 submitted for publication)

Monograph:

1. P. Petrushev, V. Popov, “Rational approximation of Real Functions”, *Cambridge University Press*, 1987, 371 pages.

Selected Articles:

1. P. Petrushev, Relations between rational and spline approximations in L_p metric, *J. Approx. Theory*, 50 (1987), 141–159.
2. P. Petrushev, Direct and converse theorems for rational and spline approximation and Besov spaces, *Lecture Notes in Mathematics 1302, Proceedings of the Conference "Function Spaces and Applications", Lund 1986*, 1988, pp. 363–377.
3. E. Moskona, P. Petrushev, Uniform rational approximation of functions with first derivative in the real Hardy space ReH^1 , *Constr. Approx.* 7 (1991), 69–103.
4. R. DeVore, P. Petrushev, and X. Yu, Nonlinear wavelet approximation in the space $C(R^d)$, *Progress in Approximation Theory* (A. A. Gonchar, E. B. Saff, eds.), New York, Springer-Verlag, 1992, pp. 261–283.
5. P. Binev, E. Saff, P. Petrushev, and O. Trifonov, Distribution of interpolation points of best L_2 -approximants (n th partial sums of Fourier series), *Constr. Approx.* 9 (1993), 445–472.
6. R. DeVore, P. Petrushev, and V. Temlyakov, Multivariate trigonometric polynomial approximation with frequencies from the hyperbolic cross, *Mat. Zametki*, 56 (1994), 36–63 (English translation in *Math. Notes*, 56 (1994), 900–918).
7. E. Moskona, P. Petrushev, and E. Saff, Gibbs phenomenon for best L_1 -trigonometric polynomial approximation, *Constr. Approx.* 11 (1995), 391–416.
8. R. DeVore, K. Oskolkov, and P. Petrushev, Approximation by feed-forward neural networks, *Ann. Numer. Math.* 4 (1997), 261–287.

9. P. Petrushev, Approximation by ridge functions and neural networks, *SIAM J. Math. Anal.* 30 (1998), 155–189.
10. A. Cohen, R. DeVore, P. Petrushev, and H. Xu, Nonlinear, Approximation and the space $BV(\mathbb{R}^2)$, *Amer. J. Math.* 121 (1999), 587–628.
11. P. Petrushev, Bases consisting of rational functions of uniformly bounded degrees or more general functions, *J. Funct. Anal.* 174 (2000), 18–75.
12. G. Kyriazis, P. Petrushev, New bases for Triebel-Lizorkin and Besov spaces, *Trans. Amer. Math. Soc.* 354 (2002), no. 2, 749–776.
13. P. Binev, W. Dahmen, R. DeVore, and P. Petrushev, Approximation classes for adaptive methods, *Serdica Math. J.* 28 (2002), 1001–1026.
14. P. Petrushev, Multivariate n -term rational and piecewise polynomial approximation, *J. Approx. Theory*, 121 (2003), 158–197.
15. B. Karaivanov, P. Petrushev, Nonlinear piecewise polynomial approximation beyond Besov spaces, *Appl. Comput. Harmon. Anal.* 15 (2003), 177–223.
16. B. Karaivanov, P. Petrushev, and R. Sharpley, Nonlinear piecewise polynomial approximation: Algorithms, *Trans. Amer. Math. Soc.* 355 (2003), 2585–2631.
17. O. Davydov, P. Petrushev, Nonlinear approximation from differentiable piecewise polynomials, *SIAM J. Math. Anal.* 35 (2003), 708–758.
18. P. Petrushev, Nonlinear n -term approximation from hierarchical spline bases, *Constructive Theory of Functions, Varna 2002* (B. Bojanov, Ed.), DARBA, Sofia, 2003, pp. 33–85.
19. G. Kyriazis, K. Park, and P. Petrushev, B-spaces and their characterization via anisotropic Franklin bases, *Approximation Theory: a volume dedicated to Borislav Bojanov* (D. K. Dimitrov, G. Nikolov, and R. Uluchev, Eds.), pp. 145–162, Prof. M. Drinov Acad. Publ. House, Sofia, 2004.
20. M. Campos-Pinto, A. Cohen, and P. Petrushev, High order geometric smoothness for conservation laws, *J. of Hyperbolic Differ. Equ.* 2 (2005), 39–59.

21. P. Petrushev, Anisotropic spaces and nonlinear n-term approximation, *Approximation Theory XI: Gatlinburg 2004*, 363–394, Mod. Methods Math., Nashboro Press, Brentwood, TN, 2005.
22. P. Petrushev, Y. Xu, Localized polynomial frames on the interval with Jacobi weights, *J. Fourier Anal. and Appl.* 11 (2005), 557–575.
23. W. Dahmen, P. Petrushev, "Push-the-Error" algorithm for nonlinear n-term approximation, *Constr. Approx.* 23 (2006), 261–304.
24. G. Kyriazis, P. Petrushev, On the construction of frames on Triebel-Lizorkin and Besov spaces, *Proc. Amer. Math. Soc.* 134 (2006), 1759–1770.
25. F. J. Narcowich, P. Petrushev, and J. D. Ward, Localized Tight Frames on Spheres, *SIAM J. Math. Anal.* 38 (2006), 574–594.
26. F. J. Narcowich, P. Petrushev, and J. D. Ward, Decomposition of Besov and Triebel-Lizorkin spaces on the sphere, *J. Funct. Anal.* 238 (2006), 530–564.
27. G. Kyriazis, K. Park, and P. Petrushev, Anisotropic Franklin bases on polygonal domains, *Math. Nachr.* 279 (2006), 1099–1127.
28. G. Kerkycharian, P. Petrushev, D. Picard and T. Willer, Needlet algorithm for estimations in inverse problems, *Electronic Journal of Statistics*, 1 (2007), 30–76.
29. W. Dahmen, S. Dekel, and P. Petrushev, Multilevel preconditioning for partition of unity methods - some analytic concepts, *Numer. Math.* 107 (2007), 503–532.
30. P. Petrushev, Yuan Xu, Localized polynomial frames on the ball, *Constr. Approx.* 27 (2008), 121–148.
31. G. Kyriazis, P. Petrushev, and Yuan Xu, Jacobi decomposition of weighted Triebel-Lizorkin and Besov spaces, *Studia Math.* 186 (2008), 161–202.
32. G. Kyriazis, P. Petrushev, and Yuan Xu, Decomposition of weighted Triebel-Lizorkin and Besov spaces on the ball, *Proc. London Math. Soc.* 97 (2008), 477–513.

33. P. Petrushev, Yuan Xu, Decomposition of spaces of distributions induced by Hermite expansions, *J. Fourier Anal. and Appl.* 14 (2008), 372–414.
34. G. Kerkyacharian, P. Petrushev, D. Picard, and Yuan Xu, Decomposition of Triebel-Lizorkin and Besov spaces in the context of Laguerre expansions, *J. Funct. Anal.* 256 (2009), 1137–1188.
35. G. Kyriazis, P. Petrushev, On the construction of bases and frames for spaces of distributions, *J. Funct. Anal.* 257 (2009), 2159–2187.
36. S. Dekel, Y. Han, and P. Petrushev, Anisotropic meshless frames on \mathbb{R}^n , *J. Fourier Anal. and Appl.* 15 (2009), 634–662.
37. S. Dekel, P. Petrushev, Anisotropic function spaces with applications, in "Multiscale, Nonlinear and Adaptive Approximation", Dedicated to Wolfgang Dahmen on the Occasion of his 60th Birthday, R. DeVore, A. Kunoth (Eds.) Springer, 2009, ISBN 978-3-642-03412-1.
38. W. Dahmen, S. Dekel, and P. Petrushev, Two-level-split Decomposition of Anisotropic Besov Spaces, *Constr. Approx.* 31 (2010), no. 2, 149–194
39. K. Ivanov, P. Petrushev, and Yuan Xu, Sub-exponentially localized kernels and frames induced by orthogonal expansions, *Math. Z.* 264 (2010), 361–397.
40. G. Kerkyacharian, G. Kyriazis, E. Le Pennec, P. Petrushev, and D. Picard, Inversion of noisy Radon transform by SVD based needlets, *Appl. Comput. Harmon. Anal.* 28 (2010), 24–45.
41. S. Dekel, P. Petrushev, and T. Weissblat, Hardy spaces on \mathbb{R}^n with pointwise variable anisotropy, *J. Fourier Anal. and Appl.* 17 (2011), 1066–1107.
42. T. Coulhon, G. Kerkyacharian, and P. Petrushev, Heat Kernel Generated Frames in the Setting of Dirichlet Spaces, *J. Fourier Anal. Appl.* 18 (2012), no. 5, 995–1066.
43. K. Ivanov, P. Petrushev, and Yuan Xu, Decomposition of spaces of distributions induced by tensor product bases, *J. Funct. Anal.* 263 (2012), no. 5, 1147–1197.

44. G. Kyriazis, P. Petrushev, “Compactly” supported frames for spaces of distributions on the ball, *Monatsh. Math.* 165 (2012), no. 3-4, 365–391.
45. K. Ivanov, P. Petrushev, Highly effective evaluation and reconstruction of geodetic quantities on the sphere, *Proceedings of the ASPRS 2013 Annual Conference*, Baltimore, March, 2013.
46. G. Kyriazis, P. Petrushev, Rational bases for spaces of holomorphic functions in the disc, *J. Lond. Math. Soc.* (2) 89 (2014), no. 2, 434–460.
47. K. Ivanov, P. Petrushev, Irregular sampling of band-limited functions on the sphere, *Appl. Comput. Harmon. Anal.* 37 (2014), no. 3, 545–562.
48. S. Dekel, G. Kerkyacharian, G. Kyriazis, and P. Petrushev, Compactly supported frames for spaces of distributions associated with nonnegative self-adjoint operators, *Studia Math.* 225 (2014), no. 2, 115–163.
49. K. Ivanov, P. Petrushev, Fast Evaluation and Irregular Sampling of Band-limited Functions on the Sphere, *Proceedings of the International Conference ”Constructive theory of functions - 2013”* Sozopol, Prof. Marin Drinov, Academic Publishing House, Sofia 2014, pp. 115–140. ISBN 978-954-322-811-9
50. G. Kerkyacharian, P. Petrushev, Heat kernel based decomposition of spaces of distributions in the framework of Dirichlet spaces, *Trans. Amer. Math. Soc.* 367 (2015), no. 1, 121–189.
51. K. Ivanov, P. Petrushev, Fast memory efficient evaluation of spherical polynomials at scattered points, *Adv. Comput. Math.* 41 (2015), no. 1, 191–230.
52. K. Ivanov, P. Petrushev, Highly effective stable evaluation of bandlimited functions on the sphere, *Numer. Algorithms*, 71 (2016), no. 3, 585–611.
53. A. G. Georgiadis, G. Kerkyacharian, G. Kyriazis, P. Petrushev, Homogeneous Besov and Triebel-Lizorkin spaces associated to non-negative

self-adjoint operators, *J. Math. Anal. Appl.* 449 (2017), no. 2, 1382–1412.

54. M. Lind, P. Petrushev, Nonlinear nonnested spline approximation, *Constr. Approx.* 45 (2017), no. 2, 143–191.
55. S. Dekel, G. Kerkyacharian, G. Kyriazis, and P. Petrushev, Hardy spaces associated with non-negative self-adjoint operators, *Studia Math.* 239 (2017), no. 1, 17–54.
56. K. Ivanov, P. Petrushev, Harmonic Besov and Triebel-Lizorkin spaces on the ball, *J. Fourier Anal. Appl.* 23 (2017), no. 5, 1062–1096.

In Press

57. K. Ivanov, N. Pavlis, and P. Petrushev, Precise and efficient evaluation of gravimetric quantities at arbitrarily scattered points in space, *Journal of Geodesy*, <https://doi.org/10.1007/s00190-017-1094-y>

Submitted for Publication

58. S. Dekel, G. Kerkyacharian, G. Kyriazis, and P. Petrushev, A new proof of the atomic decomposition of Hardy spaces, preprint.
59. G. Kerkyacharian, S. Ogawa, P. Petrushev, and D. Picard, Regularity of Gaussian Processes on Dirichlet spaces, preprint.
60. A.G. Georgiadis, G. Kerkyacharian, G. Kyriazis, and P. Petrushev, Atomic and molecular decomposition of homogeneous spaces of distributions associated with non-negative self-adjoint operators, preprint.
61. K. Ivanov, P. Petrushev, Highly localized kernels on the sphere induced by Newtonian kernels, preprint.