

# Michael S. Dodd

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## Education

- 2011–2017 **Ph.D.**, *University of Washington*, Aeronautics & Astronautics, Seattle, WA.  
Dissertation: *Direct numerical simulation of droplet-laden isotropic turbulence*  
Supervisor: Antonino Ferrante
- 2005–2009 **B.S.**, *University of Michigan*, Aerospace Engineering, Ann Arbor, MI.

## Research Experience

- 2017–present **Postdoctoral Research Fellow**, *Stanford University*, Center for Turbulence Research, Stanford, CA.
- Current project: Developing high-order, discontinuous Galerkin methods for compressible two-phase flows
  - Investigated droplet and bubble breakup in turbulent flows
  - Analyzed flow topology in droplet-laden isotropic turbulence
- 2012–2017 **Graduate Research Assistant**, *University of Washington*, Department of Aeronautics and Astronautics, Seattle, WA.
- Computational Fluid Mechanics group led by Prof. Antonino Ferrante
- Developed numerical methods for the solution of the incompressible Navier-Stokes equations for two-fluid flows
  - Performed direct numerical simulation of droplet-laden isotropic turbulence
  - Increased fundamental understanding of droplet-turbulence interaction
  - Developed a coupled volume-of-fluid and low-Mach-number approach to simulate gas-liquid flows with phase change

## Honors and Awards

- 2017 Postdoctoral Fellowship, Center for Turbulence Research, Stanford University
- 2016 ICTAM U.S. Early Career Travel Fellowship, National Academy of Sciences
- 2015, 2016 Nominated for UW College of Engineering Award for Student Research
- 2015 Selected to attend the 65th Annual Lindau Nobel Laureate Meeting
- 2014 Graduate School Fund for Excellence and Innovation Travel Award
- 2014 Marsh Fellowship, University of Washington College of Engineering
- 2013 Egtvedt Fellowship, University of Washington College of Engineering
- 2011 Paul A. Carlstedt Endowed Fellowship in Aeronautics and Astronautics

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## Journal Publications

- [3] **Dodd, M. S.** and Ferrante, A. “On the interaction of Taylor lengthscale size droplets and isotropic turbulence”. *Journal of Fluid Mechanics* 806, pp. 356–412 (2016). \*Selected to be the subject of *Focus on Fluids* (Maxey, M. R., *J. Fluid Mech.*, vol. 816, 2017, pp. 1–4).
- [2] **Dodd, M. S.** and Ferrante, A. “A fast pressure-correction method for incompressible two-fluid flows”. *Journal of Computational Physics* 273, pp. 416–434 (2014).
- [1] Baraldi, A., **Dodd, M. S.**, and Ferrante, A. “A mass-conserving volume-of-fluid method: Volume tracking and droplet surface-tension in incompressible isotropic turbulence”. *Computers & Fluids* 96, pp. 322–337 (2014).

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## Submitted

- [2] Rosti, M. E., Ge, Z., Jain, S. S., **Dodd, M. S.**, and Brandt, L. “Droplets in homogeneous shear turbulence” (submitted).
- [1] **Dodd, M. S.** and Jofre, L. “Small-scale flow topologies in decaying isotropic turbulence laden with finite-size droplets” (submitted).

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## Conference Papers

- [4] Adams, D. K., **Dodd, M. S.**, and Ferrante, A. “PSH3D: A petascale solver of the Helmholtz equation in 3D”. *27th International Conference on Parallel Computational Fluid Dynamics*, Montreal, Canada (2015).
- [3] **Dodd, M. S.** and Ferrante, A. “A coupled pressure-correction/volume of fluid method for DNS of droplet-laden turbulent flows”. *8th International Conference on Multiphase Flow*, Jeju, Korea (2013).
- [2] **Dodd, M. S.** and Ferrante, A. “Direct numerical simulation of particle dispersion in a spatially developing turbulent boundary layer”. *8th International Conference on Multiphase Flow*, Jeju, Korea (2013).
- [1] **Dodd, M. S.**, Webster, K., and Ferrante, A. “Direct numerical simulation of particle dispersion in a spatially developing turbulent boundary layer”. *7th International Conference on Computational Fluid Dynamics*, Big Island, HI (2012).

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## Non-archival Publications

- [7] **Dodd, M. S.** and Jofre, L. “Tensor-based analysis of the flow topology in droplet-laden homogeneous isotropic turbulence”. *Center for Turbulence Research Annual Research Briefs*, pp. 35–45 (2018).
- [6] Chan, W. H. R., **Dodd, M. S.**, Johnson, P. L., Urzay, J., and Moin, P. “Formation and dynamics of bubbles in breaking waves: Part I. Algorithms for the identification of bubbles and breakup/coalescence events”. *Center for Turbulence Research Annual Research Briefs*, pp. 3–20 (2018).
- [5] Chan, W. H. R., **Dodd, M. S.**, Johnson, P. L., Urzay, J., and Moin, P. “Formation and dynamics of bubbles in breaking waves: Part II. The evolution of the bubble size distribution and breakup/coalescence statistics”. *Center for Turbulence Research Annual Research Briefs*, pp. 21–34 (2018).
- [4] Paul, I. and **Dodd, M. S.** “Fine-scale turbulent invariants in a rising bubbly flow”. *Center for Turbulence Research Annual Research Briefs*, pp. 65–77 (2018).
- [3] Lai, C. C. K., Fraga, B., Chan, R., and **Dodd, M. S.** “Energy cascade in a homogeneous swarm of bubbles”. *Center for Turbulence Research Proceedings of the Summer Program*, pp. 55–64 (2018).
- [2] Rosti, M. E., Ge, Z., Jain, S. S., **Dodd, M. S.**, and Brandt, L. “Emulsions in homogeneous shear turbulence”. *Center for Turbulence Research Proceedings of the Summer Program*, pp. 65–74 (2018).
- [1] Mirjalili, S, Jain, S. S., and **Dodd, M. S.** “Interface-capturing methods for two-phase flows: An overview and recent developments”. *Center for Turbulence Research Annual Research Briefs*, pp. 117–135 (2017).

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## Conference Proceedings

- [23] Ferrante, A. and **Dodd, M.** “Towards a mass-conserving volume-of-fluid method for incompressible gas-liquid flows with phase change”. *71st Annual Meeting of the APS Division of Fluid Dynamics*, Atlanta, GA (2018).
- [22] **Dodd, M.** and Jofre, L. “Local flow topology in droplet-laden homogeneous isotropic turbulence”. *71st Annual Meeting of the APS Division of Fluid Dynamics*, Atlanta, GA (2018).
- [21] Rosti, M. E., Ge, Z., Suresh, S., **Dodd, M.**, and Brandt, L. “Droplets and bubbles in homogeneous shear turbulence”. *71st Annual Meeting of the APS Division of Fluid Dynamics*, Atlanta, GA (2018).
- [20] Fraga, B., Lai, C., Chan, R., and **Dodd, M.** “Energy cascade in a homogeneous swarm of bubbles rising in a vertical channel”. *71st Annual Meeting of the APS Division of Fluid Dynamics*, Atlanta, GA (2018).
- [19] Chan, W. H. R., **Dodd, M.**, Johnson, P., Urzay, J., and Moin, P. “Formation and dynamics of bubbles generated by turbulent breaking waves”. *71st Annual Meeting of the APS Division of Fluid Dynamics*, Atlanta, GA (2018).

- [18] **Dodd, M.** and Ferrante, A. “A combined volume-of-fluid method and low-Mach-number approach for DNS of evaporating droplets in turbulence”. *70th Annual Meeting of the APS Division of Fluid Dynamics*, Denver, CO (2017).
- [17] Ferrante, A. and **Dodd, M.** “Effects of droplet size on droplet evaporation rate in isotropic turbulence”. *70th Annual Meeting of the APS Division of Fluid Dynamics*, Denver, CO (2017).
- [16] Adams, D. K., **Dodd, M. S.**, and Ferrante, A. “PSH3D fast Poisson solver for petascale DNS”. *69th Annual Meeting of the APS Division of Fluid Dynamics*, Portland, OR (2016).
- [15] **Dodd, M. S.** and Ferrante, A. “On the effects of isotropic turbulence on the evaporation rate of a liquid droplet”. *69th Annual Meeting of the APS Division of Fluid Dynamics*, Portland, OR (2016).
- [14] Ferrante, A. and **Dodd, M. S.** “On the effects of density ratio on droplet-laden isotropic turbulence”. *69th Annual Meeting of the APS Division of Fluid Dynamics*, Portland, OR (2016).
- [13] **Dodd, M. S.** and Ferrante, A. “Effects of viscosity ratio on droplet-laden isotropic turbulence”. *24th International Congress of Theoretical and Applied Mechanics*, Montreal, Canada (2016).
- [12] Adams, D. K., **Dodd, M. S.**, and Ferrante, A. “Petascale DNS using the fast Poisson solver PSH3D”. *24th International Congress of Theoretical and Applied Mechanics*, Montreal, Canada (2016).
- [11] **Dodd, M. S.** and Ferrante, A. “DNS of evaporating droplets in decaying isotropic turbulence”. *9th International Conference on Multiphase Flow*, Firenze, Italy (2016).
- [10] **Dodd, M. S.**, Aleem, M., and Ferrante, A. “Interaction of Taylor lengthscale size droplets and isotropic turbulence”. *68th Annual Meeting of the APS Division of Fluid Dynamics, Gallery of Fluid Motion*, Boston, MA (2015).
- [9] **Dodd, M. S.** and Ferrante, A. “Modulation of isotropic turbulence by deformable droplets of Taylor lengthscale size”. *67th Annual Meeting of the APS Division of Fluid Dynamics*, San Francisco, CA (2014).
- [8] **Dodd, M. S.** and Ferrante, A. “A fast pressure-correction method for two-fluid flows”. *2nd International Conference on Numerical Methods in Multiphase Flows*, Darmstadt, Germany (2014).
- [7] **Dodd, M. S.** and Ferrante, A. “Effects of gravity on particle dispersion in a spatially developing turbulent boundary layer”. *17th U.S. National Congress on Theoretical & Applied Mechanics*, East Lansing, MI (2014).
- [6] **Dodd, M. S.** and Ferrante, A. “Modulation of isotropic turbulence by deformable droplets of Taylor length-scale size”. *17th U.S. National Congress on Theoretical & Applied Mechanics*, East Lansing, MI (2014).

- [5] **Dodd, M. S.** and Ferrante, A. “An efficient pressure-correction method for incompressible multifluid flows”. *66th Annual Meeting of the APS Division of Fluid Dynamics*, Pittsburgh, PA (2013).
- [4] Ferrante, A. and **Dodd, M. S.** “DNS of fully-resolved droplet-laden decaying isotropic turbulence”. *66th Annual Meeting of the APS Division of Fluid Dynamics*, Pittsburgh, PA (2013).
- [3] Ferrante, A. and **Dodd, M. S.** “Direct numerical simulation of particle dispersion in a spatially developing turbulent boundary layer”. *45th Annual American Geophysical Union Fall Meeting*, San Francisco, CA (2012).
- [2] **Dodd, M. S.**, Webster, K., and Ferrante, A. “DNS of particle dispersion in a spatially developing turbulent boundary layer”. *65th Annual Meeting of the APS Division of Fluid Dynamics*, San Diego, CA (2012).
- [1] Ferrante, A. and **Dodd, M. S.** “A mass-conserving volume of fluid method for DNS of droplet-laden isotropic turbulence”. *65th Annual Meeting of the APS Division of Fluid Dynamics*, San Diego, CA (2012).

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## Invited Talks

- [5] “A combined volume-of-fluid method and low-Mach-number approach for DNS of evaporating droplets in turbulence”, Center for Turbulence Research, Stanford University, Stanford, CA, February 9, 2018.
- [4] “Direct numerical simulation of droplet-laden isotropic turbulence”, Center for Turbulence Research, Stanford University, Stanford, CA, June 2, 2017.
- [3] “Direct numerical simulation of droplet-laden isotropic turbulence”, Department of Mechanical and Aerospace Engineering, Princeton University, Princeton, NJ, April 27, 2017.
- [2] “Effect of viscosity ratio on droplet-laden isotropic turbulence”, Department of Aeronautics and Astronautics, University of Washington, Seattle, WA, November 3, 2016.
- [1] “Direct numerical simulation of droplet-laden turbulent flows”, Department of Applied Mathematics, University of Washington, Seattle, WA, November 12, 2015.

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## Teaching Experience

**Teaching Assistant**, *University of Washington*.

- Winter 2017 *Computational Methods in Aerodynamics* (AE 529, graduate level)
- Winter 2016 *Computational Fluid Dynamics* (AA 543, graduate level)
- Spring 2015 *Turbulence Modeling & Simulation* (AA 544, graduate level)
- Winter 2015 *Computational Aerodynamics* (AA 598, graduate level)
- Winter 2012 *Compressible Aerodynamics* (AA 301, undergraduate level)
- Fall 2011 *Engineering Statics* (AA 210, undergraduate level)

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## Student Mentoring

- 2016–2017 Trevor Hedges (B.S. in 2018)  
Visualization of DNS of evaporating droplets in isotropic turbulence. Video submitted to the Gallery of Fluid Motion at the 70th Annual Meeting of the APS Division of Fluid Dynamics.
- 2015 Mishaal Aleem (B.S. in 2015)  
3D visualization of vortical structures in DNS of finite-size droplets in isotropic turbulence. Video submitted to the Gallery of Fluid Motion at the 68th Annual Meeting of the APS Division of Fluid Dynamics.
- 2014 Prashanth Govindarajan (M.S. in 2015)  
Physical mechanisms for turbophoresis in a spatially developing turbulent boundary layer.
- 2014 Daniel Hnatovic (B.S. in 2014)  
Path instability of a rising bubble in quiescent liquid.
- 2013 Hanna Calvert (B.S. in 2013)  
Visualization of vortical structures and particles applied to DNS of a particle-laden turbulent boundary layer.

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## Service

- 2017–present Reviewer for: *Acta Mechanica*, *Chemical Engineering Journal*, *Computers and Fluids*, *European Journal of Mechanics - B/Fluids*, *International Journal of Heat and Fluid Flow*, *International Journal of Multiphase Flow*, *Journal of Computational Physics*, *Journal of Fluid Mechanics*, *Physics of Fluids*
- 2015 Graduate student panelist for Department of Aeronautics and Astronautics Visiting Committee
- 2013–2015 Graduate student panelist for Department of Aeronautics and Astronautics prospective students
- 2014 Graduate student panelist for Department of Aeronautics and Astronautics new student orientation
- 2010–2011 Math tutor for MERC Alternative High School, Minneapolis, MN

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## Computer skills

- Languages Fortran, C/C++, MPI, OpenMP, Python, Matlab, L<sup>A</sup>T<sub>E</sub>X
- Libraries PETSc, HYPRE, FFTW
- Operating systems Linux, Mac OS X, Windows

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## Professional memberships

- American Institute of Aeronautics and Astronautics (AIAA)  
American Physical Society (APS)  
Society for Industrial and Applied Mathematics (SIAM)