

# CURRICULUM VITAE: ROBERT I. SAYE

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Lawrence Berkeley National Laboratory  
1 Cyclotron Road  
Mailstop 50A-1148  
Berkeley, CA 94720

Tel.: 510-486-5296

rsaye@lbl.gov

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## Education

University of California, Berkeley Ph. D. Applied Mathematics Advisor: James A. Sethian Thesis: <i>The Voronoi Implicit Interface Method with Applications to Multiphase Fluid Flow and Multiscale Modelling of Foam Dynamics</i>	2008–2013
The Australian National University (ANU) Bachelor of Philosophy (Honours) with First Class Honours Specialising in applied mathematics and computational science Advisor: Stephen Roberts	2004–2007

## Positions

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

## Fellowships and Awards

Luis W. Alvarez Postdoctoral Fellowship	2013–2017
International Science & Engineering Visualization Challenge, Science and NSF Honorable Mention for poster <i>The Life Cycle of a Bubble Cluster</i>	2014
Bernard Friedman Memorial Prize in Applied Mathematics, UC Berkeley	2013
Cozzarelli Prize, <i>Proceedings of the National Academy of Sciences</i>	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: evolving interface problems, multi-physics, numerical methods, high performance computing  
Specifically: high-order accurate algorithms for implicit interface methods; implicit mesh discontinuous Galerkin methods; computational fluid dynamics, fluid-structure interaction, surface physics; high performance computing methods, massively parallel simulation, multigrid algorithms; level set methods

## Published Articles

- 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)
- 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

- 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
- 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

## 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 – 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
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 – 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 Coating Flow and Dynamics during Drying</i> , with PPG Industries, Inc.	2020–2022

## News Articles

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

[Berkeley Lab Mathematicians Win Cozzarelli Prize](#), LBL Newscenter

21 Feb 2012

### **Professional Activities**

Journal reviewer: Journal of Computational Physics, SIAM Journal on Scientific Computing, Proceedings A, Communications in Applied Mathematics and Computational Science, Pure and Applied Analysis, International Journal of High Performance Computing Applications, Computer Physics Communications, Transactions on Graphics, Eurographics

American Australian Association (AAA) Fellowship application judge 2016–present

Member of the Society for Industrial and Applied Mathematics 2008–present