

CURRICULUM VITAE: ROBERT I. SAYE

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Education

University of California, Berkeley 2008–2013
Ph. D. Applied Mathematics
Advisor: James A. Sethian
Thesis: *The Voronoi Implicit Interface Method with Applications to Multiphase Fluid Flow and Multiscale Modelling of Foam Dynamics*

The Australian National University (ANU) 2004–2007
Bachelor of Philosophy (Honours) with First Class Honours
Specialising in applied mathematics and computational science
Advisor: Stephen Roberts

Positions

Lawrence Berkeley National Laboratory, *Research Scientist* 2017–present
Lawrence Berkeley National Laboratory, *Luis W. Alvarez Postdoctoral Fellow* 2013–2017
University of California, Berkeley, *Graduate Student Researcher* 2008–2013
Commonwealth Scientific and Industrial Research Organisation (CSIRO), Melbourne, Australia, 2008
Full-time research scientist

Editorial Roles

Co-Chief Editor, [Communications in Applied Mathematics and Computational Science](#) 2023–present

Fellowships and Awards

U.S. Department of Energy Early Career Research Program Awardee 2021–2026
Luis W. Alvarez Postdoctoral Fellowship 2013–2017
International Science & Engineering Visualization Challenge, Science and NSF 2014
Honorable Mention for poster *The Life Cycle of a Bubble Cluster*

Bernard Friedman Memorial Prize in Applied Mathematics, UC Berkeley 2013
Cozzarelli Prize, *Proceedings of the National Academy of Sciences* 2011
Sir Keith Murdoch Fellowship, American Australian Association 2011–2012
University Medal in Mathematics, ANU 2007
Boyapati Computer Science and Mathematics Honours Scholarship, ANU 2007
Boyapati Computer Science and Mathematics Award, ANU 2006
Hanna Neumann Prize for Mathematics, ANU 2006
Bachelor of Philosophy Undergraduate Scholarship, ANU 2004–2006

Research Interests

Broadly: interface dynamics, multi-physics, high-order numerics, high performance computing

Specifically: high-order accurate algorithms for implicit interface methods; high-order implicit mesh discontinuous Galerkin methods; multi-phase multi-physics in extremely complex geometry; high performance computing methods, massively parallel simulation, multigrid algorithms; level set methods; high-order quadrature algorithms

Published Articles

- Robert I. Saye, *A connected component labeling algorithm for implicitly defined domains*, Communications in Applied Mathematics and Computational Science, **18**(1), 29–54 (2023), [10.2140/camcos.2023.18.29](https://doi.org/10.2140/camcos.2023.18.29)
- Robert I. Saye, James A. Sethian, Brandon Petrouskie, Aaron Zatorsky, Xinyu Lu, and Reza Rock, *Insights from high-fidelity modeling of industrial rotary bell atomization*, Proceedings of the National Academy of Sciences, **120**(4), e2216709120 (2023), [doi:10.1073/pnas.2216709120](https://doi.org/10.1073/pnas.2216709120)
- V. Gulizzi and R. Saye, *Modeling wave propagation in elastic solids via high-order accurate implicit-mesh discontinuous Galerkin methods*, Computer Methods in Applied Mechanics and Engineering, **395**, 114971 (2022), [doi:10.1016/j.cma.2022.114971](https://doi.org/10.1016/j.cma.2022.114971)
- R. I. Saye, *High-order quadrature on multi-component domains implicitly defined by multivariate polynomials*, Journal of Computational Physics, **448**, 110720 (2022), [doi:10.1016/j.jcp.2021.110720](https://doi.org/10.1016/j.jcp.2021.110720)
- R. I. Saye, *Fast multigrid solution of high-order accurate multiphase Stokes problems*, Communications in Applied Mathematics and Computational Science, **15**(2), 147–196 (2020), [doi:10.2140/camcos.2020.15.33](https://doi.org/10.2140/camcos.2020.15.33)
- R. Saye, *Efficient Multigrid Solution of Elliptic Interface Problems using Viscosity-Upwinded Local Discontinuous Galerkin Methods*, Communications in Applied Mathematics and Computational Science, **14**(2), 247–283 (2019), [doi:10.2140/camcos.2019.14.247](https://doi.org/10.2140/camcos.2019.14.247)
- D. Fortunato, C. H. Rycroft, and R. Saye, *Efficient Operator-Coarsening Multigrid Schemes for Local Discontinuous Galerkin Methods*, SIAM Journal on Scientific Computing, **41**(6), A3913–A3937 (2019), [doi:10.1137/18M1206357](https://doi.org/10.1137/18M1206357); Winner, best student paper prize, 2019 Copper Mountain Conference on Iterative Methods
- M. L. Minion and R. I. Saye, *Higher-order temporal integration for the incompressible Navier–Stokes equations in bounded domains*, Journal of Computational Physics, **375**, 797–822 (2018), [doi:10.1016/j.jcp.2018.08.054](https://doi.org/10.1016/j.jcp.2018.08.054)
- R. Saye, *Implicit mesh discontinuous Galerkin methods and interfacial gauge methods for high-order accurate interface dynamics, with applications to surface tension dynamics, rigid body fluid-structure interaction, and free surface flow*, Journal of Computational Physics
 - Part I, **344**, 647–682 (2017) [doi:10.1016/j.jcp.2017.04.076](https://doi.org/10.1016/j.jcp.2017.04.076)
 - Part II, **344**, 683–723 (2017) [doi:10.1016/j.jcp.2017.05.003](https://doi.org/10.1016/j.jcp.2017.05.003)
- R. Saye, *Interfacial gauge methods for incompressible fluid flow*, **Science Advances**, **2**(6), 1–14 (2016) [doi:10.1126/sciadv.1501869](https://doi.org/10.1126/sciadv.1501869)
- R. I. Saye and J. A. Sethian, *Multiscale modelling of evolving foams*, Journal of Computational Physics, **315**, 273–301 (2016) [doi:10.1016/j.jcp.2016.02.077](https://doi.org/10.1016/j.jcp.2016.02.077)
- R. I. Saye, *High-Order Quadrature Methods for Implicitly Defined Surfaces and Volumes in Hyperrectangles*, SIAM Journal on Scientific Computing, **37**(2), A993–A1019 (2015) [doi:10.1137/140966290](https://doi.org/10.1137/140966290)
- R. I. Saye and J. A. Sethian, *The Life Cycle of a Bubble Cluster: Insight from Mathematics, Algorithms, and Supercomputers – 2013 NSF and Science journal International Science and Engineering Visualization Challenge*, **Science**, **343**(6171), 600–610 (2014) [doi:10.1126/science.343.6171.600](https://doi.org/10.1126/science.343.6171.600)
- R. I. Saye, *High-order methods for computing distances to implicitly defined surfaces*, Communications in Applied Mathematics and Computational Science, **9**(1), 107–141 (2014) [doi:10.2140/camcos.2014.9.107](https://doi.org/10.2140/camcos.2014.9.107)
- R. I. Saye and J. A. Sethian, *Multiscale Modeling of Membrane Rearrangement, Drainage, and Rupture in Evolving Foams*, **Science**, **340**(6133), 720–724 (2013) [doi:10.1126/science.1230623](https://doi.org/10.1126/science.1230623)

- R. I. Saye, *An algorithm to mesh interconnected surfaces via the Voronoi interface*, Engineering with Computers, **31**(1), 123–139 (2013) doi:[10.1007/s00366-013-0335-9](https://doi.org/10.1007/s00366-013-0335-9)
- R. I. Saye and J. A. Sethian, *Analysis and applications of the Voronoi Implicit Interface Method*, Journal of Computational Physics, **231**(18), 6051–6085 (2012) doi:[10.1016/j.jcp.2012.04.004](https://doi.org/10.1016/j.jcp.2012.04.004)
- R. I. Saye and J. A. Sethian, *The Voronoi Implicit Interface Method and Computational Challenges in Multiphase Physics*, Milan Journal of Mathematics, **80**(2), 369–379 (2012) doi:[10.1007/s00032-012-0187-6](https://doi.org/10.1007/s00032-012-0187-6)
- R. I. Saye and J. A. Sethian, *The Voronoi Implicit Interface Method for computing multiphase physics*, Proceedings of the National Academy of Sciences, **108**(49), 19498–19503 (2011) doi:[10.1073/pnas.1111557108](https://doi.org/10.1073/pnas.1111557108)
- R. I. Saye, *A Navier-Stokes Teaching Module* (online); a tutorial on the numerical solution of the incompressible Navier-Stokes equations (2006)

Book Chapters

- M. Garzon, R. I. Saye, and J. A. Sethian, *Efficient Algorithms for Tracking Moving Interfaces in Industrial Applications: Inkjet Plotters, Electrojetting, Industrial Foams, and Rotary Bell Painting*, in Chacón Rebollo, T., Donat, R., Higuera, I. (eds), Recent Advances in Industrial and Applied Mathematics, **1**, 173–194 (2022), doi:[10.1007/978-3-030-86236-7_10](https://doi.org/10.1007/978-3-030-86236-7_10)
- R. I. Saye and J. A. Sethian, *A review of level set methods to model interfaces moving under complex physics: Recent challenges and advances*, in A. Bonito and R. H. Nochetto (eds.), Geometric Partial Differential Equations - Part I, Handbook of Numerical Analysis, **21**, 509–554 (2020), doi:[10.1016/bs.hna.2019.07.003](https://doi.org/10.1016/bs.hna.2019.07.003)

In Proceedings

- R. I. Saye and J. A. Sethian, *New Interface Methods for Tracking Multiphase Physics*, in F. Ancona, A. Bressan, P. Marcati, A. Marson (eds.) Hyperbolic Problems: Theory, Numerics, Applications. Proceedings of the 14th International Conference on Hyperbolic Problems (Padova, 2012). AIMS Series on Applied Mathematics **8**, 81–87 (2014)
- R. I. Saye and J. A. Sethian, *Voronoi Implicit Interfaces: Method and Applications*, in C. M. Elliott, Y. Giga, M. Hinze, V. Styles (eds.) Interfaces and Free Boundaries: Analysis, Control and Simulation. Oberwolfach Reports **10**(1), 867–950 (2013) doi:[10.4171/OWR/2013/15](https://doi.org/10.4171/OWR/2013/15)
- R. I. Saye and J. A. Sethian, *Applications of the Voronoi Implicit Interface Method*, in M. Hintermüller, G. Leugering, J. Sokolowski (eds.) Mini-Workshop: Geometries, Shapes and Topologies in PDE-based Applications. Oberwolfach Reports **9**(4), 3375–3415 (2012) doi:[10.4171/OWR/2012/57](https://doi.org/10.4171/OWR/2012/57)

Published Articles (Misc.)

- R. Saye, *On two conjectures concerning the ternary digits of powers of two*, Journal of Integer Sequences, **25**(3), 1–9 (2022), arXiv:[10.48550/arXiv.2202.13256](https://arxiv.org/abs/10.48550/arXiv.2202.13256)

Submitted Articles

- Luke P. Corcos, Robert I. Saye, James A. Sethian, *A hybrid finite difference level set–implicit mesh discontinuous Galerkin method for multi-layer coating flows*, J. Comp. Phys, submitted August 2023.

Open-Source Software

- *Algoim – Algorithms for implicitly defined geometry, level set methods, and Voronoi implicit interface methods*, C++ code, <https://algoim.github.io>

Research Grants

Principal Investigator – U.S. Department of Energy Early Career Research Program,
Advanced Numerics for Atomization and Multi-Physics Interface Dynamics

2021–2026

Principal Investigator – High Performance Computing for Manufacturing, US Dept. of Energy, <i>Modeling Coating Flow and Dynamics during Drying</i> , with PPG Industries, Inc.	2020–2022
Principal Investigator – High Performance Computing for Manufacturing, US Dept. of Energy, <i>Optimizing Rotary Bell Atomization</i> , with PPG Industries, Inc.	2018–2019
Principal Investigator – High Performance Computing for Manufacturing, US Dept. of Energy, <i>Modeling Paint Behavior During Rotary Bell Atomization</i> , with PPG Industries, Inc.	2017–2018
Principal Investigator – Laboratory Directed Research and Development (LDRD) program, LBNL <i>High-Order Implicit Interface Methods for Complex Fluid Flow and Multiple Interface Dynamics</i>	2013–2015

Selected News Articles

New Math Captures Fluids in Unprecedented Detail , Advanced Scientific Computing Research, U.S. Department of Energy Office of Science	26 Aug 2016
New Mathematics Accurately Captures Liquids and Surfaces Moving in Synergy , LBL Newscenter	10 Jun 2016
wyborcza Nauka dla każdego (“Science for everyone”), a Polish newspaper	16 Jun 2015
2013 Visualization Challenge , <i>Science</i> , 343 (6171) (2014) doi:10.1126/science.343.6171.600	7 Feb 2014
Computing Sciences Supported Research Named Among 2013’s Best , Berkeley Lab CS News	20 Dec 2013
Our favourite pictures of 2013 , IOP Physics World	18 Dec 2013
Multiscale Modeling of Foams , SIAM News	1 Nov 2013
Media releases relating to my Science paper co-authored with J.A.Sethian:	May 2013
Revealed! The Mysteries of Bubbles – and Clouds Too , Time.com	
When one bubble pops, why do others form around it? Unlocking a bubble mystery , The Washington Post	
Physics Get Frothy as Mathematicians Dissect Mister Bubble , Scientific American	
Pinning down the physics of bubbles , Los Angeles Times	
Heady mathematics: Describing popping bubbles in a foam , Berkeley Newscenter	
Mathematics of Popping Bubbles in a Foam , LBL Newscenter	
ScienceShot: The Life Cycle of a Bubble , Science AAAS	
Can’t Pop This: Bubble Scientists Reveal the Physics of Soap , KQED Science	
Unlocking secret lives of bubbles yields perfect foam , NewScientist	
Working Up a Lather , AMS Mathematical Moments	
Geplatzte Schäume , Wissen & Forschen, page 24, Der Tagesspiegel	
Berkeley Lab Mathematicians Win Cozzarelli Prize , LBL Newscenter	21 Feb 2012

Professional Activities

Journal reviewer: Proceedings of the National Academy of Sciences, Nature Communications, SIAM Journal on Scientific Computing, Journal of Computational Physics, Nature Computational Science, Proceedings A, Communications in Applied Mathematics and Computational Science, International Journal of Multiphase Flow, Computers and Mathematics with Applications, Pure and Applied Analysis, International Journal of High Performance Computing Applications, Computer Methods in Applied Mechanics and Engineering, Computational and Applied Mathematics, Computer Physics Communications, Transactions on Graphics, Eurographics	
Co-Chief Editor, Communications in Applied Mathematics and Computational Science	2023–present
American Australian Association (AAA) Fellowship application judge	2016–present
Member of the Society for Industrial and Applied Mathematics	2008–present