Curriculum Vitae

	Andreas Kloeckner
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Objective

A challenging research position at the intersection of mathematics, applied physics, and computing.

Education

2005 – 2010	Ph.D. in Applied Mathematics (in progress) Division of Applied Mathematics, Brown University, Providence, RI *Advisor: Jan Hesthaven*
2005	Diplom degree in Applied Mathematics (Technomathematik) Institut für Angewandte Mathematik, Universität Karlsruhe, Germany *Advisor: Willy Dörfler*
2001 – 2002	Exchange Student, Department of Mathematics University of North Carolina at Charlotte, Charlotte, NC
2000	Vordiplom in Computer Science, Universität Karlsruhe, Germany

Research

The unifying theme of my research interest is the efficient numerical simulation of wave phenomena. I have worked towards this goal by pursuing a broad range of topics:

A domain-specific language (DSL) for discontinuous Galerkin schemes. Discontinuous Galerkin methods are a family of finite element methods with favorable mathematical and computational properties. I have created a language that separates the specification of the numerical scheme from implementation aspects. Any scheme thus described is instantly available across a range of mesh geometries, dimensionalities, and hardware from clusters to laptops.

Nodal DG on GPUs. Trying to further the computational reach of DG, and at the same time validating my efforts towards the creation of a user-facing "DG language" as described in the previous point, I set out in close collaboration with Tim Warburton to bring DG onto off-the-shelf graphics processors (GPUs). Exploiting DG's special structure allowed us to gain a speed advantage of more than an order of magnitude over the fastest CPU-based DG solvers. Importantly, the language technology from the last point works to make this advance available even to researchers who have (or want) no GPU programming experience.

Parallel Programming Tools. To facilitate the creation of efficient GPU code, I have developed software toolkits including PyCUDA, PyOpenCL, and CodePy that allow programmatic run-time code generation and automated tuning for massively parallel GPU architectures from a high-level language.

Solvers for the Vlasov-Maxwell system. The Vlasov-Maxwell system describes collisionless plasmas and requires modeling particle transport and electromagnetic (EM) fields. Discontinuous Galerkin (DG) schemes yield very effective EM solvers. In trying to find appropriate models for particle transport to couple with DG, I am investigating both particle-based Lagrangian schemes as well as more computationally expensive direct Eulerian phase-space approaches.

Research Presentations

11/2009	GPU Metaprogramming Applied to High-Order DG and Loop Generation. Boston University Center for Computational Science, Boston, MA
10/2009	High-order Discontinuous Galerkin Methods and Loop Generation by GPU Metaprogramming. Dept. Mathematik, Universität Basel, Basel, Switzerland
9/2009	GPU Metaprogramming using PyCUDA: Methods and Applications. Nvidia GPU Technology Conference, San Jose, CA
8/2009	GPU Metaprogramming Applied to High-Order DG and Loop Generation. Workshop on the Frontiers of Geophysical Simulation, Institute for Mathematics Applied to Geosciences, Boulder, CO
7/2009	GPU Computing: Introduction, Scripting, and Time-domain DG. Advanced Computation Department, Stanford Linear Accelerator Center, Menlo Park, CA
3/2009	PyCUDA and PyUblas: Hybrid HPC in Python made easy. Minisymposium 98 at SIAM CS&E 2009, organized by Hans Petter Langtangen, Randall LeVeque and Fernando Perez. Miami, FL
3/2009	High-Productivity Supercomputing: Metaprogramming GPUs. (with a focus on metaprogramming DG on GPUs) Minisymposium 134 at SIAM CS&E 2009, organized by Amik St-Cyr and Henry Tufo. Miami, FL
1/2009	High-Productivity Supercomputing: Metaprogramming GPUs. MIT, Cambridge, MA
10/2008	High-Order Unstructured Particle-in-Cell Simulation. Southern Methodist University, Dallas, TX
10/2008	High-Order Unstructured Particle-in-Cell Simulation. Rice University, Houston, TX
7/2008	Methods for High-Order Unstructured Particle-in-Cell Simulation. Institut für Aero- und Gasdynamik, Universität Stuttgart, Germany

Teaching

10/2009	Tutorial: *Programming GPUs with PyOpenCL.* Bernstein Center for Computational Neuroscience, Freiburg, Germany
5/2009	Day-long lecture: *Accelerated Computing* HPC Summer Institute, Ken Kennedy Institute for Information Technology, Rice University, Houston, TX
2006, 2007	TA for *Computational Linear Algebra* (twice) Brown University, Providence, RI (with Jan Hesthaven)
2006	TA for *Ordinary Differential Equations* Brown University, Providence, RI (with Volker Elling)
3/2005 – 7/2005	Co-TA for *Numerical Methods for PDEs* Universität Karlsruhe, Germany (with Vincent Heuveline)
8/2001 – 12/2001	Instructor for *College Algebra* University of North Carolina at Charlotte

Experience

6/2006 – 9/2006	J. Wallace Givens Research Associate *Mathematics and Computer Science Div., Argonne Nat'l Laboratory, Illinois* Worked on high-order unstructured electromagnetic simulation of particle accelerators (with Paul Fischer, Misun Min, and colleagues at ANL's Advanced Photon Source).
2/2005 – 7/2005	Research Associate (Wissenschaftlicher Mitarbeiter) *Institut für Angewandte Mathematik, Universität Karlsruhe, Germany* Worked on various extensions of my thesis research (with Willy Dörfler).
5/2002 – 11/2002	Research Intern *DaimlerChrysler Research & Technology, Palo Alto, CA* Worked on driver stress detection, precision GPS, and software infrastructure (with Stefan Schrödl).

Publications

2009	Algorithmic Advances for Discontinuous Galerkin Methods on Graphics Processors. AK, T. Warburton, H. Riedmann, J.S. Hesthaven. *In preparation.*
2009	PyCUDA: GPU Run-Time Code Generation for High-Performance Computing. AK, N. Pinto, Y. Lee, B. Catanzaro, P. Ivanov, and A. Fasih. *Submitted, available at* `http://arxiv.org/abs/0911.3456`.
2009	Nodal Discontinuous Galerkin Methods on Graphics Processors. AK, T. Warburton, J. Bridge, J.S. Hesthaven. *Journal of Computational Physics, Volume 228, Issue 21, 20 November 2009.*
2009	Deterministic Numerical Schemes for the Boltzmann Equation. A. Narayan, AK. *Brown University Scientific Computing Technnical Report 2009-39.*
2005	On the Computation of Maximally Localized Wannier Functions. *Diplom Thesis, Universität Karlsruhe, Germany.*

Skills

Computational	Advanced C++, Python, OCaml, Matlab, Fortran 77, POSIX Shell, UNIX (esp. Debian Linux), Office applications, LaTeX, HTML/CSS, GNU toolchain, various revision control systems, MPI, CUDA, OpenCL
Languages	German: native, English: fluent

Mentoring

4/2009 – 10/2009	Andreas Stock, Master's Thesis: *Development and Application of a Multirate Multistep AB Method to a Discontinuous Galerkin Method based Particle In Cell Scheme.*
4/2009 – 10/2009	Hendrik Riedmann, Project Thesis ("Studienarbeit"): *Efficient Numerical Treatment of the Compressible Navier-Stokes Equations with Nodal Discontinuous Galerkin Methods on Graphics Processors.*

Awards and Achievements

2009	Brown University Dissertation Fellowship
2005	Brown University Entering Graduate Student Fellowship
2001	DaimlerChrysler Scholarship Program
2000 – 2004	e-fellows.net Scholarship

Software Packages

Hedge	High-performance hybrid Discontinuous Galerkin solver with CPU, GPU and MPI (for both CPU and GPU) backends (GPL3 licensed)
PyCUDA	CUDA programming and metaprogramming in Python (MIT licensed)
PyOpenCL	OpenCL programming and metaprogramming in Python (MIT licensed)
and numerous others	such as CodePy, MeshPy, BoostMPI, PyMetis. See `http://mathema.tician.de/software` for a full list.

Coursework

Mathematics	Real and Complex Analysis, PDEs, Numerical Methods for PDEs, Discontinuous Galerkin Methods, Stochastic Differential Equations, Probability Theory, Abstract Algebra, Measure Theory, Functional Analysis, Boundary and Eigenvalue Problems, Optimization
Computer Science	Artificial Intelligence, Robotics, Cognitive Systems, Formal Systems, Algorithms, Languages and Automata
Electrical Engineering	Integrated Circuit Electronics, Analog Integrated Circuits, Introduction to Circuits, Field Theory, Integral Transforms, Communications Engineering, System Dynamics and Control

Service

Reviewer	for *Mathematics and Computers in Simulation*, Elsevier.
Creator and Maintainer	of various web services for the Scientific Computing Group and the graduate student community at the Division of Applied Mathematics, Brown University.

Citizenship

Germany

References

Available upon request.