

William M. Durham

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ACADEMIC POSITIONS from 2016 to present:
- Lecturer of Biological Physics, Dept. of Physics and Astronomy, University of Sheffield
- Member, Imagine: Imaging Life Initiative, University of Sheffield
- Research Associate, Department of Zoology, University of Oxford

from 2012 to 2016:
- Departmental Lecturer, Department of Zoology, University of Oxford
- Long Term Fellow, Human Frontier Science Program

RESEARCH INTERESTS Interactions between physics and microbiology, fluid dynamics, microorganism motility, antibiotic resistance, marine ecology, microbial evolution, biofilms, gyrotaxis, chemotaxis, mathematical modeling, microfluidics, and quantitative image analysis.

EDUCATION **Massachusetts Institute of Technology**, Cambridge, MA USA

Ph.D., Civil and Environmental Engineering, 2012

Thesis: *Phytoplankton in flow.*

Advisor: Prof. Roman Stocker

S.M., Civil and Environmental Engineering, 2006

Thesis: *The effect of fluid acceleration on sediment transport in the surf zone.*

Advisor: Prof. Ole S. Madsen

Clemson University, Clemson, SC USA

B.S., Civil Engineering, June 2004

JOURNAL PUBLICATIONS Coyte, K. Z., Tabuteau, H., Gaffney, E. A., Foster, K. R.*, **Durham, W. M.*** Microbial competition in porous environments can select against rapid biofilm growth. *Proceedings of the National Academy of Sciences, USA.* (in press)

Oliveira, N. M., Foster, K. R.*, **Durham, W. M.*** (2016) Single-cell chemotaxis during biofilm formation. *Proceedings of the National Academy of Sciences, USA.*

Oliveira, N. M., Martinez-Garcia, E., Xavier, J., **Durham, W. M.**, Kolter, R., Kim, W., Foster, K. R. (2015) Biofilm formation as a response to ecological competition. *PLoS Biology.* 13.

De Lillo, F., Cencini, M., **Durham, W. M.**, Barry, M., Stocker, R. Climent, E., Boffetta, G. (2014) Turbulent fluid acceleration generates clusters of gyrotactic microorganisms. *Physical Review Letters.* 112.

Durham, W. M., Climent, E., Barry, M., De Lillo, F., Boffetta, G., Cencini, M., Stocker, R. (2013) Turbulence drives microscale patches of motile phytoplankton. *Nature Communications.* 4.

JOURNAL
PUBLICATIONS
(continued)

Durham, W. M., Tranzer, O., Leombruni, A., Stocker, R. (2012) Division by fluid incision: biofilm patch development in porous media. *Physics of Fluids*. 24. (for the Milton Van Dyke Award in the Annual Gallery of Fluid Motion)

Durham, W. M., Stocker, R. (2012) Thin phytoplankton layers: characteristics, mechanisms, and consequences. *Annual Review of Marine Science*. 4.

Durham, W. M., Climent E., Stocker, R. (2011) Gyrotaxis in a steady vortical flow. *Physical Review Letters*. 106.

Marcos[†], Seymour, J. R.[†], Luhan, M.[†], **Durham, W. M.**[†], Mitchell, J. G., Macke, A., Stocker R.[†] (2011) Microbial alignment in flow changes ocean light climate. *Proceedings of the National Academy of Sciences, USA*. 108.

[†] denotes shared first authorship

Seymour, J. R., Ahmed, T., **Durham, W. M.**, Stocker R. (2009) Chemotactic response of marine bacteria to the extracellular products of *Synechococcus* and *Prochlorococcus*. *Aquatic Microbial Ecology*. 59.

Stocker, R. and **Durham, W. M.** (2009) Tumbling for stealth? *Science*. 325.

Durham, W. M., Kessler, J. O., and Stocker, R. (2009) Disruption of vertical motility by shear triggers formation of thin phytoplankton layers. *Science*. 323.

PAPERS IN
CONFERENCE
PROCEEDINGS

Madsen, O. S. and **Durham, W. M.** (2007) Pressure-induced subsurface sediment transport in the surf zone. *Proceedings of Coastal Sediments, American Society of Civil Engineering*.

Durham, W. M. and Gallagher, S. (2006) Bozeman bicycle network plan. *Proceedings of 10th National Conference on Transportation Planning for Small and Medium-Sized Communities*.

CURRENT
GRADUATE
STUDENTS

Derry Cooper, Master's degree supervisor, Department of Physics and Astronomy, University of Sheffield. 2016-present. Topic: Development of massively parallel bacterial tracking algorithms.

Daniel Reeve, Master's degree supervisor, Department of Physics and Astronomy, University of Sheffield. 2016-present. Topic: Development of massively parallel bacterial tracking algorithms.

Simon Calver, D. Phil. co-supervisor, Mathematical Institute, University of Oxford. 2016-present. Topic: Free boundary problems in biofilm competition and novel microfluidic systems

Mina Mohaghegh, Primary D. Phil. supervisor, Department of Physics and Astronomy, University of Sheffield. 2016-present. Topic: The impact of clay microparticles on bacterial fitness and carbon burial.

Oliver Meacock, Primary D. Phil. supervisor, Department of Zoology, University of Oxford. 2015-present. Topic: Collective bacterial motility during biofilm formation.

- Best Rotation Report, Doctoral Training Centre, University of Oxford, 2016

James Wheeler, Primary D. Phil. supervisor, Department of Zoology, University of Oxford. 2015-present. Topic: Unravelling the mechanisms of chemotactic sensing during biofilm formation.

- Best Transfer Talk, Department of Zoology, University of Oxford, 2016

PREVIOUS
GRADUATE
STUDENTS

Katharine Coyte, D. Phil. co-supervisor, Department of Mathematics, University of Oxford. 2012-2016.

Topic: Biofilm competition and evolution in porous systems.

- Best student talk, EMBL Symposium, Heidelberg, Germany, 2013
- Best poster, id2 Modelling Approaches in Biomedical Sciences Conference, University College London, 2013
- Jesus College Graduate Scholarship, Oxford University, 2013-2014

Kat received a postdoctoral fellowship from the Wellcome Trust and currently works in the Department of Computational Biology at the Memorial Sloan Kettering Cancer Center in New York, NY.

Nuno Oliveira, D. Phil. thesis project collaborator, Department of Zoology, University of Oxford. 2012-2016. (Primary advisor: Kevin R. Foster)

Topic: Bacterial chemotaxis during biofilm formation.

Nuno is currently a Herchel Smith Fellow in the Department of Applied Maths and Theoretical Physics at the University of Cambridge, UK.

PREVIOUS
UNDERGRADUATE
STUDENTS

Olivier Tranzer, Undergraduate thesis supervisor, visiting student from École Polytechnique, Paris, France. MIT. 2011.

Topic: Preferential channelization in porous media flow induced by bacterial biofilms.

P. Thatcher Clay, Undergraduate thesis supervisor, Department of Electrical Engineering and Computer Science, MIT. 2008. Topic: Development of tracking algorithms to quantify microbial motility.

Directly advised five undergraduate students through MIT's Undergraduate Research Opportunities Program (UROP): Elizabeth Lundgren, Wesley Koo, P. Thatcher Clay, Anna Shcherbina, Matt McKinley, most for multiple semesters.

TEACHING
EXPERIENCE

Lecturer, Experimental Evolution, Hilary Term 2012, 2013, 2014, 2015, 2016 Oxford University.

I lead a practical course for second year undergraduate students on the evolution of antibiotic resistance, compensatory mutations, and adaptive radiation in bacteria. I deliver a lecture at the beginning of each class to review landmark papers in the field and present the theory behind the experiments that students will be working on that day. I typically teach two simultaneous sections of this course, each with ≈ 30 students. I hire and train 6-8 postdocs and D. Phil. students to help with demonstrating experimental techniques, in addition to managing the laboratory technicians that prepare the materials.

Graduate Teaching Assistant, Introductory Fluid Dynamics, Spring 2005, MIT.

I gave weekly lectures, prepared assignments, graded homework, and assisted with writing intensive term project for 32 undergraduate students. Topics included fluid statics, conservation of mass and momentum, Bernoulli's equation, open channel flow, pump design, and Navier-Stokes equations.

AWARDS,
FELLOWSHIPS, AND
SCHOLARSHIPS

Human Frontier Science Program (HFSP) Long-Term Fellowship, three years of support, tenure began January 2012 at Oxford University, UK.

National Science Foundation (NSF) Postdoctoral Research Fellowship: Intersections of Biology and Mathematical and Physical Sciences, three years of support (gratefully declined.)

Andreas Acrivos Dissertation Award in Fluid Dynamics, a prize for a doctoral thesis of outstanding scientific quality and achievement in the area of fluid dynamics. American Physical Society - Division of Fluid Dynamics (APS-DFD). San Diego, CA, November 2012.

Milton Van Dyke Award, a prize for a fluid mechanics image displaying exceptional artistic value, scientific content, and originality. American Physical Society - Division of Fluid Dynamics (APS-DFD). Baltimore, MD, November 2011.

Raymond L. Lindeman Award, an annual award that recognizes an outstanding paper in aquatic sciences written by an author under 35 years old. American Society of Limnology and Oceanography (ASLO). San Juan, Puerto Rico, February 2011.

National Defense Science and Engineering Graduate Fellowship, three years of full support: tuition and stipend, Fall 2006 - Fall 2009.

Martin Family Society of Fellows for Sustainability, one semester of full support: tuition and stipend, Fall 2009.

Stephen and Ruth Wainwright Fellowship, to conduct fieldwork with Prof. Daniel Grünbaum at Friday Harbor Laboratory. University of Washington, August 2009.

Outstanding Student Presentation Award, given to the top 5% of presentations at the American Society of Limnology and Oceanography 2009 Aquatic Sciences Meeting, Nice, France, January 2009.

Tuition Waiver, *Summer School on Turbulence, Plankton, and Marine Snow*. Vilanova i la Geltru, Spain, September 2009.

First Place, Student Paper Competition, 10th National Conference on Transportation Planning for Small and Medium Sized Communities, Nashville, TN, September 2006.

Schoettler Fellowship, MIT, one semester of full support: tuition and stipend, Fall 2004.

E. L. Clarke Award, given to a Clemson University senior civil engineering student for outstanding academic achievement, 2004.

Leon Edwards Scholarship, given to a Clemson University senior that shows promise for an academic career, 2004.

Palmetto Fellows Scholarship, for attending Clemson University, 2000-2004.

Thermal Belt Rotary Club Scholarship, for attending Clemson University, 2000-2004.

INVITED TALKS

- EuroScience Open Forum (ESOF), Manchester, England. July 2016.
- Department of Mathematics, Imperial College London, England. May 2016.
- Department of Mathematical Sciences, University of Liverpool, England. May 2016.
- National Oceanographic Centre, Natural Environment Research Council, Liverpool, England. May 2016.
- Workshop on “Mathematics of dispersion in the environment”, University of Birmingham, Birmingham, England. April 2016.
- Workshop on “Microorganisms in turbulent flows”, Lorentz Center, University of Leiden, Leiden, Netherlands. February 2016.
- Sheffield Antimicrobial Resistance Network (SHAMROK) Launch Symposium, University of Sheffield, England. January 2016.
- Department of Mathematics, University of York, England. October 2015.
- Department of Physics, University of Sheffield, England. July 2015.
- School of Life Sciences, University of Warwick, England. June 2015.
- Cavendish Laboratory, Department of Physics, University of Cambridge, England. November 2014.
- Faculty of Engineering and the Environment, University of Southampton, England. April 2014.
- Workshop on “Concepts and Conundrums in Reacting and Deformable Porous Media”, Oxford University, Oxford, England. March 2014. (delivered by my D.Phil. student Katharine Coyte)
- Department of Physics, University of Edinburgh, Edinburgh, Scotland. March 2014.
- Geophysical and Nonlinear Fluid Dynamics seminar series, Department of Atmospheric, Oceanic and Planetary Physics, University of Oxford, Oxford, England. March 2014.
- Department of Physics, University of Warwick, Coventry, England. November 2013.
- Invited Keynote Lecture, Goldschmidt Conference. Florence, Italy. August 2013.
- School of Mathematics and Statistics, University of Glasgow, Glasgow, Scotland. January 2013.
- Department of Applied Mathematics and Theoretical Physics, University of Cambridge, Cambridge, England. November 2012.
- Plenary talk at the American Physical Society, Division of Fluid Dynamics Meeting for receiving the Andreas Acrivos Award. San Diego, CA, USA. November 2012.
- Department of Mathematics, University of York, York, England. October 2012.
- Oxford Centre for Soft and Biological Matter, University of Oxford, Oxford, UK. May 2012.
- Department of Mathematical Sciences, University of Liverpool, Liverpool, England. April 2012.
- Department of Geosciences, Université de Rennes, Rennes, France. March 2012.

INVITED TALKS
(*continued*)

Plenary talk at the American Society of Limnology and Oceanography Aquatic Sciences Meeting for receiving Raymond L. Lindeman Award. San Juan, Puerto Rico. February 2011.

Laboratoire d'Etudes en Géophysique et Océanographie Spatiales (LEGOS), Toulouse, France. July 2010.

Ocean Research Institute, Tokyo, Japan. January 2010.

Tokyo University of Marine Science and Technology, Tokyo, Japan. January 2010.

Institut de Mecanique des Fluides de Toulouse, Toulouse, France. October 2009.

Department of Applied Mathematics, Physical Mathematics Seminar, Massachusetts Institute of Technology, Cambridge, MA, USA. April 2009.

Northeastern University, Boston, MA, USA. April 2009.

CONTRIBUTED
TALKS

- Durham, W. M., Climent, E., Barry, M., DeLillo, F., Boffetta, G., Cencini, M., Stocker, R. Turbulent unmixing: how marine turbulence drives patchy distributions of motile phytoplankton. *American Physical Society, Division of Fluid Dynamics Meeting*. Pittsburg, Pennsylvania, USA. November 2013.
- Durham, W. M., Leombruni, A., Tranzer, O., Stocker, R. Division by fluid incision: bacterial biofilms in porous media. *Biological Flow: A Conference to Celebrate the 70th Birthday of Prof. Tim Pedley*. Cambridge, UK. April 2012.
- Durham, W. M., Leombruni, A., Tranzer, O., Stocker, R. On growth and flow: bacterial biofilms in porous media. *American Physical Society, Division of Fluid Dynamics Meeting*. Baltimore, Maryland, USA. November 2011.
- Durham, W. M., Climent, E., Barry, M., Stocker, R. Turbulent unmixing: the sorting of motile phytoplankton by flow. *Aspen Ocean Symposium*. Aspen, Colorado, USA. January 2011.
- Durham, W. M., Climent, E., Barry, M., Stocker, R. Turbulent unmixing: the sorting of motile phytoplankton by flow. *American Physical Society, Division of Fluid Dynamics Meeting*. Long Beach, CA, USA. November 2010.
- Durham, W. M., Climent, E., Stocker, R. Turbulent eddies produce aggregations of gyrotactic phytoplankton: a study using Taylor-Green vortex flow. *Individual and Collective Fluid Mechanics of Swimming Microorganisms*. Glasgow, Scotland, UK. July 2010.
- Durham, W. M., Climent, E., Stocker, R. Small-scale turbulence drives patchiness in the distribution of gyrotactic plankton. *Orflow 10: Living Organisms in Flows: From Small-scale Turbulence to Geophysical Flows*. Palma de Mallorca, Spain. July 2010.
- Durham, W. M., Leombruni, A., McKinley, M., Shcherbina, A., Stocker, R. A microfluidic study of biofilms on topographically complex surfaces. *American Physical Society, Division of Fluid Dynamics Meeting*. Minneapolis, Minnesota, USA. November 2009.
- Durham, W. M., Kessler, J. O., and Stocker, R. Gyrotactic trapping: the formation of thin layers of phytoplankton. *American Society for Limnology and Oceanography, Aquatic Sciences Meeting*. Nice, France. January 2009.
- Durham, W. M., Stocker, R., and Kessler, J. O., Gyrotactic trapping: a bifurcation in vertical motility triggers formation of thin phytoplankton layers. *American Physical Society, Division of Fluid Dynamics Meeting*. San Antonio, Texas, USA. November 2008.
- Durham, W. M., Kessler, J. O., and Stocker, R. Gyrotactic trapping: the formation of thin layers of phytoplankton. *Summer School on Turbulence, Plankton, and Marine Snow*. Vilanova i la Geltru, Spain. September 2008.
- Durham, W. M., Stocker, R., and Kessler, J. O. Gyrotaxis in variable shear: the formation of thin algal layers. *Euromech Colloquium 488*. Liverpool, England. June 2007. (Poster)
- Durham, W. M. and Gallagher, S. Bozeman bicycle network plan. *Proceedings of 10th National Conference on Transportation Planning for Small and Medium-Sized Communities*. Nashville, Tennessee, USA. September 2006.

SERVICE

Co-organized a mini-symposium at the International Congress of Theoretical and Applied Mechanics on "Fluid Active Matter" (with Federico Toschi). August 2016. Montreal, Canada.

Reviewed manuscripts for Journal of Fluid Mechanics, Physics of Fluids, Hydrobiologia, New Journal of Physics, Proceedings of the National Academy of Sciences USA (PNAS), Journal of Plankton Research, Limnology and Oceanography: Fluids and Environments, Lab on a Chip, Marine Ecology Progress Series, eLife

Reviewed grants proposals from Marine Science and Technology Foundation, National Science Foundation (USA), Commonwealth Scientific and Industrial Research Organization (Australia).

External Ph.D. thesis examiner for Department of Mathematics, University of Liverpool, UK (2013).

Internal D. Phil thesis examiner for Department of Zoology, University of Oxford, UK (2015).

Interviewer for Systems Biology Doctoral Training Centre (D. Phil. student admissions), University of Oxford, UK, (2013, 2014).

Served on panel discussion titled "Development and Ecology of Organisms" for NERC Doctoral Training Centre, University of Oxford, UK (2014).

Science advisor for "Virtual Microbe," an educational video game that teaches middle school students about marine microbial ecology. (with Roman Stocker)