

PERSONAL INFORMATION

Martin Magill
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I am currently completing my Ph.D. under the supervision of Dr. Hendrick W. de Haan at the University of Ontario Institute of Technology (UOIT). My primary research interest is in the use of deep neural networks to solve differential equations. This method works on high-dimensional problems, where traditional approaches fail. I am applying it to my research in nanobiophysics, to augment particle-based simulations of polymers in nanofluidic devices, as well as to directly solve the high-dimensional differential equations that describe stochastic many-body systems. Conversely, I also conduct theoretical deep learning research on these networks, as they provide unique opportunities for studying important concepts such as network generalization, interpretation, visualization, and sparsification.

EDUCATION

Master's degree in modelling and computational science from the University of Ontario Institute of Technology (2014-2016). Thesis advisors: Ed Waller and Hendrick W. de Haan. Thesis title: *Characterization of Nanopores With Internal Cavities for DNA Manipulation Using Langevin Dynamics Simulations*.

Bachelor's degree in mathematics from the University of Waterloo (2009-2014). This program included six co-op work terms including three work reports, two of which were nominated for awards. I received four ratings of "Outstanding" and two of "Excellent".

JOB EXPERIENCES

2014 September → Graduate student at the University of Ontario Institute of Technology. I completed my Masters under the supervision of Ed Waller and Hendrick W. de Haan. My research on nanopores with internal cavities was published in Physical Review Letters, and was the basis for a patent application. During this time, I was also a teaching assistant for various undergraduate courses, where my responsibilities included preparing and delivering lectures, tutorials, and evaluations to classes of ten to thirty students.

2014 May → **August (University of Waterloo)** Created a 2D pseudo-spectral numerical solver for the weakly non-linear magnetohydrodynamic shallow-water equations, and used it to study wave propagation in the solar tachocline. Wrote a coupled 2D-3D iterative pseudo-spectral numerical solver to reproduce the normal field instability in ferrofluids, and constructed an experimental demonstration. Reference: Dr. Marek Stastna, mmstastna@uwaterloo.ca.

2013 May → **August (Atomic Energy of Canada Limited)** Worked extensively with the Serpent Monte Carlo reactor physics burnup calculation code. Conducted and documented validations of new code releases and submitted bug fixes to the code author. Created and analysed simulations of the CANDU, ZED-2, CANFLEX, SCWR, and EFR designs at both the lattice and full-core levels. Reference: Dr. Alexandre Trottier, trottiera@aecl.ca.

2012 September → **December (GRRCC)** Worked as a physics technician at the Grand River Regional Cancer Centre. Conducted regular maintenance on linear accelerators used for cancer treatment. Created a GUI for analysing radiation treatment plans. Reference: Ernest Osei, ernestkwaku.osei@grhosp.on.ca.

2012 January → **April (HC RPB)** Worked as a research assistant at the Health Canada Radiation Protection Bureau. Analysed Geant4 models of the CRIPT

detector using machine learning algorithms. Upgraded and maintained a Linux-based computer cluster. Reference: Dr. Trevor Stocki, trevor.stocki@hc-sc.gc.ca.

2011 January → August (SNOLAB) Worked on the disassembly, reassembly, and operation of the DEAP-1 experiment. Designed and simulated passive calibration techniques for the DEAP-3600 experiment using a Monte Carlo simulation code. Reference: Dr. Chris Jillings, jillings@snolab.ca.

2010 May → August (Deep River Science Academy) Conducted fuel bundle optimization for the SCWR reactor design. Taught and supervised high school students. Wrote and delivered the winning presentation at the Nuclear Science Division Program Review. Reference: Dr. Jeremy Pencer, pencerj@aecl.ca.

2009 July → August (Atomic Energy of Canada Limited) Simulated advanced reactor fuel designs in various reactor conditions. Reference: Bronwyn Hyland, hylandb@aecl.ca.

2008 September → 2009 January (Atomic Energy of Canada Limited) Modelled the flow of nuclear reactor waste in advanced fuel cycles. Reference: Dr. Geoffrey Edwards, edwardsg@aecl.ca.

PUBLICATIONS
(PUBLISHED)

Magill, Martin, E. Waller, H. W. de Haan. *A sequential nanopore-channel device for polymer separation*. The Journal of Chemical Physics (2018).

Briggs, K., G. Madejski, **M. Magill**, K. Kastitis, H. W. de Haan, J. L. McGrath, and V. Tabard-Cossa. *DNA Translocations Through Nanopores Under Nanoscale Pre-Confinement*. Nano Letters (2017). Also accepted as the cover article.

Magill, Martin, C. Falconer, E. Waller, and H. W. de Haan. *Translocation Time through a Nanopore with an Internal Cavity Is Minimal for Polymers of Intermediate Length*. Physical Review Letters (2016).

Stocki, T. J., C. Warren, **M. P. C. Magill**, B. E. Morgan, J. Smith, D. Ong, V. N. P. Anghel et al. *Machine learning for the cosmic ray inspection and passive tomography project (CRIPT)*. Nuclear Science Symposium and Medical Imaging Conference (2012).

Magill, M., J. Pencer, R. Pratt, W. Young, G. W. R. Edwards, and B. Hyland. *Thorium fuel cycles in the CANDU supercritical water reactor*. 5th International Symposium on Supercritical-Water-Cooled Reactors (2011).

Hyland, B., E. D. Collins, R. J. Ellis, G. Del Cul, and **M. Magill**. *Transmutation of americium in a lanthanide matrix*. GLOBAL 2011 congress.

Hyland, B., G. R. Dyck, G. W. R. Edwards, and **M. Magill**. *Homogeneous thorium fuel cycles in CANDU reactors*. GLOBAL 2009 congress.

PUBLICATIONS
(IN PROGRESS)

Magill, M., F. Qureshi, and H. W. de Haan. *Neural Networks Trained to Solve Differential Equations Learn General Representations*. To be presented at The Conference on Neural Information Processing Systems in December 2018.

Magill, M., E. Waller, and H. W. de Haan. *Compact Neural Network Solutions to Laplace's Equation in a Nanofluidic Device*. To be presented at the Compact Deep Neural Network Representation with Industrial Applications workshop at The Conference on Neural Information Processing Systems in December 2018.

Magill, M., A. Coutino, B. Storer, F. Poulin, M. Stastna. *The dynamics of nonlinear Alfvén waves in the shallow water magnetohydrodynamic equations*. Submitted to Physical Review Fluids in October 2018.

Nagel, A., **M. Magill**, and H. W. de Haan. *Solving for the Moments of First Passage Time Distributions with Deep Learning*.

Menais, T., **M. Magill**, E. Waller, and H. W. de Haan. *Capture and Translocation of dsDNA through a Nanopore with an Internal Cavity*.

CONFERENCE
PRESENTATIONS

- 2018 June 2** Graduate Student Council Conference at UOIT. *Teaching Neural Networks to Solve Differential Equations*. Martin Magill, Faisal Qureshi, Hendrick W. de Haan.
- 2017 June 16** ONE Biophysics at the University of Toronto Mississauga. *Separation of Polymer Mixtures by Length Using a Series of Nanopores Connected by Nanochannels*. Martin Magill, Ed Waller, Hendrick W. de Haan.
- 2017 May 6** Chemical Biophysics Symposium at the University of Toronto. *Separation of Polymer Mixtures by Length Using a Series of Nanopores Connected by Nanochannels*. Martin Magill, Ed Waller, Hendrick W. de Haan.
- 2016 June 15** Canadian Association of Physicists Annual Meeting at the University of Ottawa. *The Translocation Time through a Nanopore with an Internal Cavity is Minimal for Polymers of Intermediate Length*. Martin Magill, Cory Falconer, Ed Waller, Hendrick W. de Haan.
- 2016 May 5** Graduate Student Council Conference at UOIT. *Novel Nanopores: Entropic Trapping in Polymer Filters*. Martin Magill.
- 2015 April 28** Graduate Student Council Conference at UOIT. *Recoil Energy in Beta Decay*. Martin Magill.

CONFERENCE POSTERS

- 2018 July 25** Deep Learning and Reinforcement Learning Summer School, hosted by the Canadian Institute For Advanced Research (CIFAR) and the Vector Institute. *Neural Networks Trained to Solve Differential Equations Learn General Representations*. Martin Magill, Faisal Qureshi, Hendrick W. de Haan.
- 2018 June 15** ONE Biophysics at the University of Toronto Mississauga. *Using Neural Networks to Solve Electric Fields in Slit-Well Nanofluidic Devices for Simulations of Nanoparticle Electrophoresis*. Martin Magill, Ed Waller, Hendrick W. de Haan.
- 2018 May 5** Chemical Biophysics Symposium at the University of Toronto. *Using Neural Networks to Solve Electric Fields in Slit-Well Nanofluidic Devices for Simulations of Nanoparticle Electrophoresis*. Martin Magill, Faisal Qureshi, Hendrick W. de Haan.
- 2017 May 25** Biophysical Society of Canada Annual Meeting at l'Université du Québec à Montréal. *Separation of Polymer Mixtures by Length Using a Series of Nanopores Connected by Nanochannels*. Martin Magill, Ed Waller, Hendrick W. de Haan.
- 2016 November 11** Nano Ontario Conference by the University of Guelph. *The Translocation Time through a Nanopore with an Internal Cavity is Minimal for Polymers of Intermediate Length*. Martin Magill, Ed Waller, Hendrick W. de Haan.
- 2016 May 14** Chemical Biophysics Symposium at the University of Toronto. *The Translocation Time through a Nanopore with an Internal Cavity is Minimal for Polymers of Intermediate Length*. Martin Magill, Ed Waller, Hendrick W. de Haan.
- 2015 June 18** Biophysical Society of Canada Annual Meeting at the University of Waterloo. *Nanopores With Internal Cavities as Band-Pass Filters for Polymer Length*. Martin Magill, Ed Waller, Hendrick W. de Haan.
- 2015 April 11** Chemical Biophysics Symposium at the University of Toronto. *Radiology of the Beta Decay Recoil Nucleus*. Martin Magill, Ed Waller, Hendrick W. de Haan.
- 2014 December 15** University Network of Excellence in Nuclear Engineering Meeting in Mississauga, ON. *Recoil Energy in Beta Decay*. Martin Magill, Ed Waller, Hendrick W. de Haan.

AWARDS

2018 Ontario Graduate Scholarship, University of Ontario Institute of Technology
2017 Nominated for UOIT Outstanding Thesis Award
2017 Dean's Graduate Scholarship
2017 Graduate Admission Scholarship
2017 Ontario Graduate Scholarship, University of Ontario Institute of Technology
2016 Ontario Graduate Scholarship, University of Ontario Institute of Technology
2015 Ontario Graduate Scholarship, University of Ontario Institute of Technology
2014 Undergraduate Student Research Award, University of Waterloo
2013 Arthur Beaumont Memorial Scholarship, University of Waterloo
2009 President's Scholarship of Distinction, University of Waterloo
2009 Governor General's Award, Mackenzie High School
2009 Millenium Excellence Award, Canada Millenium Foundation

COMPUTER SKILLS

Programming, scripting and markup languages Python and Bash (daily). C, L^AT_EX, tcl (Often). Matlab, C++ (seldomly).
Simulation codes and software packages TensorFlow, Keras (neural networks). ESPResSo, HOOMD-blue (molecular dynamics). FEniCS (finite element). Serpent, MCNP, Geant4, RAT (radiation Monte Carlo). WIMS (nuclear reactor criticality). Weka (machine learning).

LANGUAGE SKILLS

I was raised bilingual in English and French, although my scientific work has been conducted predominantly in English. **English:** Native tongue. **French:** Fluent.