Kevin Church

Postdoctoral Fellow, Université de Montréal

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Education

2015–2019 **Ph.D Applied Mathematics**, *University of Waterloo*
Thesis: *Invariant manifold theory for impulsive functional differential equations with applications.*
Advisors: Xinzhi Liu and Jun Liu.
Completed "Fundamentals of University Teaching" certificate program.

2012–2014 **M.Sc Mathematics**, *University of Ottawa*
Thesis: *Applications of impulsive differential equations to the control of malaria outbreaks and introduction to impulse extension equations: a general framework to study the validity of ordinary differential equation models with discontinuities in state.*
Advisor: Stacey Smith?

2008–2012 **B.Sc, Honours, Major in Mathematics, Minor in Life Sciences**, *University of Ottawa*

Employment

2021– **Postdoctoral Fellow**, *Université de Montréal*, Centre de Recherches Mathématiques
Advisor: Jean-Philippe Lessard,

2019–2021 **Postdoctoral Fellow**, *McGill University*
Advisor: Jean-Philippe Lessard

2019– **Lecturer**, *McGill University*
- Math 262 (Intermediate Calculus): September 2021 – December 2021.
- Math 262 (Intermediate Calculus): September 2020 – December 2020.
- Math 263 (Ordinary Differential Equations): September 2019 – December 2019.

2015–2019 **Lecturer, Teaching Assistant**, *University of Waterloo*
- Lecturer for Math 127 (Calculus for the Sciences): September 2017 – December 2017.
- Teaching Assistant: various academic terms from 2015 – 2019 for courses including
  - AMATH 851 (Stability Theory and Applications): January 2019 – April 2019
  - AMATH 451 (Introduction to Dynamical Systems): January 2018 – April 2018
  - AMATH 331 (Applied Real Analysis): January 2018 – April 2018
  - CS 240 (Data Structures and Data Management): May 2016 – August 2016
  - MATH 237 (Calculus III for Honours Mathematics): May 2016 – August 2016

2012–2015 **Teaching Assistant, Tutor**, *University of Ottawa*
- Teaching Assistant: various academic terms from September 2012 – December 2014.
- Math Help Center: September 2014 – April 2015.
  - Tutored students in first-year mathematics courses.
  - Bilingual (English, French) position.

Works submitted for publication

[1] K.E.M. Church, An implicit method of steps for differential equations with state-dependent delay. Submitted August 2021.

[2] K.E.M. Church, Uniqueness of solutions and linearized stability for impulsive differential equations with state-dependent delay. Submitted April 2021.

[3] K.E.M. Church and J. Lessard. Rigorous verification of Hopf bifurcations in functional differential equations of mixed type. Submitted November 2020.

[4] K.E.M. Church and G.W. Duchesne. Rigorous continuation of periodic solutions for impulsive delay differential equations. Submitted October 2020.

Papers in refereed journals

[1] K.E.M. Church and C. Fortin. Computer-assisted methods for analyzing periodic orbits in vibrating gravitational billiards. *International Journal of Bifurcation and Chaos*, 31(08):2130021, 2021.

[2] K.E.M. Church. Analysis of pandemic closing-reopening cycles using rigorous homotopy contiuation: a case study with Montreal COVID-19 data. *SIAM Journal on Applied Dynamical Systems*, 20(2), 745–783, 2021.

[3] K.E.M. Church and X. Liu. Invariant manifold-guided impulsive stabilization of delay equations. IEEE Transactions on Automatic Control, *in press*, 2021.

[4] K.E.M. Church. Eigenvalues and delay differential equations: periodic coefficients, impulses and rigorous numerics. *Journal of Dynamics and Differential Equations*, 2020.

[5] K.E.M. Church and Xinzhi Liu. Cost-Effective Robust Stabilization and Bifurcation Suppression. *SIAM Journal on Control and Optimization*, 57(3):2240–2268, 2019.

[6] K.E.M. Church and Xinzhi Liu. Analysis of a SIR model with pulse vaccination and temporary immunity: Stability, bifurcation and a cylindrical attractor. *Nonlinear Analysis: Real World Applications*, 50:240–266, 2019.

[7] K.E.M. Church and Xinzhi Liu. Computation of centre manifolds and some codimension-one bifurcations for impulsive delay differential equations. *Journal of Differential Equations*, 267(6):3852–3921, 2019.

[8] K.E.M. Church and Xinzhi Liu. Smooth centre manifolds for impulsive delay differential equations. *Journal of Differential Equations*, 265(4):1696–1759, 2018.

[9] K.E.M. Church and R.J. Smith. Continuous approximation of linear impulsive systems and a new form of robust stability. *Journal of Mathematical Analysis and Applications*, 457(1):614–644, 2018.

[10] K.E.M. Church and Xinzhi Liu. Bifurcation Analysis and Application for Impulsive Systems with Delayed Impulses. *International Journal of Bifurcation and Chaos*, 27(12):1750186, 2017.

[11] K.E.M. Church and Xinzhi Liu. Bifurcation of Bounded Solutions of Impulsive Differential Equations. *International Journal of Bifurcation and Chaos*, 26(14):1650242, 2016.

[12] K.E.M. Church and R.J. Smith. Comparing malaria surveillance with periodic spraying in the presence of insecticide-resistant mosquitoes: Should we spray regularly or based on human infections? *Mathematical Biosciences*, 276, 2016.

[13] K.E.M. Church and R.J. Smith. Existence and uniqueness of solutions of general impulse extension equations with specification to linear equations. *Dynamics of Continuous, Discrete and Impulsive Systems Series B: Applications and Algorithms*, 22(3), 2015.

[14] K.E.M. Church and Robert J Smith. Analysis of piecewise-continuous extensions of periodic linear impulsive differential equations with fixed, strictly inhomogeneous impulses. *Dynamics of Continuous, Discrete and Impulsive Systems Series B: Applications & Algorithms*, 21:101–119, 2014.

Research monographs

[1] K.E.M. Church and X. Liu. Bifurcation theory of impulsive dynamical systems. *IFSR International Series in Systems Science and Systems Engineering, Vol. 34. Springer Nature*, 2021.

Refereed conference proceedings and theses

[1] K. Church. Invariant manifold theory for impulsive functional differential equations with applications. Ph.D Thesis, University of Waterloo, 2019.

[2] K.E.M. Church. Linearization and local topological conjugacies for impulsive systems. *In: Kilgour, D.M., Kunze, H., Makarov, R., Melnik, R., Wang, X. (Eds.) Recent Advances in Mathematical and Statistics Methods: IV AMMCS International Conference, Waterloo, Canada, August 20-25, 2017*.

[3] K.E.M. Church. A new measure of robust stablity for linear ordinary impulsive differential equations. *In: Belair, J., Frigaard I., Kunze H., Makarov R., Melnik R., Spiteri R. (Eds.) Mathematical and Computational Approaches in Advancing Modern Science and Engineering*, 2016.

[4] K. Church. Applications of impulsive differential equations to the control of malaria outbreaks and introduction to impulse extension equations: a general framework to study the validity of ordinary differential equation models with discontinuities in state. M.Sc Thesis, University of Ottawa, 2014.

Selected honours, grants and fellowships

2021 **CRM-Simons Postdoctoral Fellowship**, Simons Foundation, administered by Centre de Recherches Mathématiques, one year fellowship

2020 **Applied Mathematics Doctoral Award**, University of Waterloo

2019 **NSERC Postdoctoral Fellowship**, Natural Sciences and Engineering Research Council of Canada, two-year fellowship

2019 **Joseph Wai-Hung Liu Graduate Scholarship**, University of Waterloo

2019 **Travel Grant**, Waterloo Institute for Complexity and Innovation

2018 **Graduate Fellowship**, Waterloo Institute for Complexity and Innovation

2018 **Winner, Three Minute Thesis Competition, Mathematics Faculty Heat**, University of Waterloo

2017 **Alexander Graham Bell Canada Graduate Scholarship**, Natural Sciences and Engineering Research Council of Canada, held 2017-2019

2015 **President's Graduate Scholarship**, University of Waterloo, held 2015–2019

2015 **Ontario Graduate Scholarship**, Government of Ontario, through University of Waterloo, held 2015–2017

2016 **Best Student Paper Prize: Mathematics and Statistics**, University of Ottawa

2014 **Honorable Mention, Excellence Award for Teaching Assistants**, University of Ottawa

Invited talks and organized sessions

2021 **Validated integration and implicit method of steps for differential equations with state-dependent delay**, *50 years of Functional Differential Equations at ICMC*, University of São Paulo, São Carlos, August 2-6

2021 **Computer-assisted proof of Hopf bifurcation in functional differential equations of mixed type**, *Recent advances in theory and applications of functional differential equations*, 2021 CMS 75th +1 Anniversary Summer Meeting, June 7-11

2021 **Rigorous homotopy continuation for periodic orbits in a non-smooth epidemic model**, *Minisymposium: Computer-assisted Mathematical Proofs in Nonlinear Dynamics*, SIAM Conference on Applications of Dynamical Systems, May 23-27

2021 **Computer-assisted proof of Hopf bifurcation in functional differential equations**, *Special Session on Functional Differential Equations, Theory and Applications*, 2021 AMS Spring Southeastern Sectional Meeting (formerly at Georgia Institute of Technology), March 13-14

2020 **Session organizer**, *Applications and Recent Developments in Discontinuous Dynamical Systems*, 2020 CMS Winter Meeting, December 3-8

2017 **Control of malaria in the presence of insecticide-resistant mosquitoes**, *The 10th Annual Ottawa Mathematics Conference*, uOttawa Distinguished Student Paper Lecture, June 16-19

2016 **Bifurcations in impulsive differential equations**, *The 9th Annual Ottawa Mathematics Conference*, June 17-19

2013 **A comparison of two malaria vector control strategies with impulsive differential equations**, *2013 CMS Winter Meeting*, session "Infectious Disease Modelling", December 6-9

Contributed talks

2020 **Spectral theory for impulsive delay differential equations**, *2020 CMS Winter Meeting*, session "Applications and Recent Developments in Discontinuous Dynamical Systems", December 3-8

2019 **Centre manifolds for impulsive delay differential equations: theory and applications**, *SIAM Conference on Applications of Dynamical Systems*, May 19-23

2017 **Linearization and topological conjugacies for impulsive systems**, *The IV AMMCS International Conference*, August 20-25

2015 **A new measure of robust stability for impulsive differential equations**, *The 2015 AMMCS-CAIMS Congress*, June 7-12

2011 **Modelling biological phenomena with impulsive differential equations**, *2011 Candian Undergraduate Mathematics Conference*, June 15-19

Seminars

2021 **My difficult relationship with state-dependent delay differential equations**, *Applied Mathematics Working Seminar*, McGill University, February 16

2020 **Floquet theory, invariant manifolds and control with impulsive delay differential equations**, *ISS Informal Systems Seminar*, GERAD Group for Research in Decision Analysis, November 27

2020 **Rigorous computation of periodic solutions and Floquet multipliers in delay differential equations with time-forced discontinuities**, *CRM-CAMP in Nonlinear Analysis Seminar Series*, Centre de Recherches Mathématiques, October 13

2020 **Ill-posed functional differential equations and applications to traveling waves in nonlocal reaction-diffusion equations**, *Applied Mathematics Working Seminar*, McGill University, September 22

2020 **Centre manifolds for impulsive delay differential equations: approximation and applications**, *CRM Applied Mathematics Seminars*, Centre de Recherches Mathématiques, February 24

2019 **The hidden geometry of complex dynamics and how to exploit it**, *WICI Graduate Fellowship Awardee Research Symposium*, University of Waterloo, February 12

Workshops attended

2020 **Connections in Infinite Dimensional Dynamics**, *May 18-22*, Banff, Canada

2019 **Rigorous Computational Dynamics in Infinite Dimensions**, *April 3-6*, Montreal, Canada

Supervision and mentorship

2020 **Undergraduate Summer Research Student**

- Supervised Clément Fortin, a second-year undergraduate student in mathematical physics. He worked on a project that I proposed on gravitational billiards.
- Findings were written up as a paper and published at International Journal of Bifurcation and Chaos.

2020 **CÉGEP Supervision Program**
- Supervised three CÉGEP (pre-university) students on a winter term research project.
- Students worked on a project in infectious disease modelling and vaccination, completing independent readings, writing up a report and giving a presentation to their peers.

Service

2021 **Panelist, Graduate Orientation NSERC Session**, McGill University

2021 **NSERC CGS-M Selection Committee**, McGill University

2021 **Poster Session / Red Socks Award Judge**, *SIAM Conference on Applications of Dynamical Systems 2021*

2018–2019 **Chair**, *Applied Mathematics Graduate Student Colloquium*, University of Waterloo

2018 **Chair**, *Dynamical Systems and Stability Group*, University of Waterloo

Refereeing and editorial activities

Refereeing for journals, *(in alphabetical order)*
- Bulletin des Sciences Mathématiques.
- Chaos, Solitons and Fractals.
- IEEE Transactions on Automatic Control.
- International Journal of Bifurcation and Chaos.
- Journal of Applied Mathematics.
- Journal of Differential Equations.
- Nonlinear Analysis.
- Nonlinear Analysis: Hybrid Systems.
- Nonlinear Analysis: Real-World Applications.
- SIAM Journal on Control and Optimization.
- Systems and Control Letters.

Reviewer, *MathSciNet Reviews*

Professional memberships

2020– **Canadian Mathematical Society**

2018– **Society for Industrial and Applied Mathematics**

2016– **American Mathematical Society**

2012– **Society for Mathematical Biology**

Languages

English Native

French Proficient