

SPENCER H. BRYNGELSON

✉ spencer@caltech.edu  Senior Researcher, Caltech  bryngelson-research.com

RESEARCH EXPERIENCE

- California Institute of Technology** 2018–Present
Senior Postdoctoral Scholar (with Professor Tim Colonius) *Pasadena, CA*
- Created state-of-the-art models for the disperse flows central to many therapies
 - Developed MFC, a parallel and multi-phase flow solver for biophysical problems
- Massachusetts Institute of Technology** Summer 2019
Visiting Researcher (Professor Themis Sapsis) *Cambridge, MA*
- Developed low-order moment method for cavitating bubble population dynamics
 - Physics-informed recurrent neural networks predict flow statistics
- Center for Exascale Simulation of Plasma-Coupled Combustion (XPACC)** 2017–2018
Postdoctoral Researcher (Professors Carlos Pantano, Jonathan Freund, Daniel Bodony) *Urbana, IL*
- Developed novel adjoint-based sensitivity analysis for flows with shock waves
 - Orchestrated large-scale flow simulations for uncertainty quantification of multi-physics flows
- University of Illinois at Urbana–Champaign** 2013–2017
Graduate Research Fellow (Professor Jonathan Freund) *Urbana, IL*
- Developed novel stability and rheological analyses for biomicrofluidic device design
 - Discovered buckling mechanism prohibiting flow of sickled cells
- University of Michigan–Dearborn** 2012–2013
Undergraduate Research Assistant (Professor Eric Ratts) *Dearborn, MI*
- Designed pipe flow system and heat-transfer analysis of multi-phase complex fluids

TEACHING EXPERIENCE

- University of Illinois at Urbana–Champaign**
Lecturer (Teaching Fellow) *Urbana, IL*
- Fundamentals of Fluid Dynamics (Junior Level) 2015
- University of Michigan–Dearborn**
Teaching Assistant *Dearborn, MI*
- Design and Analysis of Machine Elements (Junior Level) 2013
 - Probability, Statistics, and Reliability in Design (Senior Level) 2012
 - Statics and Mechanics of Materials (Sophomore Level) 2012

EDUCATION

- University of Illinois at Urbana–Champaign**
- Doctor of Philosophy, Theoretical and Applied Mechanics (Advisor: Jonathan Freund) 2017
 - Master of Science, Theoretical and Applied Mechanics 2015
 - Graduate Degree Certificate, Computational Science and Engineering 2015
- University of Michigan–Dearborn**
- Batchelor of Science, Mechanical Engineering, *with distinction* 2013
 - Batchelor of Science, Engineering Mathematics, *with distinction* 2013

— REFEREED JOURNAL PAPERS —

1. **S. H. Bryngelson**, T. Colonius, R. O. Fox, “QBMMlib: A library of quadrature-based moment methods,” under review at *SoftwareX*, arXiv 2008.05063 (2020)
2. J.-S. Spratt, M. Rodriguez, K. Schmidmayer, **S. H. Bryngelson**, J. Yang, C. Franck, T. Colonius, “Characterizing viscoelastic materials via ensemble-based data assimilation of bubble collapse observations,” under review at *Journal of Mechanics and Physics of Solids*, arXiv 2008.04410 (2020)
3. T. Trummler, **S. H. Bryngelson**, K. Schmidmayer, S. J. Schmidt, T. Colonius, N. A. Adams, “Near-surface dynamics of a gas bubble collapsing above a crevice,” *Journal of Fluid Mechanics* **899**, A16 (2020)
4. **S. H. Bryngelson**, K. Schmidmayer, V. Coralic, K. Maeda, J. Meng, T. Colonius, “MFC: An open-source high-order multi-component, multi-phase, and multi-scale compressible flow solver,” *Computer Physics Communications*, **4655** 107398 (2020)
5. **S. H. Bryngelson**, A. Charalampopoulos, T. P. Sapsis, T. Colonius, “A Gaussian moment method and its augmentation via LSTM recurrent neural networks for the statistics of cavitating bubble populations,” *International Journal of Multiphase Flow* **127**, 103262 (2020)
6. **S. H. Bryngelson**, T. Colonius, “Simulation of humpback whale bubble-net feeding models,” *Journal of the Acoustical Society of America* **147**, 1126–1135 (2020)
7. K. Schmidmayer, **S. H. Bryngelson**, T. Colonius, “An assessment of multicomponent flow models and interface capturing schemes for spherical bubble dynamics,” *Journal of Computational Physics* **402**, 109080 (2020)
8. **S. H. Bryngelson**, K. Schmidmayer, T. Colonius, “A quantitative comparison of phase-averaged models for bubbly, cavitating flows,” *International Journal of Multiphase Flow* **115**, 137–143 (2019)
9. **S. H. Bryngelson**, F. Guéniat, J. B. Freund, “Irregular dynamics of cellular blood flow in a model microvessel,” *Physical Review E* **100**, 012203 (2019)
10. **S. H. Bryngelson**, J. B. Freund, “Non-modal Floquet stability of capsules in large-amplitude oscillatory extensional flow,” *European Journal of Mechanics B* **77**, 171–176 (2019)
11. **S. H. Bryngelson**, J. B. Freund, “Global stability of flowing red blood cell trains,” *Physical Review Fluids* **3**, 073101 (2018)
12. **S. H. Bryngelson**, J. B. Freund, “Floquet stability analysis of capsules in viscous shear flow,” *Journal of Fluid Mechanics* **852**, 663–677 (2018)
13. **S. H. Bryngelson**, J. B. Freund, “Capsule-train stability,” *Physical Review Fluids* **1**, 033201 (2016)
14. **S. H. Bryngelson**, J. B. Freund, “Buckling and its effect on the confined flow of a model capsule suspension,” *Rheologica Acta* **55**, 451–464 (2016)

— REFEREED CONFERENCE PAPERS (+ TALKS) —

1. **S. H. Bryngelson**, T. Colonius, “Closure of phase-averaged bubbly, cavitating flow models,” *XXV International Conference of Theoretical and Applied Mechanics*, Milano, Italy (2021)
2. M. Rodriguez, **S. H. Bryngelson**, S. Cao, T. Colonius, “A unified Eulerian multiphase framework for fluid-structure interaction problems including cavitation,” *XXV International Conference of Theoretical and Applied Mechanics*, Milano, Italy (2021)
3. **S. H. Bryngelson**, R. O. Fox, T. Colonius, “Conditional moment method for fully-coupled phase-averaged cavitation models,” *11th International Symposium on Cavitation*, Daejeon, Korea (2021)

4. M. Rodriguez, **S. H. Bryngelson**, S. Cao, T. Colonius, “Acoustically-induced bubble growth and phase change dynamics near compliant surfaces,” *11th International Symposium on Cavitation*, Daejeon, Korea (2021)
5. J.-S. Spratt, M. Rodriguez, **S. H. Bryngelson**, S. Cao, T. Colonius, “Eulerian framework for bubble–cloud–kidney stone interaction,” *11th International Symposium on Cavitation*, Daejeon, Korea (2021)
6. **S. H. Bryngelson**, A. Charalampopoulos, T. P. Sapsis, T. Colonius, “Averaging methods for cavitating bubbly flows,” *33rd Symposium of Naval Hydrodynamics*, Osaka, Japan (2020)
7. **S. H. Bryngelson**, T. Colonius, “A comparison of ensemble- and volume-averaged bubbly flow models,” *10th International Conference of Multiphase Flow*, Rio de Janeiro, Brazil (2019)
8. **S. H. Bryngelson**, J. B. Freund, “Buckling and the rheology of an elastic capsule suspension,” *XXIV International Conference of Theoretical and Applied Mechanics*, Montreal, Canada (2016)
9. J. B. Freund, **S. H. Bryngelson**, “The stability of flowing trains of confined red blood cells,” *XXIV International Conference of Theoretical and Applied Mechanics*, Montreal, Canada (2016)

— OTHER PUBLICATIONS —

1. **S. H. Bryngelson**, C. Pantano, D. Bodoney, J. B. Freund, “Adjoint-based sensitivity for flows with shocks,” *XPACC Technical Report* (2018)
2. **S. H. Bryngelson**, “Stability and transition of capsule-flow systems,” *Ph.D. Dissertation*, University of Illinois at Urbana–Champaign (2017)

PRESENTATIONS

— CONFERENCE TALKS/ABSTRACTS —

1. **S. H. Bryngelson**, T. Colonius, “A fast-integration-based model for polydisperse bubble cloud dynamics and their two-way-flow coupling,” *Journal of the Acoustical Society of America* (2021)
2. **S. H. Bryngelson**, R. O. Fox, T. Colonius, “Conditioned quadrature moment methods for cavitating bubble dispersions,” *Bulletin of the American Physical Society* (2020)
3. J.-S. Spratt, M. Rodriguez, **S. H. Bryngelson**, T. Colonius “A fully Eulerian simulation framework for cavitating bubble-clouds near viscoelastic materials,” *Bulletin of the American Physical Society* (2020)
4. M. Rodriguez, **S. H. Bryngelson**, T. Colonius “Cavitation bubble growth with phase transition near a rigid wall,” *Bulletin of the American Physical Society* (2020)
5. **S. H. Bryngelson**, T. Colonius, “Annular and spiral bubble nets: A simulation-focused analysis of humpback whale feeding strategies,” *Journal of the Acoustical Society of America* **146**, 4, 2771 (2019)
6. **S. H. Bryngelson**, A. Charalampopoulos, T. P. Sapsis, T. Colonius, “Neural-network-augmented Gaussian moment method for the statistics of cavitating bubble populations,” *Bulletin of the American Physical Society* (2019)
7. T. Trummler, K. Schmidmayer, **S. H. Bryngelson**, T. Colonius, “Simulations of a collapsing gas bubble above a crevice,” *SoCal Fluids XIII* (2019)
8. **S. H. Bryngelson**, T. Colonius, “Simulations and acoustics of humpback whale bubble-net feeding,” *SoCal Fluids XIII* (2019)
9. **S. H. Bryngelson**, T. Colonius, “Modeling approaches for bubbly, cavitating flows,” *Bulletin of the American Physical Society* (2018)

10. **S. H. Bryngelson**, J. B. Freund, “Floquet stability of tank-treading and tumbling capsules in viscous shear flow,” *Bulletin of the American Physical Society* (2017)
11. **S. H. Bryngelson**, J. B. Freund, “Stability of flowing red blood cell trains,” *Blood Flow*, Paris, France (2017)
12. **S. H. Bryngelson**, J. B. Freund, “Global stability of fully coupled capsule flow systems,” *SIAM Computational Science and Engineering* (2017)
13. **S. H. Bryngelson**, J. B. Freund, “Stability and transition to chaos of regular capsule trains,” *Bulletin of the American Physical Society* (2016)
14. **S. H. Bryngelson**, J. B. Freund, “Buckling and its effect on the confined flow of a capsule suspension,” *Bulletin of the American Physical Society* (2015)

— INVITED TALKS —

1. Georgia Institute of Technology, Computational Science & Engineering Seminar Series (2020)
2. University of Washington, Mechanical Engineering Seminar Series (2019)
3. University of Michigan–Ann Arbor, Mechanical Engineering Seminar Series (2019)
4. Massachusetts Institute of Technology, Mechanical Engineering (2019)
5. University of Vermont, Mechanical Engineering Seminar Series (2019)
6. University of Utah, Mechanical Engineering Seminar Series (2019)
7. University of Michigan–Dearborn, Mechanical Engineering Seminar Series (2019)
8. California Institute of Technology, Fluid Mechanics Research Conference (2018)
9. California Institute of Technology, Computational Flow Physics Group (2018)
10. ETH Zürich, Computational Science & Engineering Lab (2017)
11. University of Illinois at Urbana–Champaign, Fluid Mechanics Seminar (2017)
12. University of Illinois at Urbana–Champaign, Biology Interest Group (2015)

STUDENTS

• Jean-Sebastien Spratt	Caltech	Ph.D., exp. 2022
• Alexis Charalampopoulos	MIT	Ph.D., exp. 2021
• Ben Stevens	Caltech	Ph.D., exp. 2021
• Esteban Cisneros	University of Illinois	Ph.D., exp. 2020
• Dr. David Mittelstein	USC/Caltech	Ph.D., 2020
• Dr. Theresa Trummler	TU Munich	Ph.D., 2020
• Franz O’Meally	Johns Hopkins	B.S., 2020
• Dr. Mauro Rodriguez	Caltech	Ph.D., 2019

AWARDS

• Stanley Weiss Outstanding Dissertation Award	University of Illinois	2017
• Hassan Aref Award (research in fluid mechanics)	University of Illinois	2016
• Alumni Teaching Fellowship	University of Illinois	2015
• Dean’s List	University of Michigan	2010–2013
• Pi Tau Sigma (honor society, member)	University of Michigan	2011

GRANTS

— FUNDED GRANTS —

- Co-PI: XSEDE CTS120005 \$135K dollar valuation, 9M CPU Hours

— PROJECTS SUPPORTED —

- ONR MURI N0014-17-1-2676 with T. Colonius
- ONR BRC N0014-17-1-2625 with T. Colonius
- NIH 2P01-DK04881 with T. Colonius
- DOE PSAAP DE-NA0002374 with J. B. Freund, W. Gropp, C. Pantano, D. Bodony
- NSF CBET 13-36972 with J. B. Freund

SOFTWARE DEVELOPED

QBMLib: Library of Quadrature-based Moment Methods

with R. O. Fox, T. Colonius

github.com/sbryngelson/QBMLib

- Automatic, symbolic computation of moment transport equation (via PBE) for given dynamics
- Several QMOM-based methods (e.g. CQMOM, CHyQMOM)
- Concise solution procedure (just 13 lines of code required)

MFC: Multi-Component Flow Code

with M. Rodriguez, J. Spratt, K. Maeda, V. Coralic, J. Meng, T. Colonius

mfc-caltech.github.io

- Multi-phase flow solver
- Sub-grid particle models
- Material interface sharpening
- MPI support, parallel I/O
- High-order interface capturing
- Characteristic-based boundary conditions

ECOGEN: Evolutive, Compressible, Open-Source, Genuine, Easy, N-phase Flow Solver

with K. Schmidmayer, M. Rodriguez, E. Daniel, F. Petitpas

code-mphi.github.io/ECOGEN

- Multi-physics compressible solver
- Unstructured meshes
- Non-oscillatory diffuse interface method
- Adaptive mesh refinement with load balancing

PlascomCM and Plascom2: Multi-Physics Turbulent Flows

with E. Cisneros, M. Campbell, D. Buchta, J. Freund

xpacc-dev.bitbucket.io/PlasCom2

- Parallel Navier–Stokes solver
- Supports fluid-structure interaction
- Strong-shock capturing
- Large-eddy turbulence models
- Chemical reactions via Cantera
- Unstructured grids

RBC3D: Spectral Boundary Integral Flow Solver

with H. Zhao, J. Freund

- Solver for flexible objects and surfaces
- Supports capsules, cells, and droplets
- Spectral accuracy (spherical harmonics)
- Weak formulation for boundary conditions

IMR: Inertial Microcavitation Rheometry

with J. Spratt, J. Yang, C. Franck

- Computes high strain-rate viscoelastic properties of soft materials
- Data assimilation correlates flow field to material kinematics
- Image processing for analyzing experimental images