

# Kevin Church

Postdoctoral Fellow, McGill University

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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

2019– **Postdoctoral Fellow**, *McGill University*.

Advisor: Jean-Philippe Lessard

2019– **Lecturer**, *McGill University*.

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

- [2] K.E.M. Church and J. Lessard. Rigorous verification of Hopf bifurcations in functional differential equations. Submitted November 2020.
- [3] 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 X. Liu. Invariant manifold-guided impulsive stabilization of delay equations. *IEEE Transactions on Automatic Control*, *in press*, 2021.
- [2] K.E.M. Church. Analysis of pandemic closing-reopening cycles using rigorous homotopy continuation: a case study with Montreal COVID-19 data. *SIAM Journal on Applied Dynamical Systems*, *in press*, 2021.
- [3] K.E.M. Church and C. Fortin. Computer-assisted methods for analyzing periodic orbits in vibrating gravitational billiards. *International Journal of Bifurcation and Chaos*, *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*, 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 stability 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**, Centre de Recherches Mathématiques & Simons Foundation, 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 **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, 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 Canadian 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 Project.**
  - o Clément Fortin, second-year undergraduate student in mathematical physics. Supervised for the summer term on a project that I proposed on gravitational billiards.
  - o Their findings were written up as a paper and published at International Journal of Bifurcation and Chaos.
- 2020 **CÉGEP Supervision Program.**
  - o Supervised three CÉGEP (pre-university) students on a winter term research project. The program is administered through McGill and counts for credit at the students' CÉGEP.
  - o 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 **NSERC CGS-M Selection Committee**, McGill University.
- 2018–2019 **Chair**, *Applied Mathematics Graduate Student Colloquium*, University of Waterloo.
- 2018 **Chair**, *Dynamical Systems and Stability Group*, University of Waterloo.
- 2018– **Reviewer**, *MathSciNet Reviews*.
- 2014– **Manuscript reviewer**, *Bulletin des Sciences Mathématiques*. *IEEE Transactions on Automatic Control*. *Nonlinear Analysis*. *Chaos, Solitons and Fractals*. *SIAM Journal on Control and Optimization*. *Nonlinear Analysis: Hybrid Systems*. *Journal of Applied Mathematics*. *IEEE Access*. *AIMS Bioengineering*. *AIMS Mathematics*. *Applications of Mathematics*.

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