Pierson Guthrey, Ph.D.

Curriculum Vitae

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EMPLOYMENT

- Michigan State University, Postdoctoral Research Assistant (2017-present)
  Advised by Dr. Andrew Christlieb

EDUCATION

- Iowa State University, Ph.D: Applied Mathematics, Minor in Aerospace Engineering, Minor in Physics
  Awarded August 2017 with a GPA of 3.7
  Advised by Dr. James Rossmanith
- Tulane University, Master of Science & Engineering: Computational Science
  Awarded May 19, 2012 with a GPA of 3.6
  Advised by Dr. James (Mac) Hyman
- Tulane University, Bachelors in Science & Engineering: Engineering Physics
  Awarded May 12, 2011 with a GPA of 3.6

AWARDS

- Lambert Award for Outstanding Research Excellence: awarded Spring 2017
- Iowa State University Research Assistantships: awarded Spring 2015 and Summer 2017
- Award: Outstanding Accomplishments on behalf of the SIAM Student Chapter 2015-2016

RESEARCH

- Regionally Implicit Discontinous Galerkin methods: a novel numerical method for nonlinear hyperbolic conservation laws which is able to take a CFL timestep restriction of at least 1.0/0.75/0.6 for 1D/2D/3D problems independent of method order (1st order to 10th order methods), while maintaining a nearest neighbor stencil. This allows the method to strong-scale to many cores while only communicating domain decomposition boundaries.
- Algorithmic development in C++, Fortran, MATLAB, Python, iPython/Jupyter notebooks
- Scalable codes on CPU, GPGPU, and FPGA architectures using OpenMP, MPI, Kokkos, OpenACC
- Software profiling and debugging with TAU, Kokkos tools, Valgrind
- Visualization with Matplotlib, MATLAB, VTK/Paraview
- Automatic programming with G-Sheets, MATLAB, MATLAB symbolic toolbox
- Educational resources for computational projects developed via Jupyter notebooks
- Methods for kinetic equations of plasmas: Using Cheng-Knorr splitting with a Maxwell solver provides efficient solutions to kinetic formulations of plasmas such as the Relativistic Vlasov-Maxwell system
- Methods of Lines Transpose: Using the exact inverse of a modified Helmholtz operator provides an efficient A-stable method for computing solutions to wave equations, such as those found in electromagnetics.
- Hydrodynamics for Non-Kinetic closures of the BBGKY Hierarchy: Visco-elastic Density Functional Theory closures of BBGKY Hierarchy provide fluid equations that facilitate correlations, giving rise to a fluid solver which facilitates correlation
- Applied Machine Learning group: Bringing data science concepts to physics

SOFTWARE

- Author of a software package to demonstrate the Regionally Implicit Discontinuous Galerkin (RIDG) methods as applied to nonlinear hyperbolic conservation laws, available for download on Github
  - Developed a code prototype for the RIDG methods for nonlinear hyperbolic conservation laws
  - Developed quadrature-free exact integrators for weak formulations of PDEs
  - Developed modules for studying the convergence and efficiency properties of the RIDG method for comparison to other methods such as RKDG
  - Developed post-processor modules to improve solution smoothness and accuracy via filtering
  - Developed MPI code to perform numerical von-Neumann stability analysis for the RIDG method via wavemode sampling
- Discontinuous Galerkin Package (DoGPack), principal author James Rossmanith, available for download on Bitbucket for C++
  - Developed a solver module for the Regionally Implicit Discontinuous Galerkin methods
  - Developed solver modules for other methods such as the ADER-DG and LIDG methods
  - Developed distributed parallel computing capabilities for the entirety of DoGPack via OpenMP+MPI and OpenACC
  - Current work: developing a solver module for the Relativistic Vlasov-Maxwell System
  - Current work: developing limiters for shock hydrodynamics such as the ADER subcell limiter
- Method of Lines Transpose for Order N Schemes (MOLTN): Development of a software package to demonstrate the Method of Lines Transpose in C++, available by request
  - Developed a software package that uses Kokkos from the ground up to efficiently handle computational kernels relevant to MOL^T
  - Developed scalable MPI abstractions to efficiently handle domain decomposition for the user
  - Demonstrated scaling on simple test problems
  - Created python scripts that automatically generate Makefiles and submit HPC batch jobs
  - Current work: Electromagnetics solver for PEC and other boundary conditions
- Developed a hydrodynamics solver for the Viscoelastic Density Functional Theory closure of the BBGKY Hierarchy (VEDF equations)
  - Developed a Jupyter notebook for code demonstration
  - Developed a Machine Learning layer to more efficiently evaluate a hyper-netted chain code
  - Current work: parallel code to explore parameter space and verify theoretical dispersion relations

PUBLICATIONS

- P.T. Guthrey and J.A. Rossmanith. The regionally-implicit discontinuous Galerkin method: Improving the stability of DG-FEM. Accepted (https://arxiv.org/abs/1711.03447), 2019.
- Guthrey, P., Kaplan, L., & Mcguire, J. (2014). Atomic form factor for twisted vortex photons interacting with atoms. Physical Review A, 89(4), Physical Review A, 4/2014, Vol.89(4). DOI: http://dx.doi.org/10.1103/PhysRevA.89.043826
- M. Thavappiragasam, A.J. Christlieb, P.T. Guthrey and J. Luginsland. A Fast and Versatile Scheme For a Decoupled Electromagnetic Potential With Perfectly Conducting Boundaries. Submitted Dec 2018 to IEEE Transactions on Plasma Science.

PAPERS IN PREPARATION

- Method of Line Transpose Based High-Order A-Stable Embedded Boundary Scheme for Complex Geometries. M. Thavappiragasama, A. Viswanathand, P. Guthrey, A. Christlieb.
- P.T. Guthrey and J.A. Rossmanith. The regionally-implicit discontinuous Galerkin method: Application to the Relativistic Vlasov-Maxwell System.
- P.T. Guthrey and J.A. Rossmanith. The regionally-implicit discontinuous Galerkin method extended to nonlinear systems with shock capturing limiters.
- P.T. Guthrey and J.A. Rossmanith. The regionally-implicit discontinuous Galerkin method: Highly scalable parallel implementation with low communication overhead.
- P.T. Guthrey, A.J. Christlieb, M. Thavappiragasama, W. Sands. The Method of Lines Transpose: Parallel Implementation for Electromagnetics
- P.T. Guthrey, A.J. Christlieb, and M. Murillo. Hydrodynamics Approach to the visco-elastic density functional theory closure of the BBGKY Hierarchy.

TEACHING EXPERIENCES

- Instructor: Computational Modeling Tools and Techniques (CMSE 202), Fall 2018 and Spring 2019
- Instructor: Calculus I (Math 132), Spring 2018
- ISU Mathematics Summer REU, Graduate student mentor for the Computational Mathematics Group (Summer 2015)
- Teaching Assistant: Calculus I, II, III, ODE Theory, Calculus for Business Majors (various semesters 2014-2017)

ACTIVITIES

- Collaboration with John Shadid at Sandia National Laboratory, Summer 2016
- High Energy Density Science Summer School 2017 in La Jolla CA: “2-week summer school to promote scholastic development through technical lectures given by field experts as well as professional development sessions aimed at early-career researchers in HEDS fields of study.”
- QUICK: Quantum Computing seminar series at Michigan State University
- President of SIAM ISU student chapter (Fall 2015 - Spring 2017), Executive committee (Fall 2013 - Spring 2014) - Organized weekly talks by faculty and students. Organized group travel to conferences.

SERVICE

- Referee for Numerische Mathematik
- Referee for the Journal of Computational Physics
- Referee for Mathematical Institute, Slovak Academy of Sciences

MEMBERSHIPS

- SIAM: Society for Industrial and Applied Mathematics
- IEEE: Institute of Electrical and Electronics Engineers
- APS DPP: American Physical Society, Division of Plasma Physics

CONFERENCES AND TALKS

INVITED

- Society for Industrial and Applied Mathematics (SIAM) Computational Science and Engineering (CSE) 2019: Regionally Implicit Discontinuous Galerkin Methods for the Relativistic Vlasov-Maxwell System
- SIAM Annual July 2017
- KI-Net ISU Conference March 2017
- SIAM CSE February 2017
- SIAM ISU September 2016: Implicit and Explicit DG Methods with Applications to the Relativistic Vlasov-Maxwell System
- SIAM Annual 2016: Implicit and Explicit DG Methods with Applications to the Relativistic Vlasov-Maxwell System
- KI-Net Scalable Methods Conference at Oak Ridge National Laboratory, October 2015
- ISU SIAM, October 2015: Basics of novel RIrDG methods
- SIAM CSE 2015: A Regionally Implicit DG Method with Applications to the Relativistic Vlasov-Maxwell System
- ISU SIAM, February 2015: Stability of Regionally Implicit DG Methods
- ISU Seminar, February 2015: Dr. Leveque's 'A Well-Balanced Path-Integral f-wave Method for Hyperbolic Problems with Source Terms'

CONTRIBUTED

- American Physical Society Division of Plasma Physics, October 2019
- International Conference on Numerical Simulation of Plasmas, September 2019
- International Conference on Plasma Science (ICOPS) 2019
- American Physical Society: Division of Plasma Physics November 2018
- International Conference on Plasma Science (ICOPS) 2018

ATTENDED

- Z Fundamental Science workshop, August 2019 at Sandia National Labs
- Kokkos Performance Portability Bootcamp, March 2019