Travis B. Thompson

Citizen of the United States

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Research Expertise

My research expertise is in the development and analysis of applied mathematical models and scientific computing methods to study the brain and neurological pathology. My research combines theory from ordinary and partial differential equations and numerical analysis with techniques from high-performance scientific computing and, more recently, data-driven applied statistics and machine learning to study salient mechanisms for important neurological diseases such as Alzheimer's and Parkinson's disease.

Research Program Funding

1 **High-resolution mathematical models of proteopathy: theory and software for Alzheimer's research**, *John Fell Fund, Oxford University*, Award Number BKD00160, 2020-2022.

Academic Appointments

2019-Present **Postdoctoral Research Asst.**, *Oxford University*, Mathematical Institute, Research Adviser: Alain Goriely.

2017-2019 **Postdoctoral Fellow**, *Simula Research Laboratory*, Dept. of Numerical analysis, and Scientific Computing, Research Adviser: Marie Rognes.

2015-2017 **Pfeiffer Postdoctoral Fellow**, *Rice University*, Dept. of Computational and Applied Mathematics, Research Adviser: Beatrice Riviere.

Industrial Appointments

2013-2015 **Software Dev. Assoc.**, *Joint Institute for Computational Sciences at Oak Ridge National Laboratory*, (High-performance computing).

2012 **Software Dev. Intern**, *Joint Institute for Computational Sciences at Oak Ridge National Laboratory*, (Internship: High-performance computing).

2000-2003 **Software Engineer**, *Integrated Decision Support Corp.*.

Education

2007–2013 **Ph.D., Mathematics**, *Texas A&M University*, College Station, TX.
Dissertation adviser: Jean-Luc Guermond

2005–2007 **M.Sc., Mathematics**, *The University of Iowa*, Iowa City, IA.

2001–2005 **B.Sc., Mathematics**, *The University of Texas, Dallas*, Richardson, TX.
Minor in computer science

Academic Publications

Publications marked with a * respect the mathematical convention of alphabetical author ordering.

Books

*1 **Mathematical modeling of the human brain: from magnetic resonance images to finite element simulation**, *Mardal K.-A., Rognes M.E., Thompson T.B. and Valnes, L.-M.*, Springer. 2022.

Journal publications

17 **Front propagation and arrival times in networks with application to neurodegenerative diseases**, *Putra P., Oliveri H., Thompson T.B. and Goriely A.*, (Submitted), 2022. preprint: doi:10.1101/2022.01.04.474911.

*16 **A-posteriori error estimation and adaptivity for multiple-network poroelasticity**, *Eliseussen E., Rognes M.E. and Thompson T.B.*, (Submitted), 2021. preprint: arxiv.org/abs/2111.13456.

15 **Predicting brain atrophy from tau pathology: A summary of clinical findings and their translation into personalized models**, *Schäfer A., Chaggar P., Thompson T.B., Goriely A. and Kuhl E.*, Brain Multiphys. 2: pp 100039, 2021. doi:10.1016/j.brain.2021.100039.

14 **Braiding Braak and Braak: Staging patterns and model selection in network neurodegeneration**, *Putra P., Thompson T.B. and Goriely, A.*, Network Neurosci. 5(4): pp 929–956, 2021. preprint: doi:10.1162/netn_a_00208.

13 **The role of clearance mechanisms in the kinetics of pathological protein aggregation involved in neurodegenerative diseases**, *Thompson T.B., Meisl G., Knowles T. and Goriely A.*, J. Chem. Phys. 154(12): pp 125101, 2021. doi:10.1063/5.0031650.

*12 **Accurate Discretization Of Poroelasticity Without Darcy Stability**, *Mardal K.-A., Rognes, M.E. and Thompson, T.*, BIT Numer. Math. 61: pp 941–976, 2021. doi:10.1007/s10543-021-00849-0.

11 **Parameter robust preconditioning by congruence for multiple-network poroelasticity**, *Piersanti E., Lee J.J., Thompson T.B., Mardal K.-A. and Rognes M.E.*, SIAM J. Sci. Comput. 43(4): pp B984–B1007., 2021. doi:10.1137/20M1326751.

10 **Anisotropic Diffusion and Traveling Waves of Toxic Proteins in Neurodegenerative Diseases**, *Kevrikidis P.G., Thompson T.B. and Goriely A.*, Phys. Rev. Lett. A., 2020. 384(36): pp 126935 doi:10.1016/j.physleta.2020.126935.

9 **Protein-protein interactions in neurodegenerative diseases: a conspiracy theory**, *Thompson T.B., Chaggar P., Kuhl E. and Goriely A.*, PLoS Comput. Biol., 2020. 16(10): pp e1008267 doi:10.1371/journal.pcbi.1008267.

*8 **An observation on the uniform preconditioners for the mixed Darcy problem**, *Bærland T., Kuchta M., Mardal K.-A. and Thompson T.B.*, Numer. Meth. Part. DE., 2020. 36(6): pp 1718-1734 doi:10.1002/num.22500.

7 **An implicit discontinuous Galerkin method for modeling edema in the intestine**, *Thompson T.B., Riviere B. and Knepley M.*, IMA J. Math. Medic. and Biol., 2019. 36(4): pp 513–548. doi:10.1093/imammb/dqz001.

*6 **A stable, enriched Galerkin element for the Stokes problem**, *Chaabane N., Girault V., Riviere B., and Thompson T.B.*, Appl. Num. Math., 2018. 132: pp 1-21. doi:10.1016/j.apnum.2018.04.008.

*5 **An conservative anti-diffusion technique for the level set method**, *Guermond J.-L., Quezada de Luna M. and Thompson T.B.*, J. Comp. and Appl. Math., 2017. 321: pp 448-468 doi:10.1016/j.cam.2017.02.016.

*4 **Error analysis of primal discontinuous Galerkin methods for a mixed formulation of the Biot equations**, *Riviere B., Tan J., and Thompson T.B.*, Comp. and Math. with Appl., 2017. 73(4): pp 666-683 doi:10.1016/j.camwa.2016.12.030.

*3 **A discrete commutator theory for the consistency and phase analysis of semi-discrete C^0 finite element approximations to the linear transport equation**, *Thompson T.*, J. Comp. and Appl. Math., 2016. 303: pp 229-248. doi:10.1016/j.cam.2016.02.042.

*2 **Validation of an entropy-viscosity model for LES**, *Guermond J.-L., Larios A. and Thompson T.B.*, In: Frohlich J., Kuerten H., Geurts B., Armenio V. (eds) Direct and Large-Eddy Simulation IX. ERCOFTAC Series, vol 20. Springer, 2015. pp 43–48. doi:10.1007/978-3-319-14448-1_6.

*1 **Coloring the Mu transpososome**, *Darcy I., Navarra-Madsen J., Thompson T.B. et. al*, BMC Bioinformatics, 2006. 7(435). doi:10.1186/1471-2105-7-435.

Papers In Preparation

1 **PrYon: A Python software library for the numerical solution of infectious disease propagation and machine learning on connectome graphs**, *Thompson T.B., Chaggar, P. and Goriely, A.*.

Research Advising

8 **2021-Present**, *Mr. Andrew O Heachteirn*, Topic: Multiscale mathematical models of the cerebral vasculature in neurodegenerative diseases (Ph.D.), Co-advisor.

7 **2019-Present**, *Ms. Georgia Brennan*, Topic: Clearance mechanisms in graph neurodegeneration dynamics (Ph.D.), Co-advisor.

6 **2019-Present**, *Mr. Pavanjit Chaggar*, Topic: Bayesian inference and machine learning for data-driven network ODE models of infectious disease (Ph.D.), Co-advisor.

5 **2019-Present**, *Mr. Prama Putra*, Topic: Graph Analysis and staging for network models of infectious proteopathy in the brain (Ph.D.), Co-advisor.

4 **2018-2019**, *Ms. Emilie Ødegaard*, Topic: A posteriori error estimates for generalized poroelasticity (M.Sc.), Co-advisor.

3 **2018**, *Mr. Kentrell Owens*, Topic: Scientific Computing with FEniCS (M.Sc. Research Intern), Advisor.

2 **2016-2017**, *Mr. James Phillips*, Topic: Mathematical modeling of soft-tissue edema (Undergraduate), Advisor.

1 **2015-2017**, *Mr. James Lee*, Topic: Data-driven mathematical modeling of edema (Undergraduate), Advisor.

Teaching

Instructor of Record

S2015-S2017 **Differential Equations in Science and Engineering (5 Semesters)**, *Rice University, Houston Texas*, Large Lecture Courses.

S2014 **Calculus I**, *University of Tennessee, Knoxville Tennessee.*

S2007 **College Algebra**, *University of Iowa, Iowa City Iowa.*

Teaching Assistant

F2007-F2012 **Calculus I, II, Multivariable Calculus, and Linear Algebra**, *Texas A&M University, College Station Texas.*

F2005-F2006 **Calculus for Biology, Multivariable Calculus**, *University of Iowa, Iowa City Iowa.*

Research Presentations

22 **Industrial and Applied Mathematics Colloquium. Mathematical Institute, Oxford. November 2021**, *(invited)*, 'Mathematics of the mind'.

21 **Department of Mathematics Colloquium, Texas Tech University. Lubbock, Texas. October 2021**, *(invited)*, 'Bioscientific Computing: Data driven mathematical modeling and analysis of neurological pathology and Alzheimer's disease'.

20 **6th Oxford International Neuron and Brain Mechanics Workshop. Oxford, United Kingdom. April 2021**, *(invited)*, 'A model of protein-protein interaction in neurodegeneration with application to Alzheimer's disease'.

19 **Interpore 2019. Valencia, Spain. May 2019**, 'Advances in conformal finite element methods for generalized poroelasticity: A-posteriori error estimates for the two-field generalized poroelasticity equations and an elliptic-parabolic framework'.

18 **2018 Simula Research Conference. Son, Norway. August 2018**, *(invited)*, 'Waterscape of the Brain: Mathematics and Scientific Computing Enabling Clinical Simulation'.

17 **SIAM Life Sciences. Minneapolis, Minnesota. August 2018.**, *(minisymposium organizer)*, 'Stokes-Biot Stability and a Mixed Formulation For Generalized Poroelasticity', Minisymposium: Robust Finite Element Methods With Application To Soft Tissue Biomechanics.

16 **ECCM-ECFD. Glasgow, United Kingdom. June 2018.**, 'A Stokes-Biot Stable Hdiv-Based Mixed Method for Generalized Poroelasticity', Minisymposium: Numerical methods for coupled problems involving fluids and solids.

15 **Lorentz Center, Leiden, Netherlands. May 2018.**, 'Stokes-Biot Stability and a Mixed Formulation for Generalized Poroelasticity', Workshop: The Computational Mathematics Aspects of Porous Media and Fluid Flow Workshop.

14 **FEniCS'18, Oxford, United Kingdom March 2018.**, 'A Robust 3-Field formulation for Generalized Poroelasticity', 2018 FEniCS Workshop and Conference.

13 **University of Houston, Houston, Texas. March 2017.**, 'Biomedical computing: modeling edema in the intestine with pressure-dependent Lame coefficients', Finite Element Rodeo.

12 **Simula Research Laboratory. Oslo, Norway. Jan 2017**, *(invited)*, 'A mathematical model of edema in the intestine', Applied Mathematics Research Seminar.

11 **Southern Methodist University (SMU). December 2016**, *(invited)*, 'A DG approach to poroelasticity, with applications to edema formation in tissue', Seminar in Computational and Applied Mathematics.

10 **University of Notre Dame. October 2016**, *(invited)*, 'A numerical model for edema formation in layered, poroelastic tissue', Seminar in Applied Mathematics.

9 **SIAM, Boston. July 2016**, *(organizer, finite element methods in the life sciences minisymposium)*, 'A Discontinuous Galerkin Method for the Poroelastic Modeling of Intestinal Edema Formation', Conference on the Life Sciences.

8 **Univ. of Maryland, College Park. April 2016**, 'A framework for analyzing C^0, semi-discreet, semi-inner product finite element discretizations of the level set equation', 2016 Finite Element Circus.

7 **Texas A&M University. March 2016**, 'A primal discontinuous Galerkin method with application to the modeling of intestinal edema', 2016 Finite Element Rodeo.

6 **Univ. of Nebraska, Lincoln. October 2015**, *(invited)*, 'From supercomputing to superconvergence: A new analytic approach quantifying the dispersive error for continuous finite element discretizations of the level set equation', Seminar in Partial Differential Equations.

5 **SIAM-SEAS, March 2014**, *'Dispersion and superconvergence analysis of the continuous finite element approximation of the linear transport equation'*, Topics in advanced finite elements, mini-symposium.

4 **Univ. of Tennessee, Knoxville. Jan 2014** , *(invited)*, 'Dispersion and superconvergence analysis of the continuous finite element approximation of the linear transport equation', Computational and applied mathematics seminar series.

3 **Oak Ridge Natl. Lab. Summer 2013**, *'Results towards a scalable, multiphase Navier-Stokes solver for high Reynolds number flows'*, Oak Ridge Computer Science and Mathematics Division seminar.

2 **National Inst. for Computational Sciences, Summer 2012**, *Leveraging the Intel®Xeon Phi™in Numerical CFD : Emerging Technology for Emerging Methods*, Doctoral seminar series.

1 **Texas Advanced Computing Center (TACC), Spring 2012**, *'A new class of massively parallel direction splitting for the incompressible Navier-Stokes equation'*.

Academic Service

As a Referee

2 **2019-Present**, *Brain Multiphysics*, Editor-in-Chief: Antoine Jerusalem.

1 **2012-Present**, *Computers & Mathematics with Applications*, Editor-in-Chief: Leszek Demkowicz.

In Collaborative Grant Writing

11 **High-resolution mathematical models of proteopathy: theory and software for Alzheimer's research**, *Funded; John Fell Fund, Oxford (Author)*, PI: T. Thompson.

10 **SciML - Scientific Computing & Machine Learning**, *Funded; ERC. (Co-Author)*, PI: K.-A. Mardal.

9 **Alzheimer's physics: Towards a framework for mathematical modeling of the processes leading to Alzheimer's disease**, *Funded; FRIPRO. (Co-Author)*, PI: K.-A. Mardal.

8 **DataSim - Data-driven Algorithms for Physical Simulations**, *Funded; FRIPRO. (Co-Author)*, PI: S. Funke.

7 **Conservative Fluid Finite Element: A modern, parallel, continuous Galerkin CFD solver for the Department of Defense CREATE-AV program**, *Funded; Dept. of Defense. (Co-Author)*, PI: R. Glasby, Co-PI: T. Erwin.

6 **Conservative Fluid Finite Element: Request for Information, Dept. of Defense**, *Accepted; Dept. of Defense, (Co-Author)*, PI: R. Glasby, Co-PI: T. Erwin, August 2014.

5 **Collaborative Research: Enabling next-generation, large-scale, turbulent, multi-fluid simulations - from theory to implementation and community development**, *Division of Mathematical Sciences, NSF. (Co-Author)*, PI: J.-L. Guermond, Co-PIs: A. Salgado, R.G. Brook, December 2013.

4 **Learning from CAAR: Mini-apps for emerging architectures**, *Oak Ridge National Lab JDRD (Co-Author)*, PI: R.G. Brook, November 2013.

3 **A highly scalable, high-performance BLAST for next-generation Intel Architectures**, *Funded; Intel Corporation (Co-Author)*, PI: R.G. Brook, Co-PI: B. Rekepalli, October 2013.

2 **Optimizing VisIt for next-generation architectures**, *Funded; Intel Corporation (Co-Author)*, PI: S. Ahern Co-PI: H. Childs, September 2013.

1 **Leveraging the large-scale high performance computing facilities at NICS to explore the efficacy of a novel entropy-viscosity based large eddy simulation model**, *Funded; National Institute for Computational Sciences (Co-Author)*, PI: J.-L. Guermond, Co-PI: A. Larios, August 2013.

Awards & Notoriety

Institute for Applied Mathematics and Computational Science Kaust Graduate Fellowship, *Texas A&M University, 2012.*

Excellence in Teaching, *Mathematics departmental award, Texas A&M University. 2012.*