

David B. Emerson

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Tufts University
Department of Mathematics
503 Boston Avenue
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Education

Tufts University, Department of Mathematics, Medford, MA

Ph.D. Applied Mathematics: May 2015

Dissertation: Advanced Discretizations and Multigrid Methods for Liquid Crystal Configurations

Committee: James Adler, Scott MacLachlan, Timothy Atherton, Thomas Manteuffel, Xiaozhe Hu

Boston College, School of Arts and Sciences, Chestnut Hill, MA

Master of Arts in Mathematics: May 2012

Master of Business Administration with Distinction: May 2012

Bachelor of Science with Honors in Computer Science, Magna Cum Laude: May 2009

Bachelor of Arts in Mathematics, Magna Cum Laude: May 2009

- Top 5% of class, Dean's Scholar of the College.

- Phi Beta Kappa Designation, Boston Pops Orchestra Scholar.

Professional Experience

Tufts University, Department of Mathematics, Medford, MA

Visiting Research Scholar: May 2015 – Present

Research Assistant: January 2015 – May 2015

Street Contxt, Toronto, Canada

Computational Scientist: November 2015 – Present

- Working on research in the areas of large-scale machine-learning methods and statistical algorithms for production level implementation.

Lawrence Livermore National Laboratories, Livermore, CA

Scientific Computing Summer Researcher: May 2014 – August 2014

- Performed research in nonlinear multigrid methods for finite-element discretizations with unstructured mesh.

Tufts University, Department of Athletics, Chestnut Hill, MA

Volunteer Assistant Coach, Cross-Country and Track: September 2013 – May 2015

- Planned and coordinated athlete training cycles.

- Supervised athlete workouts and competitions.

Tufts University, Department of Mathematics, Medford, MA

Research Assistant: May 2013 – August 2013

- Conducted research in energy-minimization finite-element methods for static liquid crystal equilibrium configurations under free elastic and augmented effects.

MITRE Corporation, McLean, VA

Operations Research Analyst: May 2011 – August 2011

- Conducted extensive constrained optimization and geometric algorithm research.

- Collaborated on the development of a model-based approach to spectrum consumption.

Boston College, Department of Athletics, Chestnut Hill, MA

Volunteer Assistant Coach, Cross-Country and Track: March 2010 – May 2012

- Coordinated and supervised practices, athlete workouts, and competitions.

Liberty Mutual, Boston, MA

MBA Product Analyst: May 2010 – August 2010

- Engineered a metric evaluation tool to compliment new and crucial business initiatives.

Code Red Inc., Boston, MA

Summer Software Engineer: Summers 2007 – 2009

- Designed buy and sell-side web applications and research management software in multiple languages across multiple platforms.

Teaching Experience

Instructor:

MATH 42: Multivariable Calculus	Tufts University	Summer 2013
MATH 42: Multivariable Calculus	Tufts University	Spring 2013
MT 004: Finite Probability	Boston College	Fall 2011

Teaching Assistant:

MATH 87: Mathematical Modeling	Tufts University	Fall 2014
MATH 152: Advanced Calculus and PDEs	Tufts University	Spring 2014
MATH 226: Grad. Numerical Analysis	Tufts University	Fall 2013
MATH 126: Numerical Analysis	Tufts University	Fall 2012
MT 101: Calculus II	Boston College	Spring 2010
MT 100: Calculus I	Boston College	Fall 2009

Research Interests

My research interests are in the areas of computational mathematics and physics, specifically in the areas of finite-element methods and least squares approaches. Currently, my research focuses on the development of theoretically-supported nonlinear constrained optimization methods coupled with finite elements for static and dynamic liquid crystal simulations. Such development concerns both accurate physical modeling as well as efficient numerical computation. The coupling of liquid crystal free elastic effects with applied electric fields, flexoelectric effects, and fluid dynamics yields interesting theoretical challenges for the design of effective and efficient computational techniques. In addition, efficient algorithm development branches into adaptive mesh refinement techniques and linear solvers for saddle point systems.

Skills

Code Languages: C, C#, C++, Java, MATLAB, Scala, VBA, Bash Script, SQL, HTML, Python, L^AT_EX

Development Tools: Visual Studio, Emacs, MATLAB, Spark, Tensorflow, Keras, Mathematica, Git, Subversion, Shell, Eclipse, IntelliJ, Make, CMake

Operating Systems: Windows, Macintosh, UNIX, Linux

Publications

- [1] D.B. Emerson *Error Estimators and Marking Strategies for Electrically Coupled Liquid Crystal Systems, Under Review*, 2018
- [2] D.B. Emerson, J.H. Adler, P.E. Farrell, S.P. MacLachlan, and T.J. Atherton. *Computing Equilibrium States of Cholesteric Liquid Crystals in Elliptical Channels with Deflation Algorithms. Liquid Crystals*, **45**(3):341-350, 2018.
- [3] D.B. Emerson. *A Posteriori Error Estimators for the Frank-Oseen Model of Liquid Crystals. J. Coupled Syst. Multiscale Dyn. (JCSMD)*, **5**(2):95-110, 2017.
- [4] J.H. Adler, D.B. Emerson, P.E. Farrell, and S.P. MacLachlan. *Combining Deflation and Nested Iteration for Computing Multiple Solutions of Nonlinear Variational Problems. SIAM J. Sci. Comput.*, **39**(1):B29-B52, 2017.

- [5] J.H. Adler, D.B. Emerson, S.P. MacLachlan, and T.A. Manteuffel. *Constrained Optimization for Liquid Crystal Equilibria*. *SIAM J. Sci. Comput.*, **38**(1):B50-B76, 2016.
- [6] A. DeBenedictis, T.J. Atherton, C. Anquetil-Deck, D.J. Cleaver, D.B. Emerson, M. Wollak, and J.H. Adler. *Competition of Lattice and Basis for Alignment of Nematic Liquid Crystals*. *Phys. Rev. E*, **92**:042501, 2015.
- [7] J.H. Adler, T.J. Atherton, T.R. Benson, D.B. Emerson, and S.P. MacLachlan. *Energy Minimization for Liquid Crystal Equilibrium with Electric and Flexoelectric Effects*. *SIAM J. Sci. Comput.*, **37**(5):S157-S176, 2015.
- [8] J.H. Adler, T.J. Atherton, D.B. Emerson, and S.P. MacLachlan. *An Energy-Minimization Finite-Element Approach for the Frank-Oseen Model of Nematic Liquid Crystals*. *SIAM J. Numer. Anal.*, **53**(5):2226-2254, 2015.

Proceedings

- [1] M.A. Stevens, C. Downs, D. Emerson, J. Adler, S. MacLachlan, and T.E. Vandervelde. *Predicting V_{OC} at Ultra-High Solar Concentration Using Computational Numerical Analysis*. In *Proceedings of the 31st European Photovoltaic Solar Energy Conference (EUPVSC)*. Hamburg, Germany, Sept. 14–18, 2015.
- [2] M. Stevens, C. Downs, D. Emerson, J. Adler, S. MacLachlan, and T.E. Vandervelde. *Studying Anomalous Open-Circuit Voltage Drop-Out in Concentrated Photovoltaics Using Computational Numerical Analysis*. In *Proceedings of the 42nd IEEE Photovoltaic Specialists Conference (PVSC)*. New Orleans, June 14–19, 2015.

Technical Reports

- [1] J.H. Adler, T.J. Atherton, D.B. Emerson, and S.P. MacLachlan. *An Energy-Minimization Finite-Element Approach for the Frank-Oseen Model of Nematic Liquid Crystals: Continuum and Discrete Analysis*. *Technical Report, Tufts University*, 2014.
- [2] J.H. Adler, D.B. Emerson, S.P. MacLachlan, T.A. Manteuffel. *Constrained Optimization for Liquid Crystal Equilibria: Extended Results*. *Technical Report, Tufts University*, 2014.

PhD Thesis

- [1] David B. Emerson. *Advanced Discretizations and Multigrid Methods for Liquid Crystal Configurations*. *ProQuest LLC, Ann Arbor, MI*, 2015. Thesis (Ph.D.)-Tufts University.

Awards

2017 Kolmogorov-Weiner Prize Recipient – August 2017, Waterloo, Ontario, Canada:
A Posteriori Error Estimators for the Frank-Oseen Model of Liquid Crystals.

5th BGCE Student Paper Prize Recipient – March 2015, Salt Lake City, UT:
Advanced Discretizations and Multigrid Methods for the Energy Minimization of Liquid Crystal Equilibrium Configurations.

Researcher – Tufts Collaborates! July 2015 – June 2016:
 Unlocking the Mystery of Ultra-Efficient Solar Cells under Concentration.

Researcher – Tufts Collaborates! July 2014 – June 2015:
 Fast by Design: Better Liquid Crystal Devices through Theory, Simulation and Experiment.

Professional Service and Activities

Referee

SIAM Journal on Scientific Computing (SISC)

Tufts University

Treasurer, Tufts University Chapter of SIAM: June 2014 – May 2015

Vice President, Tufts University Chapter of SIAM: September 2013 – May 2014

Member, Organization of Graduate Students in Mathematics: September 2012 – May 2015

Treasurer, Tufts University Chapter of SIAM: January 2013 – September 2013

Boston Athletic Association

Member, BAA Elite Running Team: October 2010 – May 2015

Boston College Athletics

Athlete, Varsity Cross Country and Track and Field: September 2005 – March 2010

- NCAA Post-graduate Scholarship finalist (2009)
- ACC Cross Country All-Academic Team (2008), ACC Track All-Academic Team (2009)
- All-New England Cross-Country (2008), New England 10k Track Champion (2008)
- Boston College Track Leadership Award (2007)

Memberships

Society for Industrial and Applied Mathematics (SIAM)

American Mathematical Society (AMS)

Conferences, Seminars, and Workshops

15th Copper Mountain Conference on Iterative Methods:

Speaker: March 30, 2018 - Frisco, CO

- *A Posteriori Error Estimators for the Frank-Oseen Liquid Crystal Model*

Tufts University Applied Mathematics Seminar:

Invited Speaker: October 30, 2017 - Medford, MA

- *A Posteriori Error Estimators for Nonlinear Variational Problems*

Applied Mathematics, Modeling, and Computational Science (AMMCS):

Speaker: August 21, 2017 - Waterloo, Canada

- *Combining Deflation and Nested Iteration for Detecting Multiple Liquid Crystal Equilibrium States*

Mathematics of Finite Elements and Applications (MAFELAP):

Speaker: June 15, 2016 - Uxbridge, United Kingdom

- *A Deflation Technique for Detecting Multiple Liquid Crystal Equilibrium States*

Tufts University Applied Mathematics Seminar:

Invited Speaker: October 28, 2015 - Medford, MA

- *A Deflation Technique for the Computation of Static Liquid Crystal Configurations*

Friedrich–Alexander Universität BGCE Research Day:

Invited Speaker: July 9, 2015 - Erlangen, Germany

- *Finite-Element and Multigrid Methods for Liquid Crystal Configurations under the Frank-Oseen Free-Energy Model*

Technische Universität München Colloquium:

Invited Speaker: July 7, 2015 - Garching, Germany

- *Finite-Element and Multigrid Methods for Liquid Crystal Configurations under the Frank-Oseen Free-Energy Model*

Essex High School STEM Academy Lectures:

Invited Speaker: May 19, 2015 - Essex Junction, VT

- *Liquid Crystals and Linear Solvers*

SIAM Conference on Computational Science and Engineering:

Speaker: March 16, 2015 - Salt Lake City, UT

- *Energy Minimization for Liquid Crystal Equilibrium Configurations with Applied Electric Fields*

SIAM Conference on Computational Science and Engineering:

5th BGCE Student Paper Prize Finalist

Invited Speaker: March 15, 2015 - Salt Lake City, UT

- *Advanced Discretizations and Multigrid Methods for the Energy Minimization of Liquid Crystal Equilibrium Configurations*

Tufts University Chapter of SIAM:

Speaker: Jan 21, 2015 - Medford, MA

- *Object-Oriented Programming in the Context of Scientific Computing*

Tufts University Applied Mathematics Seminar:

Speaker: Oct 23, 2014 - Medford, MA

- *An Introduction to Trust-Region Optimization*

Tufts University Applied Mathematics Seminar:

Speaker: Sept 17, 2014 - Medford, MA

- *An Introduction to Finite-Element Approaches for Liquid Crystal Equilibrium Configurations*

13th Copper Mountain Conference on Iterative Methods:

Speaker: April 10, 2014 - Frisco, CO

- *An Energy-Minimization Finite-Element Approach for Liquid Crystal Equilibrium Configurations with Applied Electric Fields*

ICES/USACM Workshop on Minimum Residual and Least Squares Finite Element Methods:

Poster: November 4–6, 2013 - Austin, TX

- *First-Order System Least Squares and Energy-Minimization Approaches for Static Liquid Crystal Configurations*