

# Curriculum Vitae

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## Personal

*Date of Birth:* April 11, 1963  
*Place of Birth:* Offenburg, Germany  
*Marital Status:* married, two children  
*Citizenship:* Germany

## Education

*Stanford University*, Stanford, California/USA, 1990–1994

Ph.D. in Scientific Computing and Computational Mathematics, 1994  
Ph.D. minor in Mechanical Engineering, 1994

*Universität Karlsruhe*, Karlsruhe/Germany, 1983–1985 and 1987–1990

Diploma in Mathematics (Diplom-Mathematiker), 1990

## Professional Experience

- *TU Bergakademie Freiberg* 1994–present  
wissenschaftlicher Assistent; Privatdozent since 2001
- *University of Maryland Institute of Advanced Computer Studies*  
10/1997–9/1998, postdoctoral fellow
- *Bergische Universität GH Wuppertal*, 10/2002–3/2003  
Temporary C4-Professor (Vertretungsprofessur)

## Research Experience

*Recent Research.* Department of Mathematics and Computer Science,  
Technical University of Freiberg, since 2001

- Computational methods for reactive flow

- Numerical methods for transient electromagnetic simulation in geophysics
- Computational methods for uncertainty quantification
- Krylov subspace methods for matrix functions
- Potential-theoretic convergence analysis for Krylov subspace methods

*Habilitation Research.* Department of Mathematics and Computer Science, Technical University of Freiberg, 1994–1997 and 1998–2000

- Habilitation thesis on minimal and orthogonal residual methods and their generalizations for solving linear operator equations.
- Developed general framework for the analysis of family of algorithms known as Krylov subspace methods.
- Analysed acceleration strategies for restarted minimal residual methods.
- Analysed behavior of minimal residual methods applied to stabilized finite element discretizations of convection-diffusion problems.

*Postdoctoral Research.*, University of Maryland Institute of Advanced Computer Studies, 1997–1998

- Developed iterative method for solving linear systems of equations arising from finite element discretization of acoustic scattering problems.
- Explored iterative methods for fictitious domain formulation for acoustic scattering problems.
- Implementation of this code on parallel architecture.

*Doctoral Research.*, Scientific Computing and Computational Mathematics Program, Stanford University, 1990–1994

- Developed both finite difference and finite element fictitious domain formulations for the solution of the exterior Helmholtz equation. Development and implementation of iterative solution algorithm on serial and parallel architecture.
- Research assistant in project to investigate breakup of marine cloud layers due to hydrodynamic instability; with Prof. Robert Street, Civil Engineering Department, Stanford University

- Research assistant in project to simulate mode propagation of quantum well lasers; with Prof. Robert Dutton, Electrical Engineering Department, Stanford University.

*Undergraduate Research.* Department of Mathematics, University of Karlsruhe, 1987–1989

- Diploma thesis on various applications of complex orthogonal polynomials in numerical analysis.
- Implementation of ODE solvers as student research assistant.

### **Research Interests**

- Numerical methods for reactive flow
- Uncertainty Quantification
- Iterative solution methods for large sparse linear systems of equations and their implementation on high performance computing architectures.
- Convergence of Krylov subspace methods for non-Hermitian linear systems.
- Finite element discretizations of convection diffusion, time-harmonic wave and groundwater flow problems.
- Modelling and simulation of phenomena with uncertainty, specifically stochastic finite element simulations.
- Theory and implementation of Krylov subspace methods for matrix functions and their applications to initial value problems

### **Teaching Experience**

*Universität Karlsruhe, 1987–1989*

- *Course assistant:* Analysis I,II. Graded problem sets and held review sessions.

*Stanford University, 1990–1994*

- *Teaching Assistant:* Advanced Numerical Analysis (Autumn Quarter 1991). Graded problem sets, held office hours.
- *Teaching Assistant:* Fundamentals of Numerical Computation (Spring Quarter 1993). Graded problem sets, held office hours, held the class on several occasions.

*TU Bergakademie Freiberg, 1994–present*

- *Wissenschaftlicher Assistent, 1994–9/1997 and 10/1997–2000.*  
In this function I developed and graded problem sets and exams, held review sessions and office hours and on occasion substituted for the instructor in the following courses given by the faculty of the Institut für Angewandte Mathematik II.
  - Numerical Analysis
  - Scientific Computing Project
  - Multigrid Methods
  - Parallel Methods in Numerical Analysis
  - Numerical Treatment of Ill-Posed Problems
  - Algebraic Multigrid Methods
  - Iterative Methods for Symmetric Linear Systems
  - Numerical Linear Algebra
  - Numerical Solution of Ordinary Differential Equations
  - Numerical Solution of Partial Differential Equations
  - Iterative Methods for Solving Linear Systems
  - Seminar on Mathematical Modelling
  - Seminar on Numerical Analysis
  
- *Privatdozent, since 1/2001.*  
In this function I have independently taught the following courses:
  - Approximation Theory
  - Finite Elements I and II
  - Linear Algebra with Matlab
  - Seminar on Linear Algebra in the Information Sciences
  - Numerical Analysis for Engineering Students
  - Numerical Analysis for Mathematics Students
  - Selected Topics in Numerical Analysis
  - Algorithms and Data Structures
  - Numerical Solution of Initial Value Problems for Partial Differential Equations
  - Seminar on Stochastic Modeling of Broadband Communication Networks

Furthermore, I have supervised several diploma theses and undergraduate theses, one dissertation and am currently supervising two doctoral students.

*Bergische Universität GH Wuppertal, 10/2002-3/2003*

- *Temporary C4-Professor (Vertretungsprofessur)* In this position I taught the introductory numerical analysis course for mathematics and computer science students.

### **Awards and Honors**

- Michael Jürgen Leisler Kiep Travel Fellowship, 1996, awarded annually by the Technical University Freiberg to two recent PhDs
- CISE Postdoctoral Research Associate in Computational Science and Engineering, 1997–1998; awarded by the National Science Foundation (USA)

### **Refereeing Activities**

In recent years I have reviewed manuscripts at the request of the editors of the following scientific journals:

*BIT,*  
*Computing,*  
*Numerische Mathematik,*  
*SIAM Journal on Numerical Analysis,*  
*SIAM Journal on Scientific Computing,*  
*SIAM Journal on Matrix Analysis and Applications,*  
*Linear Algebra and its Applications,*  
*Linear and Multilinear Algebra,*  
*Electronic Transactions on Numerical Analysis,*  
*Numerical Algorithms,*  
*Journal of Computational Acoustics,*  
*Journal of Computational Physics,*  
*Computer Physics Communications,*  
*Applied Numerical Mathematics,*  
*Differential Equations and Nonlinear Mechanics,*  
*Parallel Computing*

### **Professional Society Memberships**

Society of Industrial and Applied Mathematics (SIAM)  
American Mathematical Society (AMS)  
Gesellschaft für Angewandte Mathematik und Mechanik (GAMM)

## Other Activities

- English translation of the German edition of the book *Numerical Simulation in Fluid Dynamics: A Practical Introduction* by Griebel, Dornseifer and Neunhoeffler (published by SIAM).
- Founding member of the GAMM activity group on numerical linear algebra.
- Guest editor of a special edition of *Electronic Transactions on Numerical Analysis*, 2008.

## Publications

### 1. Theses:

- (a) *Diploma thesis: On several applications of complex orthogonal polynomials in numerical analysis.* Institut für Praktische Mathematik, Universität Karlsruhe, 1989  
Advisor: Prof. Wilhelm Niethammer
- (b) *Dissertation: Fast Numerical Solution of Exterior Helmholtz Problems with Radiation Boundary Condition by Imbedding.*  
Advisor: Prof. Gene H. Golub  
Stanford University, 1994  
Committee: Prof. Gene H. Golub (Stanford University)  
Prof. Joseph B. Keller (Stanford University)  
Prof. George Papanicolaou (Stanford University)
- (c) *Habilitation thesis: Minimal and Orthogonal Residual Methods and their Generalizations for Solving Linear Operator Equations.* Fakultät Mathematik und Informatik, TU Bergakademie Freiberg, 2000  
Committee: Prof. Michael Eiermann (TU Freiberg)  
Prof. Howard C. Elman (University of Maryland)  
Prof. Wolfgang Hackbusch (MPI Leipzig)

### 2. Refereed Journals:

- (a) *A Finite Element Capacitance Matrix Method for Exterior Helmholtz Problems.* *Numerische Mathematik*, Vol. 75, No. 2 (1996) pp. 175–204.
- (b) *Residual-Minimizing Krylov Subspace Methods for Stabilized Discretizations of Convection-Diffusion Equations.* *SIAM J. Matrix Anal. Appl.* Vol. 21, No. 4 (2000) pp. 1079–1101.
- (c) *Geometric Aspects of the Theory of Krylov Subspace Methods.* (with M. Eiermann) *Acta Numerica* 2001, pp. 251–312.

- (d) *Analysis of Acceleration Strategies for Restarted Minimal Residual Methods.* (with M. Eiermann and O. Schneider), J. Comp. Appl. Math. Vol. 123, (2000) pp. 261–292.
- (e) *A Multigrid Method Enhanced by Krylov Subspace Iteration for Discrete Helmholtz Equations.* (with H. Elman and D. O’Leary) SIAM J. Sci. Comp. Vol. 123 No. 4 (2001) pp. 1290–1314
- (f) *Equivalent Iterative Methods for  $p$ -Cyclic Matrices.* Numerical Algorithms, Vol. 25, pp. 161–180, (2000)
- (g) *Efficient Iterative Algorithms for the Stochastic Finite Element Method with Applications to Acoustic Scattering* (with H. Elman, D. O’Leary and M. Stewart) Comp. Meth. Appl. Mech. Engrg. Vol. 194 (2005) pp. 1037–1055
- (h) *A Restarted Krylov Subspace Method for the Evaluation of Matrix Functions* (with M. Eiermann) SIAM J. Num. Anal. 44 (2006) pp. 2481–2504
- (i) *Computational Aspects of the Stochastic Finite Element Method* (with M. Eiermann and E. Ullmann) Comput. Visual. Sci. 10 (2007) pp. 3–15
- (j) *Fast 3D simulation of transient electromagnetic fields by model reduction in the frequency domain using Krylov subspace projection* (with R. Börner and K. Spitzer) Geophys. J. Int. 173 (2008) pp. 766–780
- (k) *Implementation of a Restarted Krylov Subspace Method for the Evaluation of Matrix Functions* (with M. Afanasjew, M. Eiermann and S. Güttel) Linear Algebra Appl. 429 (2008) pp. 2293–2314
- (l) *A Generalization of the Steepest Descent Method for Matrix Functions* (with M. Afanasjew, M. Eiermann and S. Güttel) Electron. Trans. Numer. Anal. 28 (2008) 206–222
- (m) *Efficient Solvers for a Linear Stochastic Galerkin Mixed Formulation of Diffusion Problems with Random Data* (with C. E. Powell, D. Silvester and E. Ullmann) SIAM J. Sci. Comput. 31 (2009) pp. 1424–1447

### 3. Refereed Proceedings

- (a) *A Domain Decomposition Approach to solving the Helmholtz Equation with a Radiation Boundary Condition* (mit Gene H. Golub), Domain Decomposition Methods in Science and Engineering, A. Quarteroni et al. eds., Contemporary Mathematics vol. 157, AMS 1992

- (b) *Numerical Experiences with a Krylov-enhanced Multigrid Solver for Exterior Helmholtz Problems.* (with Howard Elman) Proceedings of the Fifth International Conference on Mathematical and Numerical Aspects of Wave Propagation, Waves 2000 (Santiago de Compostela), SIAM, 2000.
- (c) *Computational Aspects of the Stochastic Finite Element Method* (with Michael Eiermann and Elisabeth Ullmann) Proceedings Algorithmy 2005 Conference, Podbanske (Slovakia), to be published in Computing and Visualization in Science

#### 4. In Preparation

- (a) *Block Krylov Subspace Model Reduction for Fast TEM-Simulation* (mit Ralph-Uwe Börner, TU Freiberg)
- (b) *Asymptotic Convergence Analysis of Krylov Subspace Methods for the Evaluation of Matrix Functions* (mit Michael Eiermann, TU Freiberg)
- (c) *Dispersion and Multigrid for the Helmholtz Equation* (mit Martin Gander, Uni Genf)

#### Selected Invited Presentations

- 23.03.1995 “*Fast Solution of the Radiative Helmholtz Equation by Imbedding*”, invited by Dr. Chris Besson, Schlumberger Cambridge Research, Cambridge, UK
- 29.03.1996 “*Recent Developments in Krylov Subspace Techniques for Solving Large Sparse Non-Hermitian Linear Systems of Equations*”, invited by Prof. Peter Monk, Dept. of Mathematics, University of Delaware
- 12.12.1997 “*On Some Recurrent Theorems Concerning Krylov Subspace Methods*”, invited by Prof. Peter Levin, Dept. of Electrical Engineering, Boston University
- 08.05.1998 “*On Some Recurrent Theorems in the Theory of Krylov Subspace Methods*”, invited by Dr. Barbara Wohlmuth, Courant Institute of Mathematical Sciences, New York University
- 24.03.1999 “*A Multigrid Method Using a Krylov Subspace Smoother for the Discrete Helmholtz Equation*”, invited by Dr. Roland Freund, Bell Labs, Murray Hill, NJ
- 20.10.1999 “*Ergänzung von Mehrgitterverfahren durch Krylov-Unterraumiteration zur Lösung der Helmholtz-Gleichung*”, invited by Prof. Frank Natterer, Fakultät Mathematik und Informatik, Universität Münster
- 06.04.1999 “*Geometric Aspects in the Theory of Krylov Subspace Methods*”, invited by Dr. Martin Gander und Prof. Frederic Nataf, Ecole Polytechnique, Paris
- 17.01.2000 “*Ergänzung des Mehrgitterverfahrens durch Krylov-Unterraumverfahren zur Lösung der Helmholtz-Gleichung*”, invited by Prof. Thomas Huckle,

- Institut für Informatik, TU München
- 26.02.2001 “Acceleration Strategies for Minimal Residual Methods”,  
GAMM Meeting 2001, ETH Zürich
- 26.02.2001 “Acceleration Strategies for Minimal Residual Methods”,  
invited by Prof. Andrew Wathen, Oxford University Computing Laboratory.
- 26.03.2001 “Acceleration Strategies for Minimal Residual Methods”,  
invited by Prof. Zdeněk Strakoš, Czech Academy of Sciences.
- 11.07.2001 “Krylov Subspace and Multigrid Methods for Discretized Acoustic Scattering  
Problems”, Minisymposium Computational Acoustics and Inverse Problems,  
SIAM Annual Meeting 2001, San Diego
- 26.07.2001 “Krylov Subspace and Multigrid Methods for Discretized Acoustic Scattering  
Problems”, Minisymposium Numerical Linear Algebra in Applications,  
Enumath 2001, Ischia, Italy
- 03.09.2001 “A Comparative Study of Accelerated Restarted Minimal Residual Methods”,  
Minisymposium Recent Advances in Krylov Subspace Methods,  
SIAM-EMS Conference on Mathematics in Our Changing World, Berlin
- 07.09.2001 “Linear Algebra and the Stochastic Finite Element Method”,  
GAMM Workshop on Numerical Linear Algebra,  
Technical University Berlin, Berlin
- 08.09.2002 “Acceleration of Restarted Minimal Residual Methods”,  
invited Plenary Speaker, Computational and Applied Numerical Linear  
Algebra 2002, Milovy, Czech Republic.
- 12.10.2003 “Parametrization of the Arnoldi Process”,  
Dagstuhl Seminar on Theoretical and Computational Aspects of Matrix  
Algorithms, Schloss Dagstuhl, Germany
- 17.03.2005 “Computational Aspects of the Stochastic Finite Element Method”,  
invited plenary speaker, ALGORITMY 2005, Podbanske, Slovakia
- 30.03.2006 “Krylov Subspace Methods and Matrix Functions”,  
invited section speaker, GAMM Annual Meeting 2006, Berlin, Germany
- 24.07.2006 “Superlinear Convergence of Krylov Subspace Methods: Potential Theory and Invariant”  
Subspaces”, invited presentation, Minisymposium Iterative Methods,  
SIAM-GAMM Conference on Applied Linear Algebra, Düsseldorf, 2006
- 21.03.2007 “Efficient Linear Solvers for Stochastic Groundwater Simulations”,  
invited presentation, Minisymposium Uncertainty Quantification in Groundwater Flow  
and Transport, SIAM Geosciences Conference 2007, Sante Fe, NM
- 01.06.2008 “A Posteriori Error Estimators for Krylov Subspace Approximations of Matrix Functions”  
invited plenary talk, Householder Symposium XVII, Zeuthen, Germany
- 15.07.2008 invited presentation, LMS Durham Research Symposium on  
“Computational Linear Algebra for Partial Differential Equations”,  
Durham University, UK
- 06.09.2008 invited plenary talk, Fifth International Workshop on Numerical Analysis and  
Lattice QCD, “Restarted Krylov Subspace Methods for the Matrix Sign Function”,  
Regensburg, Germany



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(Oliver Ernst)