

CURRICULUM VITAE

George Labahn

Professor
Cheriton School of Computer Science
University of Waterloo
Waterloo, Ontario, Canada

Director, Symbolic Computation Group

Employment history

2000-present	Professor (Full)	Computer Science	University of Waterloo
1994-2000	Associate Professor	Computer Science	University of Waterloo
1988-1994	Assistant Professor	Computer Science	University of Waterloo

Administrative Positions

2008-2011	Associate Dean, Graduate Studies and Research	Faculty of Math	University of Waterloo
2006-2006	Interim Director	Computer Science	University of Waterloo
2005-2007	Vice Director	Computer Science	University of Waterloo
1999-2002	Associate Dean, Graduate Studies and Research	Faculty of Math	University of Waterloo

Advanced Degrees

Ph.D.	Univ. of Alberta	Computing Science	1988
M.Sc.	Univ. of Alberta	Computing Science	1986

Editorial Boards

Editor for the following journals:

Journal of Symbolic Computation (JSC) (2003 - present)

Transactions of Mathematical Software (TOMS) (1996 - 2007)

Granting Panels

Grant Funding Panels : National Science Foundation (NSF) (Five times)

Committee of Visitors (COV) : National Science Foundation (NSF)

Conference and Event Administration

Organization Committee (Deputy Lead), Fields Thematic Program on Computer Algebra
Fields Institute, Toronto, July 1, 2015 - Dec 31, 2015

Organizer, Banff International Research Station (BIRS) : Sparse Interpolation, Rational Approximation
and Exponential Analysis. Oaxaca, Mexico (Nov 1-6, 2016) (with A. Cuyt & A. Sidi)

Organizer, Dagstuhl Meeting : Sparse modelling and multiexponential analysis, Workshop, June 14-19 2015,
(with A. Cuyt & A. Sidi)

Organizing Committee Member, Fields Institute meeting on Hybrid Symbolic/Numeric computation,
November 11-17, 2014

Organizing Committee Member, ECCAD 2012, Oakland University, May 5, 2012

Program Committee, Mathematical Knowledge Management (MKM 2015) Washington, DC, July 2015

Program Committee: ISSAC'97 (Maui), ISSAC'07 (Waterloo), ISSAC'14 (Kobe, Japan), ISSAC'16 (Wa-
terloo)

Local Arrangements Co-Chair: ISSAC'07 (Waterloo)

General Co-Chair: ISSAC'05 (Beijing)

General Chair: MOCAA'04 (Waterloo)

Tutorial Chair: ISSAC'99 (Vancouver), Poster Chair: ISSAC'98 (Rostock)

Member, ISSAC Steering Committee: 1999 - 2002

Publications

Books

1. M.B. Monagan, K.O. Geddes, K.M. Heal, G. Labahn, S. Vorketter, J. McCarron, P DeMarco, "The
Maple Introductory Programming Guide", Springer-Verlag, (2003), 370 pages.
2. M.B. Monagan, K.O. Geddes, K.M. Heal, G. Labahn, S. Vorketter, J. McCarron, P DeMarco, "The
Maple Advanced Programming Guide", Springer-Verlag, (2003), 430 pages.
3. K.O. Geddes, S.R. Czapor and G. Labahn, "Algorithms for Computer Algebra", Kluwer Academic
Publishers, (1992), 585 pages.

Papers in Refereed Journals

1. B. Beckermann, G. Labahn and A.C. Matos, On rational functions without Froissart doublets, To appear in *Numerische Mathematik*. (2017)
2. G. Labahn, V. Neiger and W. Zhou, Fast, deterministic computation of the Hermite normal form and determinant of a polynomial matrix. *Journal of Complexity*, 42C (2017) 44-71
3. E. Hubert and G. Labahn, Computations of Invariants of Finite Abelian Groups, *Mathematics of Computation*, 85 (2016), 3029-3050
4. S. MacLean and G. Labahn, A Bayesian model for recognizing handwritten mathematical expressions, *Pattern Recognition*, 48 (2015) 2433-2445
5. W. Zhou, G. Labahn and A. Storjohann, A deterministic algorithms for inverting a polynomial matrix, *Journal of Complexity* 31(2) (2015) 162-173
6. J. Babin, P. Forsyth and G. Labahn, A Comparison of Iterated Optimal Stopping and Local Policy Iteration for American Options Under Regime Switching, *Journal of Scientific Computing* 58 (2014) 409-430.
7. W. Ng, D.E. Chang and G. Labahn, Energy Shaping for Systems with Two Degrees of Underactuation and More than Three Degrees of Freedom, *SIAM Journal on Control and Optimization* 51(2) (2013) 881-905
8. E. Hubert and G. Labahn, Scaling Invariants and Symmetry Reduction of Dynamical Systems, *Foundations of Computational Mathematics* 13(4) (2013) 479-516.
9. Y. Huang, P. Forsyth and G. Labahn, Inexact Arithmetic Considerations for Direct Control and Penalty Methods: American Options under Jump Diffusion *Applied Numerical Mathematics* **72** (2013) 33-51
10. S. Maclean and G. Labahn, A new approach for recognizing handwritten mathematics using relational grammars and fuzzy sets, *International Journal of Document Analysis and Recognition* **16**(2) (2013) 139-163
11. M. Barkatou, C. El Bacha, G. Labahn and E. Pflügel, On Simultaneous Row and Column Reduction of Higher-Order Linear Differential Systems, *Journal of Symbolic Computation* **49**(1) (2013) 45-64
12. Y. Huang, P. Forsyth and G. Labahn, Combined Fixed Point and Policy Iteration for Hamilton-Jacobi-Bellman Equations in Finance, *SIAM Journal of Numerical Analysis* **50**(4) (2012) 1861-1882
13. Y. Huang, P. Forsyth and G. Labahn, Iterative methods for the solution of a singular control formulation of a GMWB pricing problem, *Numerische Mathematik* **122**(1) (2012) 133-167.
14. W. Zhou and G. Labahn, Efficient Computation of Order Bases, *Journal of Symbolic Computation*, **47**(7) (2012) 793-819
15. Y. Huang, P.A. Forsyth and G. Labahn, Methods for pricing American options under regime switching, *SIAM Journal on Scientific Computing*, **33**(5) (2011) 2144-2168.
16. S. Maclean, G. Labahn, E. Lank, M. Marzouk and D. Tausky, Grammar-based techniques for creating ground-truthed sketch corpora, *International Journal of Document Analysis and Recognition*, **14**(1) (2011) 65-74.
17. A.C. Belanger, P.A. Forsyth and G. Labahn, Valuing the Guaranteed Minimum Death Benefit Clause with Partial Withdrawals, *Applied Mathematical Finance*, **16**(6) (2009) 451-496.

18. M. Giesbrecht, G. Labahn and W-s Lee, Symbolic-numeric Sparse Interpolation of Multivariate Polynomials, *Journal of Symbolic Computation* **44**(8) (2009) 943-959.
19. P. Forsyth and G. Labahn, Numerical Methods for Controlled Hamilton-Jacobi-Bellman PDEs in Finance, *Journal of Computational Finance* (2008) **11**(2) 1-44.
20. B. Beckermann, G. Golub and G. Labahn, On the numerical condition of a generalized Hankel eigenvalue problem, *Numerische Mathematik* **106**(1) (2007) 41-68
21. H. Cheng and G. Labahn, Output-sensitive Modular Algorithms for Polynomial Matrix Normal Forms, *Journal of Symbolic Computation*, **42**(7) (2007) 733-750.
22. B. Beckermann, G. Labahn and G. Villard, Normal Forms for General Polynomial Matrices, *Journal of Symbolic Computation*, **41**(6) (2006) 708-737.
23. B. Beckermann, H. Cheng and G. Labahn, Fraction-free Row Reduction of Matrices of Ore Polynomials, *Journal of Symbolic Computation* **41**(5) (2006) 513-543.
24. Y. d'Halluin, P.A. Forsyth and G. Labahn, A Semi-Lagrangian approach for American Asian Options under jump diffusion, *SIAM Journal of Scientific Computation* **27** (2005) 315-345.
25. Y. d'Halluin, P.A. Forsyth, and G. Labahn, A penalty method for American options with jump diffusion processes, *Numerische Mathematik*, **97**:2 (2004) 321-352.
26. Y. d'Halluin, P.A. Forsyth, K.R. Vetzal, and G. Labahn, A Numerical PDE Approach for Pricing Callable Bonds. *Applied Mathematical Finance* **8** (2001) 49-77.
27. B. Beckermann and G. Labahn, Fraction-free Computation of Matrix Rational Interpolants and Matrix GCD's. *SIAM Journal Matrix Analysis and Applications*. **22**(1) (2000) 114-144.
28. B. Beckermann and G. Labahn, Effective Computation of Rational Approximants and Interpolants. *Reliable Computing* **6** (2000) 365-390.
29. B. Beckermann and G. Labahn, When are two numerical polynomials relatively prime? *Journal of Symbolic Computation* **26** (1998) 677-689.
30. B. Beckermann and G. Labahn, A fast and numerically stable Euclidean-like algorithm for detecting relatively prime numerical polynomials. *Journal of Symbolic Computation* **26** (1998) 691-714.
31. B. Beckermann and G. Labahn, Recursiveness in Matrix Rational Interpolation Problems, *Journal of Computational and Applied Math* **77** (1997) 5-34.
32. S. Cabay, A.R. Jones and G. Labahn, Algorithm 766: Experiments with a Weakly Stable Algorithm for Computing Padé-Hermite and Simultaneous Padé Approximants, *ACM Transactions of Mathematical Software (TOMS)* **23**(1) (1997) 91-110.
33. A. Storjohann and G. Labahn, A Fast Las Vegas Algorithm for Computing the Smith Normal Form of a Polynomial Matrix, *Linear Algebra and its Applications* **253** (1997) 155-173.
34. S. Cabay, A.R. Jones and G. Labahn, Computation of Numerical Padé-Hermite and Simultaneous Padé Systems I: Near Inversion of Generalized Sylvester Matrices, *SIAM Journal Matrix Analysis and Applications* **17** (1996) 247-267.
35. S. Cabay, A.R. Jones and G. Labahn, Computation of Numerical Padé-Hermite and Simultaneous Padé Systems II: A Weakly-Stable Algorithm, *SIAM Journal Matrix Analysis and Applications* **17** (1996) 268-297.

36. G. Labahn, B. Beckermann and S. Cabay, Inversion of Mosaic Hankel Matrices via Matrix Polynomial Systems, *Linear Algebra and its Applications* **221** (1995) 253-280.
37. B. Beckermann and G. Labahn, A uniform approach for the fast computation of Matrix-type Padé approximants, *SIAM Journal Matrix Analysis and Applications* **15** (1994) 804-823.
38. G. Labahn and T. Shalom, Inversion of Toeplitz Structured Matrices using only Standard Equations, *Linear Algebra and its Applications* **207** (1994) 49-70.
39. G. Labahn, Inversion Components for Block Hankel-like Matrices, *Linear Algebra and its Applications* **177** (1992) 7-48.
40. B. Beckermann and G. Labahn, A uniform approach for Hermite Padé and simultaneous Padé Approximants and their Matrix-type generalizations, *Numerical Algorithms* **3** (1992) 45-54
41. G. Labahn and T. Shalom, Inversion of Toeplitz Matrices with only Two Standard Equations, *Linear Algebra and its Applications* **175** (1992) 143-158.
42. S. Cabay and G. Labahn, A Superfast Algorithm for Multi-dimensional Padé Approximation, *Numerical Algorithms* **2** (1992) 201-224.
43. S. Cabay, G. Labahn and B. Beckermann, On the Theory and Computation of Non-perfect Padé-Hermite Approximants, *Journal of Computational and Applied Math* **39** (1992) 295-313.
44. G. Labahn, D.K. Choi and S. Cabay, Inverses of Block Hankel and Block Toeplitz Matrices, *SIAM Journal of Computing* **19** (1990) 98-123.
45. T.C. Scott, R.A. Moore, G.J. Fee, M.B. Monagan, G. Labahn and K.O. Geddes, Perturbative Solutions of Quantum Mechanical Problems by Symbolic Computation: A Review, *International Journal of Modern Phys. C* **1** (1990) 53-76.
46. G. Labahn and S. Cabay, Matrix Padé Fractions and their Computation, *SIAM Journal of Computing* **18** (1989) 639-657.

Papers in Refereed Conference Proceedings

1. M. Giesbrecht, J. Haraldson and G. Labahn, Computing the Nearest Singular Matrix Polynomial, *Proceedings of ISSAC'17*, Kaiserslautern, Germany, (2017).
2. S. Chen, Q-H Hou, G. Labahn and R-H Wang, Existence Problem of Telescopers: Beyond the Bivariate Case. *Proceedings of ISSAC'16*, Waterloo, Ontario, July 19-22, (2016) 167-174.
3. W. Zhou and G. Labahn, Unimodular Completion of Polynomial Matrices, *Proceedings of ISSAC'14*, Kobe, Japan, July 22-25, (2014) 413-420.
4. W. Zhou and G. Labahn, Computing Column Bases for Polynomial Bases, *Proceedings of ISSAC'13*, Boston, USA, June 26-29, (2013) 379-386.
5. H. Cheng and G. Labahn, A Practical Implementation of a Modular Algorithm for Ore Polynomial Matrices, Computer Mathematics. *Proceedings of ASCM 09 and 12*. R. Feng, W-s Lee, Y. Sato (Eds.) (2014) 49-60.
6. M. Giesbrecht, G. Labahn and Y. Zhang, Computing Popov Forms of Matrices Over PBW Extensions, Computer Mathematics. *Proceedings of ASCM 09 and 12*. R. Feng, W-s Lee, Y. Sato (Eds.) (2014) 61-66.
7. E. Hubert and G. Labahn, Rational invariants of scalings from Hermite normal forms, *Proceedings of ISSAC'12*, Grenoble, France, July 22-25, (2012) 219-226.

8. W. Zhou, G. Labahn and A. Storjohann, Computing Minimal Nullspace Bases, *Proceedings of ISSAC'12*, Grenoble, France, July 22-25, (2012) 366-373.
9. S. Maclean, D. Tausky, G. Labahn, E. Lank and M. Marzouk, Is the iPad useful for sketch input? A comparison with the Tablet PC, *Proceedings of the International Symposium on Sketch-Based Interfaces and Modeling (SBIM 2011)*. (2011)
10. W. Zhou and G. Labahn, Efficient Computation of Order Bases, *Proceedings of ISSAC'09*, Seoul, Korea, ACM Press, (2009) 375-382.
11. B. Beckermann and G. Labahn, Fraction-Free Computation of Simultaneous Padé Approximants, *Proceedings of ISSAC'09*, Seoul, Korea, ACM Press, (2009) 15-22.
12. S. Maclean, D. Tausky, G. Labahn, E. Lank and M. Marzouk, Tools for the efficient generation of hand-drawn corpora based on context-free grammars, *Proceedings of the Eurographics Symposium on Sketch-Based Interfaces and Modeling (SBIM 2009)*. (2009) 125-132
13. G. Labahn, E. Lank, M. Marzouk, A. Bunt, S. Maclean and D. Tausky, MathBrush: A Case Study for Pen-based Interactive Mathematics, *Proc. of the 5th Eurographics Symposium on Sketch-Based Interfaces and Modelling (SBIM 2008)*. (2008)
14. D. Tausky, G. Labahn, E. Lank and M. Marzouk, Managing Ambiguity in Mathematical Matrices, *Proc. of the 4th Eurographics Symposium on Sketch-Based Interfaces and Modelling (SBIM 2007)*. (2007) 115-122.
15. H. Cheng and G. Labahn, On Computing Polynomial GCDs in Alternate Bases, *Proceedings of ISSAC'06*, Genoa, Italy, ACM Press, (2006).
16. M. Giesbrecht, G. Labahn and W-s Lee, Symbolic-numeric Sparse Interpolation of Multivariate Polynomials, *Proceedings of ISSAC'06*, Genoa, Italy, ACM Press, (2006).
17. M. Giesbrecht, G. Labahn and W-s Lee, Symbolic-Numeric Sparse Polynomial Interpolation in Chebyshev Basis and Trigonometric Interpolation, *Proceedings of Computer Algebra in Scientific Computing (CASC 2004)*, St. Petersburg, Russia, (2004)
18. G. Labahn and Ziming Li, Hyperexponential Solutions of Finite-rank Ideals in Uncoupled Ore Algebras, *Proceedings of ISSAC'04*, Santander, Spain, ACM Press, (2004) 213-220.
19. R. Burger, G. Labahn and M. van Hoeij, Closed form solutions of linear odes having elliptic functions as coefficients, *Proceedings of ISSAC'04*, Santander, Spain, ACM Press, (2004) 58-64.
20. C.P. Jeannerod and G. Labahn, The SNAP Package for Arithmetic with Numeric Polynomials, *Proceedings of International Congress of Mathematical Software 2002*, Beijing, China, (2002) 61-71.
21. B. Beckermann, H. Cheng and G. Labahn, Fraction-free Row Reduction of Matrices of Skew Polynomials, *Proceedings of ISSAC'02*, Lille, France, ACM Press, (2002) 8-15.
22. H. Cheng and G. Labahn, Computing all Factorizations in $Z_N[x]$, *Proceedings of ISSAC'01*, London, Canada, ACM Press, (2001) 64-71.
23. B. Beckermann, G. Labahn and G. Villard, Shifted Normal Forms of Polynomial Matrices, *Proceedings of ISSAC'99*, Vancouver, ACM Press, (1999) 189-196.
24. B. Beckermann, S. Cabay and G. Labahn, Fraction-free Computation of Matrix Padé Systems, *Proceedings of ISSAC'97*, Maui, ACM Press, (1997) 125-132.
25. D.J. Jeffrey, G. Labahn, M. von Mohrenschildt and A.D. Rich, Integration of the signum, piecewise and related functions, *Proceedings of ISSAC'97*, Maui, ACM Press, (1997) 324-330.

26. W. Heidrich, R. Bartels and G. Labahn, Fitting Uncertain Data with NURBS, *Proceedings of Curves and Surfaces*, Chamonix, France, (1997)
27. A. Storjohann and G. Labahn, Asymptotically Fast Computation of the Hermite Normal Form of an Integer Matrix, *Proceedings of ISSAC'96*, Zürich, ACM Press, (1996) 259-266.
28. K.O. Geddes and G. Labahn, Symbolic and Numeric Integration in Maple, *Proceedings of the First Asian Technology Conference in Mathematics*, Singapore, (1995) 377-386.
29. K.O. Geddes and G. Labahn, The Maple Computer Algebra System, *Proceedings of the First Asian Technology Conference in Mathematics*, Singapore, (1995) 367-376.
30. A. Storjohann and G. Labahn, Preconditioning of Rectangular Polynomial Matrices for Efficient Hermite Normal Form computation, *Proceedings of ISSAC'95*, Montreal, ACM Press, (1995) 119-125.
31. M. Van Barel, B. Beckermann, A. Bultheel and G. Labahn, Matrix Rational Interpolation with Pole Information, *Nonlinear Numerical Methods and Rational Approximation*, (A. Cuyts ed.), Antwerp, Kluwer Academic Publishers, (1994) 137-148.
32. S. Cabay and G. Labahn, A Fast, Reliable Algorithm for Calculating Padé-Hermite Forms, *Proceedings of ISSAC'89*, (G.H. Gonnet ed.), Portland, ACM Press, (1989) 95-100.
33. G. Labahn and S. Cabay, Matrix Padé Fractions, *Proceedings of EUROCAL'87*, (J. Davenport ed.), Leipzig, *Lecture Notes in Computer Science*, Springer-Verlag, (1989) 438-449.

Papers in Refereed Workshop Proceedings

1. S. Maclean, and G. Labahn, Elastic matching in linear time and constant space, *Proceedings of Ninth IAPR International Workshop on Document Analysis Systems DAS 2010*, (Short paper), (2010) 551-554
2. G. Labahn, E. Lank, S. Maclean, M. Marzouk and D. Tausky, MathBrush: A System for Doing Math on Pen-Based Devices, *Proceedings of The Eighth IAPR Workshop on Document Analysis Systems DAS 2008*, September 16-19, Nara, Japan (2008) 599-606.
3. G. Labahn, S. Maclean, M. Marzouk, I. Rutherford and D. Tausky, A preliminary report on the MathBrush pen-math system, *Proceedings of the Maple Conference 2006*, (2006) 162-178.
4. G. Labahn and T. Humphries, Symbolic Integration of Jacobian Elliptic Functions in Maple, *Proceedings of the Maple Conference 2005*, (2005) 331-339

Other Publications

1. M. Giesbrecht, G. Labahn and W-s Lee, Symbolic-Numeric Sparse Polynomial Interpolation of Multivariate Polynomials, *Proc. 9th Rhine Workshop on Computer Algebra* (2004).
2. G. Labahn and M. Mutrie, Reduction of Elliptic Integrals to Legendre Normal Form, *University of Waterloo Tech Report 97-21* (1997)
3. G. Labahn, Solving Linear Differential Equations in Maple, *MapleTech*, 2 (1995) 20-28.

Software

1. Symbolic integration of Erf, Si, Ci and Fresnel Functions (2008)

2. Symbolic integration of Elliptic Functions (2004)
3. Solving linear differential equations having doubly-periodic coefficients (2002-2004)
4. The *MatrixPolynomialAlgebra* package (2002)
5. Special function solutions of higher order linear odes using the Meijer G ode (2000)
6. Solving linear differential equation using differential factorization (1999-2000)
7. Solution of linear differential equations via special functions (1996-2000)
8. Computation of indefinite Elliptic integrals (1996)
9. The *Plots* graphics package in Maple (1990-1995)
10. The *Plottools* graphics package in Maple (1995)
11. The *inttrans* package for computation of integral transforms in Maple (1992-1995)
12. Computation of definite Elliptic Integrals in Maple (1991-1996)
13. The linear differential equation solver in Maple (1993-1998)
14. Matrix similarity in Maple (1994)
15. Frobenius and Jordan Normal Forms in Maple (1992-1995)
16. Indefinite Integration of Bessel Functions in Maple (1993)
17. Extensions of Risch Algorithm for functions defined by integrals in Maple (1992)
18. Implementation of bivariate modular gcd algorithm in Maple (1991)
19. Computation of the Matrix Exponential in Maple (1989)

Graduate Supervision

Current PhD students

Joseph Haldorson - 2015 to present (with M. Giesbrecht)
Parsiad Azimzadeh - 2016 to present

Previous PhD students : (8)

Current MMath students

Bangyao Xu - 2017 to present

Previous Masters students (36)

Current Post Docs

Hui Huang - 2017 to present (with M. Giesbrecht and E. Schost)

Recent Talks (last 4 years)

1. On rational functions without Froissart doublets, SIAM Conference in Applied Algebraic Geometry, Atlanta, USA, (August 2017)
2. Fast computation of determinants and Hermite Normal Forms of polynomial matrices, ENS-Lyon, Lyon, France, (March 2017)
3. Finite group actions on dynamical systems, Plenary talk : FELim, Limoges, France, (March 2016)
4. Finite Abelian Actions on Polynomial Systems, Kolchin Seminar, CUNY, NY (March 2016)
5. Symbolic-Numeric Computation with Rational Functions, Symbolic/Numeric Seminar, CUNY, NY (March 2016)
6. Pen-Math Systems. CS Colloquium, University of Waterloo (Dec 2015)
7. Arithmetic of Polynomial Matrices, Fields Institute, Toronto, (Oct 2015)
8. Symmetries and Polynomial Systems, Fields Institute, Toronto, (Sept 2015)
9. Symmetry reduction by finite, abelian groups. Foundations of Computational Mathematics (FoCM'14), Montevideo, Uruguay (Dec 2014)
10. Unimodular Completion of Polynomial Matrices. International Symposium on Symbolic and Algebraic Computation (ISSAC'14), Kobe, Japan (July 2014)
11. Scaling Invariants of Dynamical Systems. Applications of Computer Algebra (ACA), New York, USA (July 2014)
12. Rational Invariants of Finite Abelian groups. Applications of Computer Algebra (ACA), Fordham University, USA (July 2014)
13. Numerical Considerations for the Sparse Interpolation Problem. SIAM Conference in Algebraic Geometry, Fort Collins, USA (August 2013)
14. Interpolation with Alternate Bases. SIAM Conference in Algebraic Geometry, Fort Collins, USA (August 2013)
15. Applications of fast kernel computation of polynomial matrices. AMMCS-2013, Providence, USA (June 2013)
16. The Conditioning of the Generalized Hankel Eigenvalue Problem. Project GALAAD, INRIA Mediterranee, Sophia Antipolis, France (July 2012)
17. Rational invariants of scalings from Hermite normal forms. International Symposium on Symbolic and Algebraic Computation (ISSAC'12), Grenoble, France (July 2012)
18. Fast Computation of Nullspace Bases. Laboratoire LIP, l'Ecole Normale Supérieure de Lyon, Lyon, France (April 2012)
19. Scaling Symmetries and Integer Linear Algebra. Laboratoire de Mathématiques Paul Painlevé Université des Sciences et Technologies de Lille, Lille, France (March 2012)

20. Fast Computation of Nullspace Bases. Laboratoire de Mathematiques Paul Painleve Universite des Sciences et Technologies de Lille, Lille, France (March 2012)

Research Funding (last 10 years)

NSERC Individual Operating Grant	2015-2019	\$43,000/yr
NSERC/Scotiabank CRD Grant (with P. Forsyth)	2012-2015	\$25,000/yr
Scotiabank Grant (with P. Forsyth)	2012-2015	\$25,000/yr
NSERC Individual Operating Grant	2010-2014	\$51,000/yr
MITACS Grant Mathematics of Computer Algebra and Analysis (with M. Monagan and 12 others)	Apr 12-Mar 13	\$222,000/yr
MITACS Grant Mathematics of Computer Algebra and Analysis (with M. Monagan and 12 others)	Apr 11-Mar 12	\$222,000/yr

NSERC/Scotiabank Industrial Chair (with D. Berry and K. Czarnecki)	2008-2012	\$491,885/yr
Tata Consulting Services, India Portfolio Optimization with Liquidity Risk (with P. Forsyth)	2008	\$25,000
MITACS Grant Mathematics of Computer Algebra and Analysis (with M. Monagan and 12 others)	Apr 09-Mar 11	\$227,000/yr
MITACS Grant Mathematics of Computer Algebra and Analysis (with M. Monagan and 12 others)	Apr 07-Mar 09	\$254,000/yr
NSERC Individual Operating Grant	2006-2010	\$49,000/yr
MITACS Grant Mathematics of Computer Algebra and Analysis (P. Borwein (PI) and 12 others)	Apr 05-Mar 07	\$254,000/yr
MITACS Grant Mathematics of Computer Algebra and Analysis (P. Borwein (PI) and 12 others)	Apr 03-Mar 05	\$252,000/yr
MICROSOFT INDUSTRIAL Grant Pen-based Mathematics for PC Tablets (with S. Watt and M. Giesbrecht)	Apr 04-Mar 07	\$252,000/yr