# Vincent Quenneville-Bélair

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## Summary

My current research is in scientific computing and numerical analysis, the mathematical design and analysis of computer simulations. My focus is on the development of new finite element methods for wave propagation simulation. The application is on gravitational waves in the framework of Einstein's theory of General Relativity.

Programming Skills: C, Fortran, Python, Matlab, CUDA, OpenMP, MPI.

## Education

**PhD. Applied Mathematics.**   Adviser: Prof. Douglas N. Arnold, University of Minnesota.   2015
  Best Poster Design and Presentation, SIAM CSE 2015
  University of Minnesota Doctoral Dissertation Fellowship (1 year)
  NSERC Alexander Graham Bell Canada Graduate Scholarship for Doctoral Studies (3 years)
  FQRNT Doctoral Research Scholarship (3 years; declined)

**MCS. Master of Computer Science.**   University of Minnesota.   2014

**MSc. Applied Mathematics.**   Adviser: Prof. Bernardo Cockburn, University of Minnesota.   2011
  FQRNT Master's Research Scholarship (2 years)

**BSc. First Class Honours in Mathematics and Physics.**   McGill University, Canada.   2008
  Mathematical Contest in Modeling by COMAP: Meritorious Winner (twice; coached by Prof. Nilima Nigam)
  DAAD-RISE Internship in Germany (declined)
  Association of Universities and Colleges of Canada: Gaz Métro Scholarship (twice)

## Academic Experience

**Chu Assistant Professor.**   *Applied Physics and Applied Mathematics, Columbia University.*   2015-

**Doctoral Thesis.**   *Adviser: Prof. Douglas N. Arnold, University of Minnesota.*   2011-2015
- Create and analyze novel finite element methods for gravitational wave propagation.
- Implement in parallel on a cluster of the Minnesota Supercomputing Institute in Python and FEniCS.

  Poster at Doctoral Research Showcase, University of Minnesota, 2015
  Poster at MSI Research Exhibition, 2015
  Poster at SIAM CSE 2015, awarded Best Design and Presentation
  Poster at IMA Special Workshop: Structure-Preserving Discretizations of PDEs, 2014.
  Invited Talk at Columbia University APAM, 2015
  Invited Talk at Student Days, SIAM Annual Meeting, 2013

**Master Thesis.**   *Adviser: Prof. Bernardo Cockburn, University of Minnesota.*   2009-2011
- Investigate the superconvergence of a new discontinuous finite element method for acoustic waves.

  Peer-reviewed article with Cockburn in Mathematics of Computation, 2014
  Invited Talk: US National Congress on Computational Mechanics, 2011
  Invited Talk: International Congress on Industrial and Applied Mathematics, 2011

**Research Assistant for Starkey Hearing Technology.** *Adviser: Prof. Fadil Santosa, University of Minnesota.* 2009
- Predict the elastodynamic response of an idealized ear canal using Fortran-based seismic modeling.

**NSERC Research Assistant.** *Adviser: Prof. Jay Louise Nadeau, McGill University.* 2008
- Model an oscillatory networks of genes in bacteria.
- Implement simulation using Mathematica.

**ISM Research Assistant.** *Adviser: Prof. Henri Darmon, McGill University.* 2007
- Design a geometric algorithm for recognizing rational numbers using shortest vectors in approximation lattices.

  Two peer-reviewed articles in McGill Undergraduate Mathematics Magazine, 2008
  Talk at Canadian Undergrad Mathematics Conferences, Simon Fraser University, 2007

**Research Assistant.** *Adviser: Prof. Peter Grütter, McGill University.* 2006
- Design a fibre walker for an atomic force microscope.

**Research Assistant.** *Advisers: Prof. Srikar Vengallatore & Prof. Peter Grütter, McGill University.* 2005
- Model molecular heat and strain distribution using finite elements.

**Research Assistant.** *Adviser: Prof. William Skene, Université de Montréal, Canada.* 2004
- Synthesis and characterization of pH-dependent reversible luminous polymers.

# Industrial Experience

**Chief Data Scientist at Vizanda.** 2016
- Develop web-based software to automatically understand generic user input data and rapidly offer relevant visualizations and intelligent insights.

**Intern at Schlumberger-Doll Research Center.** *Adviser: Dr.ir. Aria Abubakar.* 2011
- Develop forward elastic scattering code in 3D based on different Frequency Domain Finite Difference methods.
- Integrate the Fortran code in Schlumberger's commercial software.

**Fields-MITACS Industrial Problem-Solving Workshop** 2008
Model and detect highly synchronized event in brain recordings.
*Problem by the Hospital for Sick Children, Canada.*

**IMA Math Modeling in Industry Workshop** 2007
Classify Earth-orbiting objects from worldwide data of astronomical telescopes using clustering techniques.
*Problem by The Aerospace Corporation*

**Mathematical Problems in Industry at University of Delaware** 2007
Predict filter saturation from a simple filtration process through porous media.
*Problem by W.L. Gore Associates*

**Graduate Student Mathematical Modeling Camp at Rensselaer Polytechnic Institute** 2007
Optimize an underground geothermal heating system through water flow modeling.
*Adviser: Prof. Burt S. Tilley, Olin College*

  Peer-reviewed article with Ortan, Tilley, and Townsend, International Journal of Heat and Mass Transfer, 2009
  Peer-reviewed article with Ortan in McGill Undergraduate Mathematics Magazine, 2008

# PEER-REVIEWED PUBLICATIONS

B. Cockburn and V. Q.-Bélair. *Uniform-in-time superconvergence of the HDG methods for the acoustic wave equation.* Mathematics of Computation, 83(285):65–85, 2014.

A. Ortan, V. Q.-Bélair, B. S. Tilley, and J. Townsend. *On Taylor Dispersion Effects for Transient Solutions in Geothermal Heating Systems.* International Journal of Heat and Mass Transfer, 52(21–22):5072–5080, 2009.

A. Ortan, E. Prosk, and V. Q.-Bélair. *The Airplane Seating Problem.* McGill Undergraduate Mathematics Magazine (MUMM), 2:23–25, 2008.

A. Ortan and V. Q.-Bélair. *Optimizing Efficiency of a Geothermal Air Conditioner.* MUMM, 2:13–15, 2008.

V. Q.-Bélair. *On Primes in Arithmetic Progressions.* MUMM, 2:7–9, 2008.

—. *Once Upon a Time in a p-adic Approximation Lattice.* MUMM, 2:41–43, 2008.

A. Ortan and V. Q.-Bélair. *Euler's Brick.* MUMM, 1:30–33, 2006.

V. Q.-Bélair. *Living without Math.* MUMM, 1:36, 2006.

# TECHNICAL REPORTS

V. Q.-Bélair, G. Pan, and A. Abubakar. *Second Order Staggered Grid Frequency-Domain Finite Difference (FDFD) for Elastodynamics in Three Dimensions.* Technical report, Schlumberger-Doll Research Center, Cambridge, Massachusetts, 2011.

H. Ahmed, P. Chidyagwai, K. Gou, Y. Liu, T. Milgrom, and V. Q.-Bélair. *Associating Earth-Orbiting Objects Detected by Astronomical Telescopes.* Technical report, Mathematical Modeling in Industry XI, IMA, Minnesota, 2007.

A. Atena, Q. Chen, P. Green, A. Ortan, M. Ozlem, V. Q.-Bélair, A. Rubio, and P. D. Vu. *My Air Conditioner? You're Standing on It!* Technical report, Rensselaer Polytechnic Institute, USA, 2007. Graduate Student Mathematical Modeling Camp.

V. Q.-Bélair. *Dirichlet's Theorem.* In *Canadian Undergraduate Mathematics Conference Annual*, pages 43–46. 2007.

# INVITED PRESENTATIONS

V. Q.-Bélair. *A New Approach to Finite Element Simulation of General Relativity.* Numerical Analysis Seminar, University of Maryland, 2016.

—. *A New Approach to Finite Element Simulation of General Relativity.* APAM, Columbia University, 2015.

—. *Finite Element Methods for the Evolution Problem in General Relativity.* Student Days: SIAM Student Chapter Presentations, SIAM Annual Meeting, 2013.

—. *A Priori Error Analysis for the Hybridizable Discontinuous Galerkin method on Acoustic Waves.* Invited Minisymposium on Discontinuous Galerkin Methods, 11th US National Congress on Computational Mechanics (USNCCM), 2011.

—. *A Priori Error Analysis for the Hybridizable Discontinuous Galerkin method on Acoustic Waves.* Invited Minisymposium on Discontinuous Galerkin Methods, 7th International Congress on Industrial and Applied Mathematics (ICIAM), 2011.

—. *A Crowning Achievement of XIX*[th] *Century: Dirichlet's Theorem on Primes in Arithmetic Progressions.* Canadian Undergrad Mathematics Conferences (CUMC), Simon Fraser University, 2007.

# PRESENTATIONS

V. Q.-Bélair. *Finite Element Methods for the Evolution Problem in General Relativity.* Junior Colloquium, University of Minnesota, 2015.

—. *Poster: Finite Element Methods for the Evolution Problem in General Relativity.* ICIAM, 2015.

—. *Poster: Finite Element Methods for the Evolution Problem in General Relativity.* SIAM CSE Conference, 2015.

—. *Poster: Finite Element Methods for the Evolution Problem in General Relativity.* IMA Special Workshop: Structure-Preserving Discretizations of Partial Differential Equations, 2014.

—. *Poster: Finite Element Methods for the Evolution Problem in General Relativity.* SIAM Annual Meeting, 2014.

A. Ortan and V. Q.-Bélair. *Surface Reconstruction from Unorganized Point Cloud.* Computational Geometry Course, University of Minnesota, 2013.

V. Q.-Bélair. *5-minute Thesis Presentation: Finite Element Methods for the Evolution Problem in General Relativity.* SIAM Student Chapter, University of Minnesota, 2013.

—. *Ride the FEniCS, and solve your PDEs.* SIAM Student Chapter, University of Minnesota, 2013.

A. Ortan and V. Q.-Bélair. *The Modeling Contest in Mathematics.* Training and Information Session, SIAM Student Chapter at the University of Minnesota, 2012.

V. Q.-Bélair. *Hyperbolicity of $3+1$ Formalisms in Numerical Relativity.* Working Seminar, University of Minnesota, 2012.

—. *More on the $3+1$ Formalisms in Numerical Relativity.* Working Seminar, University of Minnesota, 2012.

—. *Time Evolution and Regge Calculus.* Working Seminar, University of Minnesota, 2012.

—. *The Analysis of the Hybridizable Discontinuous Galerkin Methods for the Acoustic Wave Equation.* Seminar in Numerical Analysis, University of Minnesota, 2011.

—. *Distributions in PDE.* SIAM Student Chapter Seminar in PDE, University of Minnesota, 2011.

—. *Green's Functions and Integral Methods for PDEs.* SIAM Student Chapter Seminar in PDE, University of Minnesota, 2011.

—. *Introduction to the $3+1$ Formalism in Numerical Relativity.* Working Seminar, University of Minnesota, 2011.

I. Mitrea, A. Ortan, V. Q.-Bélair, and Y. Wang. *The Modeling Contest in Mathematics.* Training and Information Session, IMA, 2010.

V. Q.-Bélair. *Polynomial Approximation Theory.* Seminar in Numerical Analysis, University of Minnesota, 2010.

—. *Poster: Sparsity in the Discontinuous Galerkin Method.* Winter School in Pure and Applied Math, McGill University, 2010.

—. *A Threedimensional H(curl)-conforming Finite Element by Nédélec.* Summer School on Computational Wave Propagation, Institute for Mathematics and its Applications (IMA), Michigan State University, 2010.

—. *A Threedimensional H(curl)-conforming Finite Element by Nédélec.* Seminar in Numerical Analysis, University of Minnesota, 2010.

—. *A Threedimensional H(div)-conforming Finite Element.* Seminar in Numerical Analysis, University of Minnesota, 2010.

J. Townsend, A. Ortan, V. Q.-Bélair, and B. Tilley. *Taylor Dispersion and the Optimization of Residential Geothermal Heating Systems.* Texas, 2008.

V. Q.-Bélair. *Associating Earth-Orbiting Objects.* Mathematical Modeling in Industry XI, IMA, 2007.

—. *Dirichlet's Theorem on Primes in Arithmetic Progressions.* Undergrad Summer Seminar in Number Theory, McGill University, 2007.

—. *p-adic Approximation Lattices.* Undergrad Summer Seminar in Number Theory, McGill University, 2007.

—. *Poster: Designing of an Optical Fiber Walker for an Atomic Force Microscope.* Physics Department Poster Session, McGill University, 2006.

# ACADEMIC ACTIVITIES

**Teaching**

  Partial Differential Equations, 2015-2016

  Modeling Contest in Math Mentoring, 2010-2015 (2 Meritorious Winners and 5 Honorable Mentions)

  Sequences, Series, and Foundations, 2013

  Multivariable Calculus and CSE Calculus 2, 2011-2012

  CSE Linear Algebra and Differential Equations, 2009-2010

  Excursions in Mathematics, Precalculus II, College Algebra and Probability, 2008-2009

**Leadership**

  Founding the SIAM Student Chapter at the University of Minnesota: 2010-2015

  Founding the McGill Undergraduate Mathematics Magazine: 2 issues, 50 pages, 400 copies each, in 2006-2008.