PHILIPPE H. TRINH

DEPARTMENTAL LECTURER IN MATHEMATICAL MODELLING

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RESEARCH INTERESTS

Fluid and solid mechanics, perturbation theory and asymptotic analysis, exponential asymptotics, free-surface flows, thin films and elastocapillary flows, wave-structure interactions, hydrodynamic instabilities

RESEARCH SUMMARY

My research is motivated by a range of physical applications in fluid and solid mechanics, from classical hydrodynamics and wave-structure interactions, to thin film flow, elastocapillary systems, and biological models of tissue growth or pattern formation. My primary area of expertise concerns the study of problems that involve a breakdown of traditional techniques in perturbation theory. Many of these problems involve the study of nonlinear differential equations and require the development of specialized methodologies and techniques, such as *exponential asymptotics* or *asymptotics beyond-all-orders*.

ACADEMIC POSITIONS

2016–2019 **Departmental Lecturer in Mathematical Modelling**
Mathematical Institute, University of Oxford
Oxford Centre for Industrial and Applied Mathematics
with: EPSRC Centre for Industrially Focused Mathematical Modelling

2012–2016 **Darby Fellow in Applied Mathematics**
Lincoln College, University of Oxford
& Oxford Centre for Industrial and Applied Mathematics

2010–2012 **Lecturer & Research Associate**
Princeton University
Program in Applied and Computational Mathematics
with: Profs. Weinan E and Howard A. Stone

EDUCATION

2007-2010 **Doctor of Philosophy in Mathematics**
Mathematical Institute, University of Oxford
Oxford Centre for Industrial and Applied Mathematics
Supervisor: Prof. S. Jonathan Chapman
Thesis: Exponential asymptotics and free-surface flows

2006-2007 **Master of Science in Applied Mathematics**
Carleton University (Ottawa, Ontario)
School of Mathematics and Statistics
Supervisor: Prof. David E. Amundsen
Thesis: Resonant solutions of Korteweg-de Vries equations

2004-2006 **Bachelor of Mathematics in Pure Mathematics**
Carleton University (Ottawa, Ontario)
School of Mathematics and Statistics

RESEARCH VISITS

Summer 2014, 2015	Duke University Department of Mathematics *Working with:* Prof. Thomas P. Witelski *Research topics:* Formation of finite-time singularities in PDEs, rupture in thin film flows, vortex reconnection, self-similarity
Summer 2013, 2014	University of British Columbia Mathematics Department *Working with:* Prof. Michael J. Ward *Research topics:* Reaction-diffusion equations on curved surfaces, localized spot patterns, differential-algebraic equations
May 2014	Princeton University Department of Mathematics *Working with:* Prof. Howard A. Stone & the Complex Fluids Group *Research topics:* Thin film flows on curved surfaces, interfacial instabilities, bubble dynamics (Bretherton problem), contact line problems

ACADEMIC ACHIEVEMENTS & AWARDS

2010	Oxford University Teaching Excellence Award (MPLS Division)
2010	Tuck Fellowship (IWWWFB/University of Adelaide) Inaugural recipient; award associated with the International Workshop on Water Waves and Floating Bodies, and administered by the University of Adelaide and Australian Mathematics Society.
2007-2010	Clarendon Scholarship (University of Oxford)
2007	Commonwealth Scholarship (CSFP)
2007-2010	NSERC Postgraduate Doctoral Scholarship (Canada)
2007	Gary S. Duck Award in Physics, Math, and Photonics
2007	University Senate Medal (Carleton)
2004, 2006	Canadian Governor General's Academic Medal
2006	NSERC Postgraduate Master's Scholarship (Canada)
2006	Graduate Studies and Research Scholarship (Carleton)
2006	Carleton Mathematics Departmental Scholarship (Carleton)
2005, 2006	USRA NSERC Undergrad. Research Award (Carleton)
2005	Helga H. Shirmer Mathematics Award (Carleton)

SUBMITTED OR PRE-PRINT PUBLICATIONS*

2016 Trinh, P. H. 2016 On reduced models for gravity waves generated by moving bodies. *J. Fluid Mech.* (in review) arxiv.org/abs/1510.06647

2016 Trinh, P. H., Wilson, S. K. & Stone, H. A. 2016 Elastic plates on thin viscous films. *J. Fluid Mech.* (To be submitted) arxiv.org/abs/1410.8558

2016 Hammoud, N., Trinh, P. H., Howell, P. D. & Stone, H. A. 2016 The influence of van der Waals forces on a bubble moving in a tube. *Phys. Rev. Fluids* (in review) arxiv.org/abs/1601.00726

*All preprints viewable on the arXiv or personal website.

REFEREED JOURNAL AND BOOK PUBLICATIONS**

2016 Trinh, P. H. 2016 A topological study of gravity waves generated by moving bodies using the method of steepest descents. *Proc. Roy. Soc. A* **472** (20150833). doi:10.1098/rspa.2015.0833 arxiv.org/abs/1510.06014

2016 Crew, S. C. & Trinh, P. H. 2016 New singularities for Stokes waves. *J. Fluid Mech.* **798**, 256–283. doi:10.1017/jfm.2016.309 arxiv.org/abs/1510.04254

2016 Jamieson-Lane, A., Trinh, P. H. & Ward, M. J. 2016 Localized spot patterns on the sphere for reaction-diffusion systems: Theory and open problems. In *Math. and Comp. App. in Adv. Mod. Sci. and Eng.* (ed. J. Bélair et al.). Springer. doi:10.1007/978-3-319-30379-6_58

2016 Trinh, P. H. & Ward, M. J. 2016 The dynamics of localized spot patterns for reaction-diffusion systems on the sphere. *Nonlinearity* **29** (3), 766–806. doi:10.1088/0951-7715/29/3/766

2015 Ren, W., Trinh, P. H. & E, W. 2015 On the distinguished limits of the Navier slip model of the moving contact line problem. *J. Fluid Mech.* **772**, 107–126. doi:10.1017/jfm.2015.173

2015 Trinh, P. H. & Chapman, S. J. 2015 Exponential asymptotics and problems with coalescing singularities. *Nonlinearity* **28** (5), 1229–1256. doi:10.1088/0951-7715/28/5/1229

2014 Trinh, P. H., Wilson, S. K. & Stone, H. A. 2014 A pinned or free-floating rigid plate on a thin viscous film. *J. Fluid Mech.* **760**, 407–430. doi:10.1017/jfm.2014.526

2014 Trinh, P. H., Kim, H., Hammoud, N., Howell, P. D., Chapman, S. J. & Stone, H. A. 2014 Curvature suppresses the Rayleigh-Taylor instability. *Phys. Fluids* **26** (5), 051704. doi:10.1063/1.4876476

2014 Trinh, P. H. & Chapman, S. J. 2014 The wake of a two-dimensional ship in the low-speed limit: results for multi-cornered hulls. *J. Fluid Mech.* **741**, 492–513. doi:10.1017/jfm.2013.589

2013 Wexler, J. S., Trinh, P. H., Berthet, H., Quennouz, N., du Roure, Olivia, Huppert, H. E., Linder, A. & Stone, H. A. 2013 Bending of elastic fibres in viscous flows: the influence of confinement. *J. Fluid Mech.* **720**, 517–544. doi:10.1017/jfm.2013.49

2013 Chapman, S. J., Trinh, P. H. & Witelski, T. P. 2013 Exponential asymptotics for thin film rupture. *SIAM J. Appl. Math.* **73** (1), 232–253. doi:10.1137/120872012

2013 Trinh, P. H. & Chapman, S. J. 2013 New gravity-capillary waves at low speeds. Part 1: Linear theory. *J. Fluid Mech.* **724**, 367–391. doi:10.1017/jfm.2013.110

2013 Trinh, P. H. & Chapman, S. J. 2013 New gravity-capillary waves at low speeds. Part 2: Nonlinear theory. *J. Fluid Mech.* **724**, 392–424. doi:10.1017/jfm.2013.110

2011 Trinh, P. H., Chapman, S. J. & Vanden-Broeck, J.-M. 2011 Do waveless ships exist? Results for single-cornered hulls. *J. Fluid Mech.* **685**, 413–439. doi:10.1017/jfm.2011.325

2010 Trinh, P. H. 2010 *Asymptotic Methods in Fluid Mechanics: Survey and Recent Advances*, chap. Exponential Asymptotics and Stokes Line Smoothing for Generalized Solitary Waves, pp. 121–126. SpringerWienNewYork

2010 Trinh, P. & Amundsen, D. 2010 Unifying steady-state resonant solutions of a broad class of KdV-type equations. *J. Comput. Appl. Math.* **234** (6), 1788–1795. doi:10.1016/j.cam.2009.08.029

IN PREPARATION

— Trinh, P. H. & Witelski, T. P. 2016 Complex singularities and selection mechanisms in nonlinear differential equations. *(In preparation)*

— Macdonald, C. B., Mäerz, T. & Trinh, P. H. 20– Thin film equations with the Closest Point Method. *(In preparation)*

— Trinh, P. H. & Vella, D. 20– Near threshold buckling analysis of a floating elastic annulus. *(In preparation)*

**Only including refereed journal publications.
For conference proceedings, theses, reports, see personal website

STUDENT RESEARCH SUPERVISION

Ph.D.	=	Doctoral dissertation
M.Sc.	=	Master of Science dissertation
CDT MP	=	ESPRC Doctoral Training industrial mini project
SumRes	=	Summer research project
MMath	=	4th year dissertation or equivalent
BA Math	=	3rd year dissertation or equivalent

Year	Student	School	Type	Project title	Comments
2015–Present	Helen Fletcher	Oxford	Ph.D.	Active wave absorption for polychromatic waves	Co-advised with S.J. Chapman & J. Whiteley
2016	Davin Lunz	Oxford	CDT MP	Prediction of bulk properties from microstructure	Co-advised with J. Chapman & M. Bruna
2012–2016	Naima Hammoud	Princeton	Ph.D.	On instabilities in thin film flows	Co-advised with H.A. Stone Trinh *et al.* (2014), *Phys. Fluids* Hammoud *et al.* (2016), *Submitted to PRF*
2014–2015	Amy Guyomard	Oxford	M.Sc.	The multi-dimensional method of steepest descents	
2016–2017	Thomas Chandler	Oxford	MMath	On the separation between free surface and rigid wall	
2016–2017	Yyanis Johnson-Llambias	Oxford	MMath	Bifurcations in water waves in finite depth	Summer funding from Lincoln College
2016–2017	Oliver Mulley	Oxford	MMath	Gravity-capillary waves with vorticity	
2016–2017	John Fitzgerald	Oxford	BA Math	Numerical methods for complex rays	Summer funding from Lincoln College
2016–2017	Charlie Hutchings	Oxford	BA Math	On the Bender-Wu problem and hydrodynamics	
Summer 2016	Thomas Chandler	Oxford	SumRes	Splash models for breaking waves	Funded by EPSRC CDT InFoMM
2015–2016	Sean Jamshidi	Oxford	MMath	Searching for new gravity-capillary waves	Presented BAMC 2016 (Oxford, UK)
2015–2016	Thomas Chandler	Oxford	MMath	Splash models for flows near the bow of a ship	Presented BAMC 2016 (Oxford, UK)
Summer 2015	Samuel Crew	Oxford	SumRes	New singularities for Stokes waves	Presented BAMC 2016 (Oxford, UK) Crew & Trinh (2016) J. Fluid Mech.
2014–2015	Alexander Gower	Oxford	MMath	Phase field models and the thin film limit	
2014–2015	Benjamin Whitlock	Oxford	MMath	Models for thin film flows on curved surfaces	
2014–2015	Jamie Cruickshank	Oxford	MMath	Tissue growth in a mono-layerd epithelium	Co-advised with S. Waters
2013–2014	Lucy Auton	Oxford	MMath	Multiple scales for discrete difference equations	Co-advised with C. Hall
2013–2014	Thomas Pettifor	Oxford	MMath	Discrete and continuum models for in vitro tissue growth	Co-advised with S. Waters
2013–2014	Melissa Varney	Oxford	MMath	Mathematical models for the wrinkling of thin sheets	Co-advised with D. Vella
2013–2014	Stephanie Yayoi Teramoto	Princeton	MMath	Stability of patterns in reaction-diffusion equations	Winner SIAM 2013 contest for Teaching Dynamical Systems
2011–2012	Rafael Y. Grinberg	Princeton	MMath	Topics in real analysis	Departmental thesis award
2011–2012	Daniel Wu	Princeton	BA Math	Functional analysis and applications to potential theory	

FUNDING & GRANTS

2016 **Oxford Mathematics Summer Research Bursary**

A grant for £2500 to Thomas Chandler (MMath) in order to undertake a summer research project on the study of splash models for breaking water waves.

2015, 2016 **EPSRC Centre in Industrially Focused Mathematical Modelling**
(2016) Joint principal investigator for an industrial mini-project on prediction of bulk properties from microstructure. Joint funding from the EPSRC Centre for Doctoral Training in Industrially Focused Mathematical Modelling (InFoMM) and National Physical Laboratory.

(2015–Present) Joint principal investigator for a Ph.D. project to develop mathematical models to predict boundary and internal processes for a high resolution computational wave flume. Joint funding from InFoMM, the US Army Corps of Engineers (USACE), and HR Wallingford Ltd.

2014, 2015 **Zilkha Fund (Lincoln College, Oxford)**

Two grants of £2000 awarded by the Trustees of the Zilkha fund to cover research trips to the University of British Columbia (hosted by Michael Ward) and to Duke University (hosted by Thomas Witelski).

TEACHING AWARDS

2010 **University of Oxford Teaching Excellence Award**
Through student and faculty nominations, I was recognized by the Mathematical, Physical, and Life Sciences Division (MPLS) for my commitment to teaching and innovative approaches in the classroom.

TEACHING EXPERIENCE

2016–Present **Lecturer and Course Coordinator**
Teaching for the EPSRC Centre in Industrially Focused Mathematical Modelling
Mathematical Institute, University of Oxford

Responsibilities: teaching and lecturing of several courses for doctoral students, including core modules in (i) Mathematical Modelling; (ii) Modelling, analysis and computation of continuous real-world problems; (iii) Maths for energy.
* *Teaching on-going for current academic year*

2011-2012 **Lecturer and Course Coordinator**
MAT350 Introduction to Differential Equations (3rd year, Mathematics)
Mathematics Department, Princeton University

Responsibilities: managing a teaching assistant, designing and delivering the course lectures, writing course notes and assignments, and creating midterm and final examinations.

2000–2016 **Departmental & College Tutor**
University of Oxford & Princeton University

I have taught all the classes below either as a departmental tutor (managing teaching assistants, directing and teaching classes of 15-30 students), or as a college tutor (in the Oxford tutorial system; a more supervisory role involving tutorial teaching). Many of these roles have given me the opportunity to develop further additional course material (for tutorials, examination preparation, etc.).

Math Alive!	• *Princeton (Mathematics, yr. 1)*
Applied differential equations	• *Princeton (Mathematics, yr. 3)*
Geometry	• *Oxford (Mathematics, yr. 1)*
Multivariable calculus	• *Oxford (Mathematics, yr. 1)*
Fourier series and PDEs	• *Oxford (Mathematics, yr. 1)*
Applications to mathematical physics	• *Oxford (Mathematics, yr. 1)*
Differential equations I–II	• *Oxford (Mathematics, yr. 2)*
Integral equations	• *Oxford (Mathematics, yr. 2)*
Calculus of variations	• *Oxford (Mathematics, yr. 2)*
Classical mechanics	• *Oxford (Mathematics, yr. 2)*
Techniques in applied mathematics	• *Oxford (Mathematics, yr. 3)*
Viscous flows	• *Oxford (Mathematics, yr. 3)*
Waves and compressible flow	• *Oxford (Mathematics, yr. 3)*
Perturbation methods	• *Oxford (Mathematics, yr. 4)*
Applied complex variables	• *Oxford (Mathematics, yr. 4)*
Vector spaces and matrices	• *Oxford (Physics, yr. 1)*
Normal modes and waves	• *Oxford (Physics, yr. 1)*
Multiple integrals and vector calculus	• *Oxford (Physics, yr. 1)*

RESEARCH & ADMINISTRATIVE MANAGEMENT

2016–Present **EPSRC Centre (CDT) in Industrially Focused Mathematical Modelling**

As part of my role as departmental lecturer, I work as one of the core members of the Centre for Doctoral Training in Mathematical Modelling. The role involves general research and administrative responsibilities of running the CDT; this includes helping to manage students and their faculty and industrial supervisors, hosting visitors, and organizing academic-industrial events.

2014 **OCIAM Industrial and Interdisciplinary Workshops**

In 2014, I was involved with coordinating and managing the industrial workshops. The role required collaborating with Oxford faculty in organizing speakers (chosen from industry or other departments), hosting visitors during the workshops, and serving as a bridge between the industrial and academic communities.

2012–2016 **Member of Governing Body at Lincoln College**

I served as an active member of Lincoln College's Governing Body, which provided me with the opportunity to participate in many aspects of the college management. In particular, I acted as an interviewer for several staff and lecturer positions, in addition to the typical responsibilities of interviewing undergraduate candidates within Oxford's collegiate scheme.

2012–2016 **Fellow for Schools Liaison at Lincoln College**

My role as the Fellow for Schools Liaison involved traveling to schools in Lincolnshire and the surrounding area for outreach efforts on behalf of the college. These events gave me an opportunity to discuss Oxford applications, the interview process, academic and undergraduate life with younger school students. The role also involved acting as a host during open days or special events within Oxford.

2011-2012 **Princeton University ALTA faculty advisory board**

I was nominated to serve as a member of the faculty advisory board for the ALTA (Academic Life Total Assessment) project organized by the Princeton Undergraduate Student Government. The goal of the project is to provide a detailed assessment of undergraduate life and suggest ways of improving the student learning experience.

A SELECTION OF TALKS

"Beyond all orders: the role of exponentially small effects in the physical sciences"

On: The emergence of techniques in exponential asymptotics from the historical resolution of several long-standing problems; a survey of current research with focus on applications to thin film rupture and hydrodynamics.

2015 Applied and Computational Mathematics Seminar, Edinburgh University (UK)
2015 Center for Nonlinear and Complex Systems Seminar, Duke University (USA)
2015 Fluid Dynamics Seminar, Imperial College London (UK)

"On Tulin's paradox: an exact theory of gravity wave generation by moving bodies"

On: The resolution of long-standing questions posed by M.P. Tulin in regards to developing an exact theory of wave-structure interactions; a proposal of a new steepest descent methodology.

2015 International Conference on Nonlinear Evolution Equations and Wave Phenomena (IMACS), University of Georgia (USA)
2015 International Applied and Computational Complex Analysis workshop, Imperial College London (UK)

"Have you seen our water waves? Theoretical predictions of new gravity-capillary waves at low speeds"

On: Exponential asymptotics has allowed for the theoretical prediction of new classes of gravity-capillary waves, induced by flows over nonlinear geometries.

2014 Applied Mathematics Seminar, University College London (UK)
2013 Applied Mathematics Seminar, University of Delaware (USA)

"*Thin film flows on curved surfaces*"

On: On the importance and theory of thin film dynamics on general curved surfaces, and the suppression of the Rayleigh-Taylor instability through substrate curvature.

2014 Oxford-Princeton Collaborative Workshop, Princeton University (USA)

"*The contact lens problem and thin film flows with elastic structures*"

On: Studying the role of competing effects of surface tension, viscosity, and substrate rigidity on thin film free-surface interactions with a rigid or elastic plate.

2015 Fluids & Elasticity 2015, Biarritz (France)