K. Chad Sockwell, Curriculum Vitae

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CURRENT RESEARCH INTEREST

Computational Climate Modeling, Geophysical Fluid Dynamics, Superconductivity, Finite Element Method, Finite Difference Method, Non-Linear P.D.Es, Linear Solvers, Reduced Order Models, Krylov Solvers, Preconditioners, Multi-grid Methods, Higher Order and Parallel Time Integrators, Exponential Time Integrators, Stiff Time Integrators.

OTHER RESEARCH INTEREST

Physical Modeling, Fluid Dynamics, Hamiltonian Systems, Discrete Exterior Calculus, Differential Geometry, Analysis, Elementary Physics, Quantum Physics, General Relativity, Mathematical Physics, Computational Physics, Scientific Computing

EDUCATION

Doctor of Philosophy, **Computational Science**   Expected Summer 2019
Florida State University, Tallahassee, FL
Advisor: Dr. Max Gunzburger
Dissertation: TBA
Relevant Courses: Applied Computational Science II, Finite Element Method, High Performance Computing, Data Mining, Control and Optimization of PDEs Seminar, Spectral Methods Seminar, Computational and Theoretical Fluid Dynamics Seminar, Numerical Methods of UQ and ROM (Group) Seminar

Master of Science, **Computational Science**   December 2016
Florida State University, Tallahassee, FL
Advisors: Dr. Max Gunzburger, Dr. Janet Peterson
Thesis: *Modeling and Simulating Vortex Pinning and Transport Currents for High Temperature Superconductors*
Relevant Courses: Applied Computational Science I, Scientific Programming, Quantum Mechanics A, Scientific Computing for Integral Equation Methods

Bachelor of Science, Honors in The Major, **Computational Science**   December 2015
Florida State University, Tallahassee, FL
Advisors: Dr. Max Gunzburger, Dr. Janet Peterson
Thesis: *Investigation into Numerical Models of New High Temperature Superconductors*
Relevant Courses: Computational Methods for Continuous Problems, Computational Methods for Discrete Problems

Bachelor of Arts, **Physics** December 2015
Florida State University, Tallahassee, FL
Relevant Courses: Quantum Theory of Matter A&B, Electricity and Magnetism I&II, Mechanics I&II, Special and General Relativity

PROFESSIONAL EXPERIENCE

Graduate Research Assistant at LANL January 2019 – Present
Theoretical Division, Los Alamos National Lab, Los Alamos, NM
Mentor: Dr. Luke Van Roekel (LANL)
Research: I am developing physics preserving reduced order modeling techniques for ocean models, such as MPAS-O. The goal is to produce a reduced order model capable of assisting in uncertainty quantification calculations, data assimilation, and produce high-resolution initializations at a reduced cost.

DOE SCGSR Awardee January 2018 – January 2019
Theoretical Division, Los Alamos National Lab, Los Alamos, NM
Advisors: Dr. Max Gunzburger (FSU), Dr. Todd Ringler (LANL), Dr. Luke Van Roekel (LANL)
Research: This research coincides with my current dissertation research. This award allows me get a hands on experience with scientists at LANL who have developed MPAS-Ocean, the software which my research intends to benefit. I am currently investigating two faucets of research. Firstly, I am continuing my research on exponential integrators, with an aim on developing a CFL free, multi-resolution time integrator. Secondly I am investigating reduced order models and reduced basis methods for the MPAS-O model in order to further improve the efficiency of my time integrator developments and produce a reduced model with a less restrictive CFL constraint. A reduced order model with a reduced basis method would also have several other beneficial implications for MPAS-Ocean.

Research Assistant September 2016 – Present
Scientific Computing, Florida State University, Tallahassee, FL
Advisor: Dr. Max Gunzburger
Research: Investigating and Implementing high performance, multi-resolution techniques for the MPAS-Ocean Software that is a part of the ACME climate model under the Biological and Environmental Research branch the DOE office of science. This includes finding optimal time stepping methods for hyperbolic equations (specifically the rotating shallow water equations and the primitive equations) in a finite volume setting with non-uniform spherical centroidal voronoi tessellation. Currently we are investigating exponential integrators as well as other spatially dependent and multi-rate time stepping methods. In particular, we are investigating performance and the ability to allow time step sizes that exceed that set by the CFL condition.

Teaching Assistant for ISC1057: Computational Thinking June 2016 – August 2016
Department Of Scientific Computing , Florida State University, Tallahassee, FL
Advisor: Dr. Janet Peterson
Duties: Producing Slides and Quizes (on Sacrotive Software) for a new entry level coarse in the Scientific Computing Department at FSU.

Teaching Assistant for LIS2360: Web Apps January 2016 – May 2016
Program in Interdisciplinary Computing , Florida State University, Tallahassee, FL
Advisor: Professor Christy Chatmon
Duties: Assisting students with web development and web applications involving html, css, javascript, ect. Grading student assignments, holding face to face office hours, providing online help through forums, and assisting students with computer lab assignments.

Research Assistant September 2014 – December 2015
Scientific Computing, Florida State University, Tallahassee, FL
Advisor: Dr. Max Gunzburger

Research: Numerical simulations of superconductivity using Ginzburg-Landau type models and the finite element method. This includes producing and developing software in parallel computing environment and modeling superconducting materials such as magnesium diboride.

SKILLS

Numerical Mathematics:

- Domain Knowledge of Scientific Computing and Numerical Analysis, Finite element method, Finite difference method, Solving Non-Linear P.D.E's, Linear Solvers, Krylov Solvers, Preconditioners, Multi-grid methods, Higher order and Parallel Time Integrators, Exponential and Stiff Time Integrators, Optimization Techniques

Programing:

- Fortran (Very Experienced), Matlab (Very Experienced), C++(Very Experienced), MPI (Very Experienced), OOP (Very Experienced), C (Experienced), Python (Experienced)

Software:

- Trilinos, PETSC, MPAS-O, deal ii, SuperLU, Triangle, LATEX, Word, Linux OS, Microsoft OS, MPI, OPENMP

JOURNAL REFEREEING

Journals
- *Journal of Computational Physics, Elsevier*

PUBLICATIONS

Published:

- 2018: K. Chad Sockwell, Max Gunzburger, Janet Peterson *Pinning Effects in Two Band Superconductors*, Physica C, Volume 555, 15 December 2018, Pages 7-14.

Submitted:

- 2018: Konstantin Pieper, K. Chad Sockwell, Max Gunzburger *Exponential Time Differencing for Mimetic Multilayer Ocean Models*, Journal of Computational Physics

In Preparation:

- K. Chad Sockwell, Konstantin Pieper, Max Gunzburger *Hamiltonian Structure Preserving Reduced-Order Model for the Shallow Water Equations*
- K. Chad Sockwell, Konstantin Pieper, Max Gunzburger *Exponential Integrator - Rational Krylov Methods for Mimetic Ocean Models*

CONFERENCES, WORKSHOPS, AND PRESENTATIONS

Conferences & Workshops:

- SIAM Conference on Computational Science and Engineering (CSE15), Salk Lake City UT., Mar. 14 - 18, 2015.
- SIAM 8th Annual SIAM Student Mini-conference, Clemson University, Clemson SC., Feb. 6 2016.
- SIAM Annual SIAM SEAS Conference, University of Georgia at Athens, Athens GA., Mar. 12-13, 2016.
- SIAM Conference on Scientific Computing and Engineering (CSE 17), Atlanta GA. Feb. 27 to Mar. 3, 2017.
- SIAM Annual SIAM SEAS Conference, Florida State University, Tallahassee FL., Mar. 18 - 19, 2017.
- DOE ACME All Hands Meeting, Bolger Conference Center, Potomac MD., Jun. 4 - 7, 2017.
- 16th International Workshop on Multi-scale (Un)-structured Mesh Numerical Modeling for Coastal, Shelf, and Global Ocean Dynamics (IMUM 2017), Stanford University, Stanford CA., Aug. 29 - Sep. 1, 2017.
- AGU 2018 Ocean Sciences Meeting, Portland OR., Feb. 11 - 16 2018.
- DOE 15th Copper Mountain Conference On Iterative Methods, Copper Mountain CO., Mar. 25 - 30, 2018
- DOE Workshop on Initialization of High-Resolution Earth System Models, Rockville MD., Apr. 9 - 10, 2018.
- DOE 2018 Modeling PI Meeting - E3SM meeting, Bolger Conference Center, Potomac MD., Nov. 5 - 9, 2018.
- AGU 2018 AGU Fall Meeting - Washington D.C., Dec. 10 - 14, 2018.
- SIAM Conference on Scientific Computing and Engineering (CSE 19) - Spokane WA., Feb. 25 - Mar. 1, 2019.

Poster Presentations:

- 2015 Undergraduate Poster Symposium (SIAM) , *Investigation into Numerical Models of New High Temperature Superconductors*
- 2015 Computational Science EXPO, Department of Scientific Computing, Florida State University, *Investigation into Numerical Models of New High Temperature Superconductors*
- 2015 Presidents Showcase of Undergraduate Research Excellence, Poster Symposium, *Pinning effects in two band superconductors*
- 2016 Computational Science EXPO, Department of Scientific Computing, Florida State University, *Passing Resistance Free Transport Currents Through Two-Band Superconductors*
- 2017 SIAM CSE, Altanta GA., *Conservation Properties and Performance of Exponential Integrators for Nonlinear Conservation Laws*
- 2017 SIAM SEAS, Florida State University, Tallahasee FL. *Conservation Properties and Performance of Exponential Integrators for Nonlinear Conservation Laws* ((Multiple Authors: Konstantin Pieper, K. Chad Sockwell (presenter), Max Gunzburger, Lili Ju, Zhu Wang)
- 2017 ACME All Hands, Potomac MD. *Exponential Time Differencing and Parallel Implementation* (Multiple authors: Thi Thau Phuong Hoang (presenter), Konstantin Pieper (presenter), K. Chad Sockwell, Zhu Wang, Max Gunzburger, Lili Ju,)
- 2018 Summer Student Symposium at LANL, Los Alamos, NM. *Exponential Integrator - Krylov Methods For Mimetic Ocean Models*

- 2018 DOE Modeling PI Meeting - E3M Meeting, Potomac MD. *Exponential Integrators with Fast and Slow Mode Splitting for Multilayer Ocean Models* (Multiple Authors: Konstantin Pieper (presenter), K. Chad Sockwell, Max Gunzburger)

- 2018 DOE Modeling PI Meeting - E3M Meeting, Potomac MD. *Hamiltonian Structure Preserving Reduced-Order Model for the Shallow Water Equations* (Multiple Authors: K. Chad Sockwell (presenter), Konstantin Pieper, Max Gunzburger)

- 2018 AGU Fall Meeting - Washington D.C. *Hamiltonian Structure Preserving Reduced-Order Model for the Shallow Water Equations* (Multiple Authors: K. Chad Sockwell (presenter), Konstantin Pieper, Max Gunzburger)

Talks:

- Title: Scientific Computing, Audience: Society of Math students, Florida State University, Oct. 2015

- Title: Scientific Computing, Audience: Society of Physics students, Florida State University, Oct. 2015

- Title: Scientific Computing, short video recored version, link on webpage:
  `http://people.sc.fsu.edu/~kcs12j/`

- Title: Simulation of Vortex Pinning in Two-Band Superconductors, Audience: 8th Annual SIAM Student Mini-conference, Clemson University, Feb. 2016

- Title: Simulation of Vortex Pinning in Two-Band Superconductors, Audience: SIAM SEAS conference 2016, University of Georgia at Athens, Athens GA.

- A Novel Normal Inclusion Modeling Strategy For Vortex Pinning in Two-Band, High-Temperature Superconductors, Computational Engineering (BGCE) Student Paper Prize finalist talk, Audience: SIAM CSE 2017, Atlanta, GA.

- A Novel Normal Inclusion Modeling Strategy For Vortex Pinning in Two-Band, High-Temperature Superconductors, Audience: SIAM SEAS 2017, Florida State University, Tallahassee FL.

- Exponential Integrator - Rational Krylov Methods for Mimetic Ocean Models, Student Lightning Talk at LANL, Aug. 2018

- Exponential Integrator - Rational Krylov Methods for Mimetic Ocean Models, COSIM group meeting talk at LANL, Oct. 2018

- Hamiltonian Structure Preserving Reduced-Order Model for the Shallow Water Equations, E3SM Virtual Meeting, Jan. 2019, YouTube link: `https://www.youtube.com/watch?v=Q_E2aHpQC7o&t=8s`

- Hamiltonian Structure Preserving Reduced-Order Model for Mimetic Ocean Models, Computational Engineering (BGCE) Student Paper Prize finalist talk, Audience: SIAM CSE 2019, Spokane WA.

PROFESSIONAL SOCIETIES

- American Physical Society (APS)
- Society for Industrial and Applied Mathematics (SIAM)

HONORS, AWARDS, AND GRANTS

- Sigma Pi Sigma, Physics Honor Society (SPS), 2015

- Mentored Research and Creative Endeavors Award, Summer Research Award (MRCE), $1000, 2015

- Bavarian Graduate School of Computational Engineering (BGCE) Student Paper Prize finalist, 2017, Link to article at FSU:
  `https://www.sc.fsu.edu/news-and-events/headlines/1220-sockwell-finalist-for-paper-prize`

- 2017 ACME All Hands Best Poster Award, Potomac MD. *Exponential Time Differencing and Parallel Implementation* (Multiple authors: Thi Thau Phuong Hoang, Konstantin Pieper, K. Chad Sockwell, Max Gunzburger, Lili Ju, Zhu Wang)
- DOE Office of Science, Scientific Computing Graduate Student Research (SCGSR) Program awardee for one year (Jan 2017 - Jan 2018). Hosting Lab - LANL, Lab adviser- Dr. Todd Ringler. Proposal - Algorithmic Improvements of the Temporal Scheme in The MPAS-O Software for Multi-resolution Climate Modeling.
- 2018 "Summer Student Symposium at LANL" outstanding poster award, *Exponential Integrator - Krylov Methods For Mimetic Ocean Models*
- Bavarian Graduate School of Computational Engineering (BGCE) Student Paper Prize finalist, 2019