

## ANDREW KNYAZEV (Andrei Kniazev)

November 22, 2011

Department of Mathematical and Statistical Sciences  
University of Colorado Denver Downtown Campus  
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### Education

<u>Institution</u>	<u>Date</u>	<u>Degree</u>	<u>Major</u>
Dept. Cybernetics and Comput. Sci., Moscow State University	1981	M.S.	Computer Sciences
Institute of Numerical Mathematics, Soviet Academy of Sciences	1985	Ph.D.	Numerical Math.

### Professional Experience

1994-present Professor since 2009, Associate Professor, Mathematics, UC Denver  
2008, July Visiting Professor, Ecole Normale Supérieure de Cachan, Paris  
1999-2001 Director, Center for Computational Mathematics, UC Denver  
1992-1994 Visiting Researcher, Courant Inst. of Mathematical Sciences, NYU  
1983-1992 Senior Scientist, Inst. of Numer. Math. Soviet Ac. Sci., Moscow  
1985-1992 Assistant Professor, Moscow Physico-Technical Institute  
1986-1988 Instructor, Moscow State University, Dept. of Math. and Mechanics  
1982-1985 Instructor, Moscow Institute of Engineering and Physics  
1981-1983 Software Engineer, Kurchatov's Institute of Atomic Energy, Moscow

**Current Research Interests:** numerical linear algebra, iterative solution of large sparse linear systems and eigenproblems, bounds for eigenvalues, numerical solution of partial differential equations, parallel computing, homogenization, numerical methods in linear elasticity, domain decomposition, embedding and multigrid methods, finite element methods, spectral clustering in data mining, biclustering for DNA microarray data, spectral image segmentation and graph partitioning, electronic structure calculations, localization.

### Grants, Fellowships, and Contracts Awarded

2012 DOE, Lawrence Livermore National Laboratory, Center for Applied Scientific Computing, External collaborator on LDRD proposal, PI Jean-Luc Fattebert,  $O(N)$  algorithm for First-Principles Molecular Dynamics at Exascale, 2012-1214, subcontract \$126,000  
2011 NSF Award DMS 1115734, Parallel Preconditioned Eigenvalue and Singular Value Solvers, 2011-2014, \$180,000  
2007 NSF Award DMS 0728941, Analysis of Microarray Gene Expression Data, 2007-2008, \$99,973  
2006 NSF DNS 0612751, Locally Optimal Preconditioned Eigenvalue Solvers, 2006-2010, Continuing Grant: \$79,958+\$83,134+\$86,450=\$249,542.  
2006 UC Denver Faculty Development Grant Award, \$2,000.  
2004 NSF CNS-0420985: MRI: Collaborative Research: Acquisition of an IBM BlueGene/L Supercomputer, under the direction of Jan Mandel, Andrew Knyazev, in collaboration with CNS-0421498 Richard D. Loft, University Corporation for Atmospheric Research and CNS-0420873 H. Tufo, University of Colorado, \$ 119,332.  
2004 DOE, Sandia Labs: Robust deflation analysis for preconditioned eigensolvers for large-scale modal analysis. 2004, \$ 49,995.

2004 DOE, Lawrence Livermore National Laboratory, The Center for Applied Scientific Computing: Preconditioned eigensolvers, 2004-2005. Through FusionNumerics.

2003 National Science Foundation, DMS: Preconditioned Algorithms for Large Eigenvalue Problems, Supplemental through the Approaches to Combat Terrorism program, 2003-2005, \$53,554.

2003 UC Denver Faculty Development Award: Prototype Parallel Generalized Eigensolver, \$3,275.

2002 National Science Foundation, DMS 0208773: Preconditioned Algorithms for Large Eigenvalue Problems, 2002-2005, \$ 157,500.

2002 NSF DMS 0209311: Sixth IMACS International Symposium on Iterative Methods in Scientific Computing at UC Denver, 2002-2003, \$ 16,555.

2002 DOE, Lawrence Livermore National Laboratory, The Center for Applied Scientific Computing: Preconditioned eigensolvers, \$53,604.

2002 DOE, Lawrence Livermore National Laboratory, The Center for Applied Scientific Computing: Sixth IMACS International Symposium on Iterative Methods in Scientific Computing at UC Denver, 2002-2003, \$ 3,000.

2001 NASA Earth Science Enterprise's Atmospheric Chemistry Modeling and Data Analysis Program: Towards interactive three-dimensional chemical data assimilation. Joint with Boris Khattatov (The PI), Jean-Francois Lamarque, 2001-2003, \$ 177,127.

2001 UC Denver Seed Money Award, \$700. 2000 One-semester Faculty Research Fellowship, University of Colorado Denver.

2000 National Science Foundation, DMS MRI/SCREMS 0079719. The PI. Joint with L. Benethum, S. Billups, T. Russell, J. Mandel, 2000-2001, \$ 100,000.

1995 National Science Foundation, SCREMS. Joint with Tom Russell (the PI), Jan Mandel, Leo Franca, and Chaoqun Liu, \$ 50,000.

1995 National Science Foundation, DMS 9501507: Preconditioned Parallel Methods for Large Symmetric Eigenproblems, 1995-1998, \$ 60,000.

### **Honors and Awards**

2007-2008 Excellence in Research Award University of Colorado Denver.

1999-2000 Teaching Excellence Award for the College of Liberal Arts and Sciences at the University of Colorado Denver.

1998-1999 Researcher/Creative Artist Award for the College of Liberal Arts and Sciences at the University of Colorado Denver.

1999 UC Denver nominee for the University of Colorado President's Faculty Excellence Award for Advancing Teaching and Learning through Technology.

## **BIBLIOGRAPHY—Andrew Knyazev**

### **Publications in Refereed Journals**

1982 E.G. D'yakonov and A.V. Knyazev, Group iterative method for finding lower-order eigenvalues. Moscow Univ., Ser. 15, Comput. Math. Cyber., no. 2, 32-40.

1986 V.S. Apokorina and A.V. Knyazev, BIPR-5M software code. VANT, ser. Physics and Technology of Nuclear Reactors, no. 5, Physics and Computational Methods of Nuclear Reactors, 34-35.

1986 A.V. Knyazev, Sharp a priori error estimates of the Rayleigh-Ritz method without assumptions of fixed sign or compactness. Math. Notes, 38, no. 5-6, 998-1002.

1987 A.V. Knyazev, On modified gradient methods for eigenvalue problems. Diff. Uravn., no. 4, 715-717. In Russian.

1987 A.V. Knyazev, Convergence rate estimates for iterative methods for mesh symmetric eigenvalue problem. Sov. J. Num. Anal. Math. Modelling, 2, no. 5, 371-396.

1987 A.V. Knyazev, Methods for the derivation of some estimates in a symmetric eigenvalue problem. In *Comp. Processes Systems* no. 5, Moscow, "Nauka", 164-173. In Russian.

1988 A.V. Knyazev and A.L. Skorokhodov, On the convergence rate of the steepest descent method in Euclidean norm. *USSR Comp. Math. Math. Phys.*, 28, no. 5, 195-196.

1989 A.V. Knyazev and A.L. Skorokhodov, Preconditioned iterative methods in subspace for solving linear systems with indefinite coefficient matrices and eigenvalue problems. *Sov. J. Num. Anal. Math. Modelling*, 4, no. 4, 283-310.

1990 A.V. Knyazev, V.I. Lebedev, and A.L. Skorokhodov, The Temple-Lehmann methods in iterative algorithms. *Sov. J. Num. Anal. Math. Modelling*, 5, no. 4, 265-273.

1991 N.S. Bakhvalov and A.V. Knyazev, Methods of effective computation of homogenized properties for the composites with a periodic structure which consist of essentially different components. In *Comp. Processes Systems* no.8, Moscow, "Nauka", 52-94. In Russian.

1991 A.V. Knyazev and A.L. Skorokhodov, On exact estimates of the convergence rate of the steepest ascent method in the symmetric eigenvalue problem. *Lin. Algebra Appl.*, v.154-156, 245-257.

1992 E.G. D'yakonov and A.V. Knyazev, On an iterative method for finding lower eigenvalues. *Russian J. Num. Anal. Math. Modelling*, 7, no. 6, 473-486.

1992 A.V. Knyazev, A parallel algorithm of subspace iterations and its implementation on a multiprocessor with ring architecture. *Russian J. Numer. Anal. Math. Modelling* 7, no. 1, 55-61.

1993 A.V. Knyazev and I.S. Sharapov, Variational Rayleigh quotient iteration methods for symmetric eigenvalue problem. *East-West J. of Numerical Mathematics*, 1, no. 2, 121-128.

1994 N.S. Bakhvalov, A.V. Knyazev, and M.E. Eglit, An inequality of the Korn type and orthogonal decompositions in spaces of matrices. *Russian Acad. Sci. Math. Doklady*, 48, no.1, 127-129.

1994 N.S. Bakhvalov and A.V. Knyazev, Fictitious domain methods and computation of homogenized properties of composites with a periodic structure of essentially different components. In *Numerical Methods and Applications*, Ed. Gury I. Marchuk, CRC Press, 221-276.

1994 A.V. Knyazev and A.L. Skorokhodov, The preconditioned gradient-type iterative methods in a subspace for partial generalized symmetric eigenvalue problem. *SIAM J. Numerical Analysis*, v. 31, 1226.

1996 J. Bramble, J. Pasciak, and A.V. Knyazev, A subspace preconditioning algorithm for eigenvector/eigenvalue computation. *Advances in Computational Mathematics*, 6, no. 2, 159-189.

1997 A.V. Knyazev, New estimates for Ritz vectors. *Math. Comp.* 66, no. 219, 985-995.

1998 A.V. Knyazev, Preconditioned eigensolvers - an oxymoron? *Electronic Transactions on Numerical Analysis*, 7, 104-123.

2000 A.V. Knyazev, Preconditioned eigensolvers. In "Templates for the Solution of Algebraic Eigenvalue Problems: A Practical Guide," Editors: Zhaojun Bai, James Demmel, Jack Dongarra, Axel Ruhe, and Henk Van der Vorst, SIAM.

2001 A.V. Knyazev, Toward the Optimal Preconditioned Eigensolver: Locally Optimal Block Preconditioned Conjugate Gradient Method. *SIAM Journal on Scientific Computing*, v. 23, no. 2, pp. 517-541.

2002 N. S. Bakhvalov, A. V. Knyazev, and R. R. Parashkevov, Extension Theorems for Stokes and Lamé equations for nearly incompressible media and their applications to numerical solution of problems with highly discontinuous coefficients. *Numerical Linear Algebra with Applications*, v. 9, no. 2, 115-139.

2002 A.V. Knyazev, M.E. Argentati, Principal Angles between Subspaces in an A-Based Scalar Product: Algorithms and Perturbation Estimates. *SIAM Journal on Scientific Computing*, v. 23, no. 6, 2008-2040.

2003 A.V. Knyazev, and O. Widlund, Lavrentiev Regularization + Ritz Approximation = Uniform Finite Element Error Estimates for Differential Equations with Rough Coefficients. *Mathematics*

of Computation, 72 (2003), 17-40.

2003 A.V. Knyazev and K. Neymeyr, A geometric theory for preconditioned inverse iteration. III: A short and sharp convergence estimate for generalized eigenvalue problems. *Linear Algebra and Its Applications*, 358 (2003), Issues 1-3, 95-114.

2003 A.V. Knyazev and K. Neymeyr, Efficient solution of symmetric eigenvalue problems using multigrid preconditioners in the locally optimal block conjugate gradient method. *ETNA*, 15 (2003), 38-55.

2003 A.V. Knyazev, Analysis of transmission problems on Lipschitz boundaries in stronger norms. *Journal of Numerical Mathematics*, 11, no. 3 (2003), 225-234.

2005 Stephen Billups, Andrew Knyazev and Jan Mandel, Introduction, *Applied Numerical Mathematics*, 54, 2 (2005), pp. 105-106.

2005 Jan Mandel, Lynn S. Bennethum, Mingshi Chen, Janice L. Coen, Craig C. Douglas, Leopoldo P. Franca, Craig J. Johns, Minjeong Kim, Andrew V. Knyazev, Robert Kremens, Vaibhav Kulkarni, Guan Qin, Anthony Vodacek, Jianjia Wu, Wei Zhao, and Adam Zornes, Towards a Dynamic Data Driven Application System for Wildfire Simulation, in: V.S. Sunderam et al. (Eds.): *Computational Science - Proceedings ICCS'2005*, Lecture Notes in Computer Science 3515, (2005) pp. 632-639.

2006 A. V. Knyazev and M. E. Argentati, On Proximity of Rayleigh Quotients for Different Vectors and Ritz Values Generated by Different Trial Subspaces. *Linear Algebra and Its Applications*, 415 (2006), no. 1, 82-95.

2006 A. V. Knyazev and J. Osborn, New A Priori FEM Error Estimates for Eigenvalues. *SIAM Journal on Numerical Analysis*, 43 (2006), no. 6 2647-2667.

2006 A. V. Knyazev and M. E. Argentati, Majorization for Changes in Angles Between Subspaces, Ritz values, and graph Laplacian spectra, *SIAM Journal on Matrix Analysis and Applications (SIMAX)*, 29 (2006/2007), no. 1, pp. 15-32.

2007 A. V. Knyazev, Observations on degenerate saddle point problems. *Comput. Methods Appl. Mech. Engrg.* 196, Issues 37-40, 3742-3749.

2007 A. V. Knyazev, I. Lashuk, M. E. Argentati, and E. Ovchinnikov, Block Locally Optimal Preconditioned Eigenvalue Solvers (BLOPEX) in hypre and PETSc. *SIAM Journal on Scientific Computing*, 25(5): 2224-2239.

2007 A. V. Knyazev and I. Lashuk, Steepest descent and conjugate gradient methods with variable preconditioning. *SIAM Journal on Matrix Analysis and Applications*, 29(4), 1267-1280.

2008 F. Bottin, S. Leroux, A. Knyazev, G. Zerah, Large scale ab initio calculations based on three levels of parallelization. *Comp. Material Sci.*, 42(2), 329-336.

2008 M. E. Argentati, A. V. Knyazev, C. C. Paige, and I. Panayotov, Bounds on changes in Ritz values for a perturbed invariant subspace of a Hermitian matrix, *SIAM Journal on Matrix Analysis and Applications*, 30(2) 548-559.

2009 A. V. Knyazev and K. Neymeyr, Gradient flow approach to geometric convergence analysis of preconditioned eigensolvers. *SIAM Journal on Matrix Analysis and Applications*, 31(2) 621-628.

2010 A. V. Knyazev and M. E. Argentati, Rayleigh-Ritz majorization error bounds with applications to FEM. *SIAM. J. Matrix Anal. Appl.* 31(3), pp. 1521-1537.

2010 A. V. Knyazev, A. Jujunashvili, and M. E. Argentati, Angles Between Infinite Dimensional Subspaces with Applications to the Rayleigh-Ritz and Alternating Projectors Methods. *Journal of Functional Analysis*, 259, pp. 1323-1345.

### **In preparation**

2011 A. V. Knyazev and D. McCuan, Multilevel eigensolvers for spectral clustering.

2011 A. V. Knyazev and D. McCuan, BLOPEX demystified.

2011 A. V. Knyazev and E. Vecharynski, Preconditioned solvers for singular value computation.  
 2011 A. V. Knyazev and E. Vecharynski, Absolute value preconditioning for symmetric indefinite linear systems.  
 2011 A. V. Knyazev and E. Vecharynski, Absolute value preconditioning for eigenvalue problems.  
 2011 A. V. Knyazev and P. Zhu, Rayleigh-Ritz majorization error bounds of the mixed type  
 2011 A. V. Knyazev and P. Zhu, Majorization-type convergence rate bounds for subspace iterations  
 2011 A. V. Knyazev and M. Kniazeva, Variability in the DNA microarray for the wild type *Caenorhabditis elegans*  
 and more...

### **Refereed Symposia Proceedings**

1991 N.S. Bakhvalov, A.V. Knyazev, and G.M. Kobel'kov, Iterative methods for solving equations with highly varying coefficients, Proc. IV Int. Symp. Domain Decomposition Methods for Partial Differential Equations (1990), 197-205, SIAM, Philadelphia.  
 1991 A.V. Knyazev, A preconditioned conjugate gradient method for eigenvalue problems and its implementation in a subspace. Proc. Eigenwertaufgaben in Natur- und Ingenieurwissenschaften und ihre numerische Behandlung, Oberwolfach, 1990. International Ser. Numerical Mathematics, v. 96, 143-154. Birkhauser, Basel.  
 1992 A.V. Knyazev, Iterative solution of PDE with strongly varying coefficients: algebraic version. Proc. IMACS Symp. Iterative methods in linear algebra, Brussels, 1991. Iterative methods in linear algebra, R. Beauwens and P. de Groen (Editors), 85-89, Elsevier, Amsterdam.  
 1995 N.S. Bakhvalov and A.V. Knyazev, Preconditioned Iterative Methods in a Subspace, In Domain Decomposition Methods in Science and Engineering, Ed. D. Keyes and J. Xu, AMS, 157-162.  
 2007 I. Lashuk, M. E. Argentati, E. Ovchinnikov and A. V. Knyazev, Preconditioned Eigensolver LOBPCG in hypre and PETSc. Lecture Notes Comp. Sci. Engineering, Springer, 55(2007), 635-642.

### **Books**

1984 Lebedev, V.I., Bakhvalovi, N.S., Agoshkov, V.I., Baburin, O.V., Knyazev, A.V., and Shutyaev, V.P., Parallel algorithms for solving some stationary problems of mathematical physics. Foreword by G.I. Marchuk. Dept. Num. Math. USSR Ac. Sci, Moscow. In Russian.  
 1986 A.V. Knyazev, Computation of eigenvalues and eigenvectors for mesh problems: algorithms and error estimates. Dept. Num. Math. USSR Ac. Sci., Moscow, 187 pp. In Russian.

### **Translations of Books**

1988 Ikramov, Kh.D. and Knyazev, A. V. Moscow, Mir Publ., 1988. 208 pp. Translation into Russian of the book: Gregory, R. T.; Krishnamurthy, E. V., Methods and applications of error-free computation. Springer-Verlag, New York, 1984. xii+194 pp. ISBN: 0-387-90967-2  
 1989 Ikramov, Kh.D., Knyazev, A. V., and Tyrtysnikov, E.E. Moscow, Mir Publ., 1989. Translation into Russian of the book: Horn, R.A. and Johnson, Ch. R. Matrix analysis. Cambridge Univ. Press, Cambridge, 1986.

### **Selected Non-Referees publications**

1981 D'yakonov, E.G. and Knyazev, A.V., An iterative method for finding the smallest eigenvalues. -Preprint 26, Dept. Num. Math. USSR Ac. Sci., Moscow. In Russian.  
 1983 Knyazev, A.V., Methods for the simultaneous computation of several eigenvectors. -Preprint 3749/16, Atomic Energy Inst., Moscow. In Russian.  
 1983 Knyazev, A.V., Some two-step methods for finding the boundaries of the spectrum of a linear matrix pencil. -Preprint 3749/16, Atomic Energy Inst., Moscow. In Russian.

- 1983 Knyazev, A.V. and Lebedev, V.I., Estimates for convergence and analysis of the optimality of iterative methods for the simultaneous computation of several eigenvectors. -In Comp. Meth. Linear Algebra, Dept. Num. Math. USSR Ac. Sci., Moscow, 94-114. In Russian.
- 1984 Knyazev, A.V., Practical implementation of Bauer's iterations for neutron-physical computations. -Preprint 79, Dept. Num. Math. USSR Ac. Sci., Moscow. In Russian.
- 1985 Knyazev, A.V., Modified gradient methods and their block analogous for the problems  $Mu = \lambda Lu, M = M, L = L > 0$ . -In Computer Arch. Num. Meth., Dept. Num. Math. USSR Ac. Sci., Moscow, 19-32. In Russian.
- 1985 Knyazev, A.V., The Kato-Temple block algorithm for estimation of eigenvalues: substantiation and application. -In Conjugate Equations Theory Perturbations Math. Phys. Problems, Dept. Num. Math. USSR Ac. Sci., Moscow, 127-135. In Russian.
- 1990 Bakhvalov, N.S. and Knyazev, A.V., A new iterative algorithm for solving the fictitious fluxes method problems for elliptic eqations. -Proc.EQUADIFF 7, Praha, 1989. -Teubner-Texte zur Mathematik, b. 118, 225-227. -Leipzig: BSB Teubner.
- 2005 A. V. Knyazev and M. E. Argentati, Implementation of a Preconditioned Eigensolver Using Hypre, Technical report UCD-CCM 220, April 2005, at the Center for Computational Mathematics, University of Colorado Denver.

### **Selected Meeting Presentations**

- 1990 4-th Symposium Domain Decomposition Methods for Partial Differential Equations, Moscow.
- 1990 Eigenwertaufgaben in Natur- und Ingenieurwissenschaften und ihre numerische Behandlung, Oberwolfach. *Invited speaker.*
- 1990 XI Householder Symposium, Tylosand, SWEDEN. *Invited speaker.*
- 1991 IMACS Symp. Iterative methods in linear algebra, Brussels. *Invited speaker.*
- 1993 XII Householder Symposium, Lake Arrowhead, USA. *Invited speaker.*
- 1997 Uniform wellposedness of a mixed formulation of symmetric problems with rough coefficients with application to highly nonhomogeneous linear elasticity, Copper Mountain Multigrid.
- 1997 Some history of preconditioned iterative methods for symmetric eigenvalue problems, Workshop on pre-conditioning eigenvalue problems, Argonne. *Invited speaker.*
- 1997 Forty years of preconditioned iterative methods for large symmetric eigenvalue problems, SIAM 45th Anniversary Meeting, *Organizer of the minisymposium Preconditioned Methods for Large Eigenproblems.*
- 1997 DDM for eigenproblems: eigensolvers vs. system solvers on subdomains, Tenth International Conference on Domain Decomposition Methods.
- 1997 A Subspace Preconditioning Algorithm for Eigenvector/Eigenvalue Computation, Sixth SIAM Conference on Applied Linear Algebra.
- 1998 Preconditioned eigensolvers - an oxymoron? Copper Mountain Iterative Methods Conf.
- 1998 Uniform Finite Element Error Estimates for Differential Equations with Rough Coefficients. Conference State of the Art in Finite Element Method, City University of Hong Kong.
- 1998 Iterative solution of the Lamé equations with highly discontinuous coefficients. Conference: Iterative solution methods for the elasticity equations as arising in mechanics and biomechanics IMMB'98, University of Nijmegen, The Netherlands. *Invited speaker.*
- 1998 Preconditioned eigensolvers. International Symposium on Theory and Algorithms for Large Scale Matrix Problems, Dalian University of Technology, Dalian, China. *Invited speaker.*
- 1999 MiniSymposium Very Large Eigenvalue Problems, USNCCM, UC-Boulder. *Organizer.*
- 1999 Domain Decomposition Methods for Eigenproblems, at the MiniSymposium Domain Decomposition Techniques, USNCCM, UC-Boulder. *Invited speaker.*
- 2000 III International Workshop on Accurate Solution of Eigenvalue Problems, July 3-6, 2000,

Hagen, Germany. *Invited speaker.*

2001 Conference on Preconditioned Robust Iterative Solution Methods for Problems with Singularities PRISM'2001, May 21-23, 2001, University of Nijmegen, The Netherlands. *Invited speaker.*

2001 Schnelle Loser fur partielle Differentialgleichungen, 2001, Oberwolfach: Uniform Finite Element Error Estimates for Differential Equations with Jumps in the Coefficients. *Invited speaker.*

2002 Miniworkshop: Preconditioning in Eigenvalue Computations, 2002, Oberwolfach. *Organizer.*

2002 Householder Symposium XV, June 17th - 21st, 2002, Peebles, Scotland: Toward the Optimal Preconditioned Eigensolver: Locally Optimal Block Preconditioned Conjugate Gradient Method. *Invited speaker.*

2003 Sixth IMACS International Symposium on Iterative Methods in Scientific Computing UC Denver, March 27-30, 2003. *Organizer.*

2003 11-th Copper Mountain Conference on Multigrid Methods, March 30 - APRIL 4, 2003: Implementation of a Scalable Preconditioned Eigenvalue Solver Using Hypre—jointly with M. Argentati

2003 Eighth SIAM Conference on Applied Linear Algebra, College of William and Mary, Williamsburg, Virginia, July 15-19, 2003: Is there life after the Lanczos method?

2003 Ppreconditioning 2003, Napa CA, OCTOBER 27-29, 2003 Scalable Preconditioned Eigenvalue Solver in Hypre—jointly with Merico E. Argentati

2003 Clustering Large Data Sets Workshop Third IEEE International Conference on Data Mining (ICDM 2003) Melbourne, Florida, November 19 - 22, 2003

2003 Theory and Numerics of Matrix Eigenvalue Problems, BIRS workshop, Banff, Alberta, Canada, November 22-27, 2003. *Invited speaker.*

2004 NSF-IC Approaches to Combat Terrorism PI Workshop Arlington, Virginia June 8, 2004 Preconditioned Algorithms for Large Eigenvalue Problems *Invited speaker.*

2004 Butcher Symposium on Genomics and Biotechnology, Broomfield, CO. November 11, 2004: Finding functional gene clusters responsive to changes in the Monomethyl Branched-Chain Fatty Acid levels—jointly with Min Han (MCDB, CU Boulder).

2005 Householder Symposium XVI, Seven Springs Resort, Champion, Pennsylvania, May 23-27, 2005: Preconditioned Eigenvalue Solvers in Electronic Structure Calculations. *Invited speaker.*

2005 Eight U.S. Congress for Computational Mechanics Austin, TX: Extension Theorems for Lamé Equations for Nearly Incompressible Media with Applications to Numerical Solution of Problems with Highly Discontinuous Coefficients—jointly with N. S. Bakhvalov and R. R. Parashkevov. Invited talk at the minisymposium "Homogenization: Symposium in Honor of Prof. Ivo Babuska." Analysis of Transmission Problems on Lipschitz Boundaries in Stronger Norms. Invited talk at the minisymposium "Domain Decomposition and Fictitious Domain Methods."

2006 SIAM Conference on Parallel Processing for Scientific Computing CP13 San Francisco, February 22-24, 2006: Block Locally Optimal Preconditioned Eigenvalue Solvers—jointly with Merico Argentati, Ilya Lashuk and Evgueni Ovtchinnikov.

2006 Ninth Copper Mountain Conference on Iterative Methods April 2-7, 2006: Block Locally Optimal Preconditioned Eigenvalue Solvers (BLOPEX)—jointly with Merico Argentati, Ilya Lashuk and Evgueni Ovtchinnikov. A priori error bounds for eigenvalues approximated by the Ritz values—jointly with Merico Argentati (the speaker). Steepest descent and conjugate gradient methods with variable preconditioning—jointly with Ilya Lashuk (the speaker).

2006 Fast Manifold Learning Workshop William & Mary in Williamsburg, VA, April 14-15, 2006: Multiscale Preconditioning for Computing Eigenvalues of Graph Laplacians in Image Segmentation. *Invited speaker.*

2006 Workshop on Algorithms for Modern Massive Data Sets Stanford University and Yahoo! Research June 21-24, 2006: Multiscale Spectral Graph Partitioning and Image Segmentation.

2007 Stanford 50: State of the Art and Future Directions of Computational Mathematics and Nu-

merical Computing, March 29 - 31, 2007 Stanford University: Accuracy of Ritz values from a given subspace—jointly with M. E. Argentati, C. C. Paige (the speaker), and I. Panayotov.

2007 Computational Partial Differential Equations TU Berlin, June 6, 2007: New A Priori FEM Error Estimates for Eigenvalues—jointly with John Osborn. *Invited speaker.*

2007 ICIAM 07 Zurich, Switzerland, 16-20 July 2007: Block Locally Optimal Preconditioned Eigenvalue Solvers (BLOPEX) (invited Minisymposium IC/MP/020/U/333 speaker)

2008 Tenth Copper Mountain Conference on Iterative Methods April 6-11, 2008:

- o Large scale parallel ab initio electronic structure calculations with the LOBPCG method - jointly with Zerah (the speaker), Bottin, and Le Roux.
- o Majorization-based convergence rate bounds of subspace iterations and the block Lanczos method - jointly with M. Argentati
- o Eigensolvers for analysis of microarray gene expression data

2008 Householder Symposium XVII Zeuthen, Germany June 1-6, 2008 *Invited speaker.*

2008 IACM/ECCOMAS Congress Venice, June 30th-July 5th 2008: Eigensolvers for analysis of microarray gene expression data (invited Minisymposium speaker).

2009 Oberwolfach workshop, August 9-15, 2009 Linear and Nonlinear Eigenproblems for PDEs *Organizer and invited speaker.*

For **complete list of Presentations**, see <http://math.ucdenver.edu/~aknyazev/research/conf/> .

## **TEACHING—Andrew Knyazev**

### **Courses Taught**

Undergraduate: Calculus I, II, and III, Applied Linear Algebra, Numerical Analysis I and II, Elementary Differential Equations, Complex Variables.

Graduate: Applied Linear Algebra, Applied Analysis, Approximation Theory, Numerical Linear Algebra, Iterative Methods, Functional Analysis, Foundations of Finite Element Methods.

### **List of Graduate Students Supervised:**

1990-1992 Ilya A. Sharapov, M.S., Inst. Numerical Math. Russian Academy of Sciences

1987-1991 Alexander L. Skorokhodov, Ph.D., Inst. Numerical Math. Russian Academy of Sciences

2000-2002 Dave Duran, M.S., UC Denver

1999-2003 Merico E. Argentati, Ph.D., UC Denver

2003-2005 Abram Jujunashvili, Ph.D., UC Denver

2003-2007 Ilya Lashuk, Ph.D., UC Denver

2006-2011 Eugene Vecharynski, Ph.D., UC Denver

2010 Bryan Smith, Ph.D., UC Denver

2007-pres Donald McCuan, Ph.D., UC Denver

2007-pres Peizhen Zhu, Ph.D., UC Denver

### **Teaching-related Conferences attended:**

1998 BOOT CAMP for PROFS, University of Colorado at Colorado Springs.

1998 From Best Practices through Assessment: Teaching with Technology. UC Colorado Springs.

1999 Virtual Universities and the future of higher education, Breckenridge, Colorado.

1999 Collaboration in the Development and Use of Technology for Teaching and Learning: Teaching with Technology. Colorado School of Mines, Golden.

2011 Experiences Teaching Math Using Wikipedia. Twenty-Third Annual International Conference on Technology in Collegiate Mathematics, Denver, March 17–20, 2011.

## **SERVICE—Andrew Knyazev**

### **Department of Mathematics/CCM, UC Denver**

1994-pres Development of teaching with technology and Internet-based teaching methods  
1994-1995 Merit Review Committee  
1995-1996 Search Committee  
1994-1999 Graduate Committee (5 terms)  
1996-1997 Merit Review Committee  
1995-1997 Web Coordinator of the Department  
1997 Math Awareness Week Organizer: Math and the Internet  
1997-1999 Linear Algebra Prelim Committee  
1998-2000 Coordinator of CCM Colloquia  
1999-2000 Web Supervisor  
2001-2002 Graduate Committee  
2001-2002 Research Coordinator of the Department  
2001-2002 Linear Algebra Prelim Committee  
2002-2003 Analysis Prelim Committee  
2003-2005 Linear Algebra Prelim Committee  
2003-2005 CCM Executive Committee  
2004-2005 Merit Review Committee  
2004-2006 Coordinator of CCM Colloquia  
2006-2007 Departmental Executive Committee  
2008-2009 Analysis Prelim Committee  
2008-2010 CCM Executive Committee  
2009-2010 Merit Review Committee  
2009-2010 By-laws Committee  
2009-2011 CCM Associate director, Coordinator of CCM Colloquia

### **College of Liberal Arts and Sciences, UC Denver**

1999-2000 Research Awards Committee  
1999-2001 Center for Computational Mathematics, Director  
2008-2009 Dissemination grant proposals Committee  
2008-2010 Research Awards Committee  
2010-2012 DAC - C/T Track Hiring Committee  
2010-2012 Dean's Advisory Committee (DAC)

### **Campus-wide, UC Denver and HSC**

2002-2004 RTP Committee UC Denver  
2006-2010 Tenure Track Mentoring Program at UCD  
2008-2010 Research/Creative Activities Awards Committee UC Denver  
2011 Associate Vice Chancellor for Academic Affairs ad hoc committee for the designation of University of Colorado Distinguished Professor

### **System-wide—University of Colorado**

1999 Program Committee, CU Teaching with Technology Conference  
2005-2006 President's Teaching and Learning Collaborative steering committee

## Outside of University of Colorado

1997 Organizer of a Minisymposium at the SIAM annual Meeting.

1999 Organizer of a Minisymposium at the US Congress on Comp. Mechanics.

2001-2007 Editorial board of Comp. Methods in Applied Math.

2006-pres Editorial board of Int. J. Comp. Sci. and Math.

2002-2004 NERSC Computational Review Panel

2002 Organizer of the Oberwolfach Miniworkshop "Preconditioning in Eigenvalue Computations"

2003 Organizer of Sixth IMACS International Symposium on Iterative Methods in Scientific Computing, UC Denver

2003-2005 Guest Editor of Applied Numerical Mathematics

2003-2006 Guest Editor of Linear Algebra and Its Applications

2006 Program Committee, Clustering Large High Dimensional Datasets Workshop, Hong Kong

2006 Program Committee, IMACS Conference on Iterative Methods, College Station, TX

2003,2007 Program Committee, CMAM conferences, Minsk, Belarus

1998-pres Regular referee and panelist for the NSF program in Numerical Mathematics

1995-pres Referee for SIAM Journals, Mathematics of Computation, Linear Algebra and Its Applications, etc.

1994-pres Development of public software: LOBPCG and other MATLAB codes, BLOPEX software package for *hypre* and PETSc, collaboration with ABINIT developers.

2008 Program Committee, Text Mining workshop at SIAM Conference on Data Mining

2009 Organizer of the Oberwolfach Workshop "Linear and Nonlinear Eigenproblems for PDEs"

2013 Organizer of the Oberwolfach Workshop "Numerical solution of PDE eigenvalue problems"