CURRICULUM VITAE

Matthew James Hancock

Instructor in Applied Mathematics
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EDUCATION

Ph.D., Environmental Fluid Mechanics 1999-2004
Dept. of Civil & Environmental Engineering, Massachusetts Institute of Technology
Thesis title: Generation of sand bars under surface waves
Advisor: Prof. Chiang C. Mei

M. Math, Applied Math 1998-1999
Dept. of Applied Mathematics, University of Waterloo.
Thesis title: The Use of Theta Functions in Water Wave Theory
Advisor: Prof. Kevin G. Lamb

B. Math, Double Honors in Applied and Pure Math 1993-1998
University of Waterloo, Waterloo, Ontario, Canada

FELLOWSHIPS & AWARDS

- William Asbjornsen Albert Memorial Fellowship, M.I.T., 2003
- Presidential Fellowship, M.I.T., 1999
- Canadian National Science and Research Council Graduate Fellowship, 1998
- University of Waterloo Graduate Entrance Scholarship, 1998
- Graduated on Dean's Honors List, University of Waterloo, May 1998
- Fejer-Aczel Award, University of Waterloo, Jan. 1998
- University of Waterloo Senate Scholarship, Feb. 1995
- National Science and Research Council of Canada Undergraduate Fellowship, 1992-1996

RESEARCH EXPERIENCE

2005-2008 Massachusetts Institute of Technology, Instructorship in Applied Math

Theoretical modeling of wetting on textured rigid and elastic surfaces. Numerical modeling (Surface Evolver) of the receding edge of the droplet to predict receding contact angle on textured rigid and elastic substrates. Goal of study is to elucidate the effects of the geometry and elasticity of the roughness elements on the wetting, adhesive, and structural properties of textured surfaces. In collaboration with Prof. John Bush (Dept. of Math, MIT) and Dr. Manu Prakash (Harvard).

Theoretical modeling of motion and self-assembly of small floating particles on a free surface. In collaboration with Prof. John Bush and Dr. Sunghwan Jung (MIT).

Theoretical modeling of small hydrophobic particles impacting a free surface: contact line motion, surface tension, with applications in biolocomotion and contaminant transport. In collaboration with Prof. John Bush.

1999-2004 Massachusetts Institute of Technology, Doctoral Research

Theoretical modeling and experimental investigation of sand bar formation under ocean surface waves, including effects of suspended sediment (fine grains) and bed load transport on a sloping mean seabed in water of intermediate depth. Model predictions compared with available laboratory and field data. Sediment sorting studied experimentally under standing waves with two grain sizes. In collaboration with Prof. Chiang C. Mei.

Theoretical modeling of wave propagation over a bottom with random undulations, leading to multiple scattering of the incident wave and thus a conservative form of wave damping. In collaboration with Prof. Chiang C. Mei.

Experimental investigation and theoretical modeling of the influence of surfactants on water jets impinging on contaminated reservoirs. In collaboration with Prof. John Bush.

1998-1999 University of Waterloo, Masters Thesis Research

Theoretical review of shallow water wave equations and the use of theta functions as exact solutions to the Boussinesq model for two-way wave propagation. Advisor: Prof. Kevin Lamb.

1995-1998 University of Waterloo, Undergraduate Research

By finding a suitable variable transformation, asymptotic states and decay rates were computed for a 5 variable system of non-autonomous, nonlinear ODEs describing a cosmological model. In collaboration with Prof. John Wainwright.

REASEARCH INTERESTS

Microfluidics, Nanotechnology and Biotechnology

- fluid mechanics on a slide: wetting, particle seeding, and beading on a microassay
- wetting of textured rigid and elastic surfaces, with application to superhydrophobic surfaces in microfluidic devices
- motion and self-assembly of small particles in a fluid or on a free surface

Biological Fluid Mechanics and Biophysics

- mechanics of the inner ear: hair cell movement on the basilar membrane in the fluid-filled cochlea, with applications to hearing
- flow of air in the vocal tract with applications to speech production
- oscillatory flow through flexible tubes, with application to blood flow
- oscillatory flow through porous media, with application to the uptake of gases in the lung

Environmental Fluid Mechanics and Wave Propagation

- wave propagation through multiphase plumes and other media possessing random properties, with applications to ultrasound in the body and sonar in the ocean
- nonlinear effects in the dynamics of the boundary between a poroelastic material and a fluid, under oscillatory flow, with applications in tunnel dynamics and bio-mechanics
- mechanisms of sand bar formation on sandy beaches: Bragg resonance, wave groups, harmonic interaction of surface waves in shallow water
- sediment sorting under oscillatory flow

Fundamental Fluid Mechanics

- impact of drops on a free surface, with application to particulate transport
- motion and self-assembly of small floating particles
- Marangoni flows and the effects of surfactants

TEACHING EXPERIENCE

18.354 Nonlinear Dynamics II : Continuum Systems, Course Instructor, Winter 2008, 2007, 2006

18.303 Linear Partial Differential Equations, Course Instructor, Fall 2006, 2005, 2004

18.075 Advanced Calculus for Engineers, Course Instructor, Fall 2007

18.01 Calculus, Section instructor, Fall 2005

18.03 Differential Equations, Section instructor, Winter 2005

1.63 Advanced Fluid Dynamics of the Environment, Teaching Assistant, Fall 2002

PUBLICATIONS

Hancock, M. J., B. J. Landry, and C. C. Mei (2008), Sandbar formation under surface waves: Theory and experiments, *J. Geophys. Res*., **113**, C07022, doi:10.1029/2007JC004374

Landry, B. J., M. J. Hancock, and C. C. Mei. (2007) Note on Sediment Sorting in a Sandy Bed under Standing Water Waves. *Coast. Eng.* **54**, 694-699

Mei, C. C. and M. J. Hancock. (2003) Weakly nonlinear surface waves over a random seabed. *J. Fluid Mech*. **475**, 247-268.

Pihl, J. H., C. C. Mei and M. J. Hancock. (2002) Surface gravity waves over a two-dimensional random seabed. *Phys. Rev. E* **66**, 016611.

Hancock, M. J. and J. W. M. Bush. (2002) Fluid pipes. *J. Fluid Mech*., **466**, 285-304.

Horwood, J. T., M. J. Hancock, D. The and J. Wainwright. (2003) Late-time asymptotic dynamics of Bianchi VIII cosmologies. *Class. Quantum Grav.* **20**, 1757-1777.

Nilsson, U. S., M. J. Hancock and J. Wainwright. (2000) Non-tilted Bianchi VII0 models - the radiation fluid. *Class. Quantum Grav.* **17**, 3119-34.

Wainwright, J., Hancock, M. J. and Uggla, C. (1999) Asymptotic self-similarity breaking at late times in cosmology. *Class. Quantum Grav.* **16**, 2577-98.

Wainwright, J., A. A. Coley, G. F. R. Ellis and M. Hancock. (1998) On the isotropy of the Universe : do Bianchi VIIh cosmologies isotropize? *Class. Quantum Grav.* **15,** 331-50.

IN PREPARATION

Hancock, M. J. & J. W. M. Bush. Wetting on textured elastic surfaces.
Hancock, M. J. & J. W. M. Bush. Bouncing stones: the rebound of small hydrophobic bodies impacting a free surface.

CONFERENCE PRESENTATIONS

'Sandbar Formation Under Surface Waves', 2008 ASLO Ocean Sciences Meeting, Orlando, FL, March 2008

'Sandbar Formation Under Surface Waves', American Geophysical Union Fall Meeting, San Francisco, CA, December 2007

'The rebound of small particles impacting a free surface', American Physical Society : 60th Annual Meeting of the Division of Fluid Dynamics, Salt Lake City, UT, November 2007

'*Locomotion of partially submerged creatures on a free surface*', Mathematical Methods and Modeling of Biophysical Phenomena, Angra dos Reis, Brazil, February 2005

'*Tail-walking*', American Physical Society : 57th Annual Meeting of the Division of Fluid Dynamics, Seattle, WA, November 2004

'*Evolution of sand bars under waves*', American Physical Society : 56th Annual Meeting of the Division of Fluid Dynamics, Meadowlands, NJ, November 2003

`Fluid Pipes', American Physical Society : 53rd Annual Meeting of the Division of Fluid Dynamics, Washington, D. C., November 2000

INVITED LECTURES

'Generation of sand bars under waves', Physical Mathematics Seminar, Dept. of Mathematics, Massachusetts Institute of Technology, Oct 5, 2004.

'Generation of sand bars under waves', Environmental Fluid Mechanics Seminar, Dept. of Civil & Environmental Engineering, Massachusetts Institute of Technology, Sept 16, 2004.

`Ocean Waves and Sand bars', Physical Mathematics Seminar, Dept. of Mathematics, Massachusetts Institute of Technology, Feb 4, 2003.

`Sand bars and Ocean Waves', Dept. of Applied Mathematics Seminar Series, University of Waterloo, Nov 14, 2002.

REFERENCES

Professor John W. M. Bush
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Massachusetts Institute of Technology
Rm. 2-392
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Professor Chiang C. Mei
Dept. of Civil & Environmental Engineering
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Professor Ole S. Madsen
Dept. of Civil & Environmental Engineering
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Professor Ain A. Sonin
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