

# Antoine Allard

## Curriculum Vitæ

Assistant Professor  
Département de physique, de génie physique et d'optique  
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Université Laval  
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## ACADEMIC POSITIONS

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| <b>Université Laval</b><br>Assistant Professor<br>★ Sentinelle Nord Research Chair on Applications and Theory of Network Analysis                                                                                                                       | Québec, Canada<br>2018–present |
| <b>Universitat de Barcelona</b><br>Postdoctoral Fellow<br>★ Awarded the Juan de la Cierva – Incorporación postdoctoral fellowship                                                                                                                       | Barcelona, Spain<br>2018       |
| <b>Centre de Recerca Matemàtica</b><br>Senior Research Fellow                                                                                                                                                                                           | Bellaterra, Spain<br>2017      |
| <b>Universitat de Barcelona</b><br>Postdoctoral Fellow<br>★ Awarded the Fonds de recherche du Québec – Nature et Technologies postdoctoral fellowship                                                                                                   | Barcelona, Spain<br>2014–2016  |
| <b>University of British Columbia Centre for Disease Control</b><br>Research Assistant                                                                                                                                                                  | Vancouver, Canada<br>2006–2007 |
| <b>Université Laval</b><br>Undergraduate Research Assistant<br>○ Supervisor: Louis J. Dubé, Nonlinear Dynamics Group<br>★ Natural Sciences and Engineering Research Council of Canada Undergraduate Student Research Award                              | Québec, Canada<br>2006         |
| <b>Centre de Recherche de l'Hôtel-Dieu de Québec</b><br>Undergraduate Research Assistant<br>○ Supervisor: Luc Beaulieu, Radio Oncology Department<br>★ Natural Sciences and Engineering Research Council of Canada Undergraduate Student Research Award | Québec, Canada<br>2005         |
| <b>Université Laval</b><br>Undergraduate Research Assistant<br>○ Supervisor: Gilles Joncas, Astrophysics Group                                                                                                                                          | Québec, Canada<br>2004         |

## EDUCATION

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| <b>Université Laval</b><br>Ph.D. in Physics<br>○ Thesis Title: <i>Percolation sur graphes aléatoires: Modélisation et description analytique</i> <sup>1</sup><br>○ Advisor: Louis J. Dubé<br>★ Awarded the CIHR Frederick Banting and Charles Best Canada Graduate Scholarship<br>★ Thesis added to the Board of Honour for receiving the highest overall mark | Québec, Canada<br>2009–2014 |
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<sup>1</sup>Percolation on random graphs: Modelling and analytical description

**Santa Fe Institute**  
Complex Systems Summer School

Santa Fe, NM, USA  
2011

**Université Laval**

M.Sc. in Physics

Québec, Canada  
2006–2008

- Thesis Title: *Modélisation Mathématique en Épidémiologie par Réseaux de Contacts: Introduction de l'Hétérogénéité dans la Transmissibilité<sup>2</sup>*
- Advisor: Louis J. Dubé
- ★ Thesis added to the Board of Honour for receiving the highest overall mark

**Université Laval**

B.Sc. in Physics (Theoretical Physics option)

Québec, Canada  
2003–2006

- ★ Rouge et Or Distinction for excellence in academic undergraduate results
- ★ Nominated 2003 AESGUL Prize for “Student of the year” (chosen by the peers)

## FUNDING AND AWARDS

### Grants

- Discovery Grant, *Natural Sciences and Engineering Research Council of Canada* (NSERC), 2019–2024
- Sentinelle Nord Research Chair on Applications and Theory of Network Analysis, *Université Laval*, 2018–2023

### Fellowships

- Juan de la Cierva – Incorporación (postdoctoral fellowship), *Ministerio de Economía, Industria y Competitividad de España*, 2017–2019
- Postdoctoral Fellowship, *Fonds de recherche du Québec – Nature et Technologies* (FRQNT), 2014–2016
- Frederick Banting and Charles Best Canada Graduate Scholarships - Doctoral Awards, *Canadian Institutes of Health Research* (CIHR), 2009–2012
- Doctoral Research Scholarship, *Fonds de recherche du Québec – Nature et Technologies* (FRQ-NT), 2008 (declined)
- Doctoral Research Scholarship, *Fondation de l'Université Laval*, 2008 (declined)
- Undergraduate Student Research Award, *Natural Sciences and Engineering Research Council of Canada* (NSERC), 2006
- Undergraduate Student Research Award, *Natural Sciences and Engineering Research Council of Canada* (NSERC), 2005

### Other Recognitions

- 2019 AESGUL Prize for “Teacher of the year” (elected by the undergraduate students), 2019
- Board of Honour for a Ph.D.'s Thesis (highest distinction), Faculty of Graduate Studies, Université Laval, 2014
- Nominated 2013 AESGUL Prize for “Staff member of the year” as the Teaching Assistant of PHY-3000 Statistical Physics (elected by the undergraduate students), 2014
- Board of Honour for a Master's Thesis (highest distinction), Faculty of Graduate Studies, Université Laval, 2009
- Third Place at the Student Competition (Poster Presentation), Congress of the Canadian Association of Physicists, Quebec City, 2008
- 2006 AESGUL Prize for “Staff member of the year” as the Teaching Assistant of PHY-1002 Mathematical Physics II (elected by the undergraduate students), 2007
- Rouge et Or Distinction for excellence in academic undergraduate results, 2006
- Nominated 2003 AESGUL Prize for “Student of the year” (chosen by the peers), 2004

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<sup>2</sup>Mathematical modelling in contact networks for epidemiology: Introduction of heterogeneity in transmissibility.

## TEACHING

### Université Laval

Québec, Canada

#### Teacher

- PHY-7053 Theory of Complex Systems and Networks Winter 2020
- PHY-3500 Numerical Physics (partial task) Winter 2020
- PHY-3000 Statistical Physics Fall 2019
- PHY-2502 Nonlinear Dynamics, Chaos and Complexity Winter 2019
- PHY-7008 B Special Subjects Deep Learning: Theory and applications Winter 2019
- PHY-3000 Statistical Physics Fall 2018
- ★ Awarded 2019 AESGUL Prize for “Teacher of the year” (elected by the undergraduate students)

### Université Laval

Québec, Canada

#### Teaching Assistant

- PHY-3000 Statistical Physics Fall 2013
- ★ Nominated 2013 AESGUL Prize for “Staff member of the year” (elected by the undergraduate students)
- PHY-2502 Nonlinear Dynamics, Chaos and Complexity Fall 2012
- PHY-3000 Statistical Physics Fall 2010
- PHY-3000 Statistical Physics Fall 2009
- PHY-1002 Mathematical Physics II Fall 2007
- PHY-2502 Nonlinear Dynamics, Chaos and Complexity Winter 2007
- PHY-1002 Mathematical Physics II Fall 2006
- ★ Awarded 2006 AESGUL Prize for “Staff member of the year” (elected by the undergraduate students)

### St. Anthony’s RC Girls School/Hetton School

Sunderland, United Kingdom

#### Foreign Language Assistant

2008–2009

## MENTORING

### Ph.D. students

- Charles Murphy, *Université Laval*, 2018–present
- Vincent Thibeault, *Université Laval*, Fall 2019

### M.Sc. students

- Béatrice Désy, *Université Laval*, Fall 2019
- Francis Normand<sup>3</sup>, *Université Laval*, 2019–present
- Charles Murphy<sup>3</sup>, *Université Laval*, 2016–2017

### Summer interns

- Olivier Ribordy, *Université Laval*, 2019
- François Thibault, *Université Laval*, 2019

### Bachelor’s thesis

- Marta Cavero Lázaro<sup>3</sup>, *Universitat Autònoma de Barcelona*, 2018

## ORGANIZING ACTIVITIES

### Complex Networks Winter Workshop (CNWW)

Québec, Canada

#### Co-director

December 2019

- In collaboration with [Sentinelle Nord](#) and the [Vermont Complex Systems Center](#)

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<sup>3</sup>Acting/acted as co-advisor.

## **International School and Conference on Network Science (NetSci 2019)**

School, Poster Session, and Satellite Co-Chair

Burlington VT, USA

May 2019

- Organized by the [Vermont Complex Systems Center](#)

## **Complex Networks Winter Workshop (CNWW)**

Co-director

Québec, Canada

December 2018

- In collaboration with [Sentinelle Nord](#), the [Vermont Complex Systems Center](#) and the [Network Science Institute](#)

## **Contagion & Networks (ContNet2018)**

Co-organizer

Paris, France

June 2018

- Satellite symposium of the International School and Conference on Network Science (NetSci 2018)
- In collaboration with B. M. Althouse, L. Hébert-Dufresne and S. V. Scarpino

## **Contagion & Networks (ContNet2017)**

Co-organizer

Indianapolis IN, USA

June 2017

- Satellite symposium of the International School and Conference on Network Science (NetSci 2017)
- In collaboration with B. M. Althouse, L. Hébert-Dufresne and S. V. Scarpino

## REVIEWING ACTIVITIES

### **Program committee**

- 8th International Conference on Complex Networks and their Applications (Complex Networks 2019)
- 10th Conference on Network Modeling and Analysis (MARAMI 2019)
- International School and Conference on Network Science (NetSci 2019)
- 7th International Conference on Complex Networks and their Applications (Complex Networks 2018)
- International School and Conference on Network Science (NetSci 2018)
- 6th International Conference on Complex Networks and their Applications (Complex Networks 2017)
- Mapping Complexity: Foundations and Applications of Network Geometry workshop (MACFANG-17)
- 5th International Workshop on Complex Networks and their Applications (Complex Networks 2016)

### **Jury**

- Xavier Roy-Pomerleau (Master's thesis, *Université Laval*, 2019)
- Vincent Thibeault (Master's thesis, *Université Laval*, 2019)
- Guillaume St-Onge (PhD exam, *Université Laval*, 2019)
- Edward Laurence (PhD seminar, *Université Laval*, 2018)
- Edward Laurence (PhD exam, *Université Laval*, 2017)
- Jaume Palmer Real (Master's thesis, *Universitat Autònoma de Barcelona*, 2017)

### **Scholarships**

- Larkin Kerwin undergraduate scholarship, *Université Laval*, 2019

### **Scientific journals**

- Applied Network Science
- Bioinformatics
- Discrete Dynamics in Nature and Society
- Europhysics Letters
- IEEE's Transactions on Network Science and Engineering
- Nature Communications
- Physica A

- Physical Review E
- Physical Review Letters
- Physical Review X
- PLOS ONE
- Scientific Reports

## ADMINISTRATIVE ACTIVITIES

<b>Student Investment Fund</b> Board member	Université Laval 2012–2013
<b>Physics Graduate Student Union</b> Treasurer	Université Laval 2011–2012
<b>Physics Graduate Program Committee</b> Member	Université Laval 2011–2012
<b>Physics Professoral Assembly</b> Student representative	Université Laval 2010–2012
<b>Physics Undergraduate Student Union</b> Treasurer	Université Laval 2004–2006

## PUBLICATIONS AND PRESENTATIONS

### Submitted manuscripts

- *Geometric renormalization unravels self-similarity of the multiscale human connectome*, M. Zheng, **A. Allard**, Patric Hagmann, M. Á. Serrano, [arXiv:1904.11793](#) (2019)
- *Mercator: uncovering faithful hyperbolic embeddings of complex networks*, G. García-Pérez<sup>4</sup>, **A. Allard**<sup>4</sup>, M. Á. Serrano and M. Boguñá, [arXiv:1904.10814](#) (2019)
- *Smeared phase transitions in percolation on real complex networks*, L. Hébert-Dufresne and **A. Allard**, [arXiv:1810.00735](#) (2018)
- *Navigable maps of structural brain networks across species*, **A. Allard** and M. Á. Serrano, [arXiv:1801.06079](#) (2018)

### Research publications<sup>5</sup> (refereed)

- *Percolation and the effective structure of complex networks*, **A. Allard** and L. Hébert-Dufresne, *Phys. Rev. X* **9**, 011023 (2019) [1]
- *Geometric evolution of complex networks with degree correlations*, C. Murphy, **A. Allard**, E. Laurence, G. St-Onge, and L. J. Dubé, *Phys. Rev. E* **97**, 032309 (2018) [2]
- *The risk of sustained sexual transmission of Zika is underestimated*, **A. Allard**<sup>4</sup>, B. M. Althouse<sup>4</sup>, L. Hébert-Dufresne<sup>4</sup>, and S. V. Scarpino<sup>4</sup>, *PLoS Pathog.* **13**, e1006633 (2017) [25]
- *Asymmetric percolation drives a double transition in sexual contact networks*, **A. Allard**, B. M. Althouse, S. V. Scarpino, and L. Hébert-Dufresne, *Proc. Natl. Acad. Sci. USA* **114**, 8969–8973 (2017) [16]

<sup>4</sup>Equal contribution.

<sup>5</sup>Known number of citations in brackets (according to [Google Scholar](#)).

- *Strategic tradeoffs in competitor dynamics on adaptive networks*, L. Hébert-Dufresne, **A. Allard**, P.-A. Noël, J.-G. Young, and E. Libby, *Sci. Rep.* 7, 7576 (2017) [4]
- *The geometric nature of weights in real complex networks*, **A. Allard**, M. Á. Serrano, G. García-Pérez, and M. Boguñá, *Nat. Commun.* 8, 14103 (2017) [36]
  - ★ Featured in [Nature Physics' Research highlights](#).
  - ★ Featured in [Nature Communications' Web collection on complex systems](#).
- *The effect of a prudent adaptive behaviour on disease transmission*, S. V. Scarpino, **A. Allard**, and L. Hébert-Dufresne, *Nature Phys.* 12, 1042–1046 (2016) [28]
  - ★ Featured in [Nature Physics' News & Views](#).
  - ★ In the top 5% of all research outputs scored by [Altmetric](#) (media coverage).
- *The hidden hyperbolic geometry of international trade: World Trade Atlas 1870–2013*, G. García-Pérez, M. Boguñá, **A. Allard**, and M. Á. Serrano, *Sci. Rep.* 6, 33441 (2016) [32]
  - ★ Featured in the section *Economía* of the newspaper *El Periódico*.
- *Growing networks of overlapping communities with internal structure*, J.-G. Young, L. Hébert-Dufresne, **A. Allard**, and L. J. Dubé, *Phys. Rev. E* 94, 022317 (2016) [5]
- *Multi-scale structure and topological anomaly detection via a new network statistic: The onion decomposition*, L. Hébert-Dufresne, J. Grochow, and **A. Allard**, *Sci. Rep.* 6, 31708 (2016) [9]
- *Constrained growth of complex scale-independent systems*, L. Hébert-Dufresne, **A. Allard**, J.-G. Young, and L. J. Dubé, *Phys. Rev. E* 93, 032304 (2016) [10]
  - ★ Featured in the *Editors' Suggestions* section of *Phys. Rev. E*.
- *Complex networks as an emerging property of hierarchical preferential attachment*, L. Hébert-Dufresne, E. Laurence, **A. Allard**, J.-G. Young, and L. J. Dubé, *Phys. Rev. E* 92, 062809 (2015) [9]
- *General and exact approach to percolation on random graphs*, **A. Allard**, L. Hébert-Dufresne, J.-G. Young, and L. J. Dubé, *Phys. Rev. E* 92, 062807 (2015) [15]
- *A shadowing problem in the detection of overlapping communities: Lifting the resolution limit through a cascading procedure*, J.-G. Young, **A. Allard**, L. Hébert-Dufresne, and L. J. Dubé, *PLOS ONE* 10, e0140133 (2015) [10]
- *Spreading dynamics on complex networks: a general stochastic approach*, P.-A. Noël, **A. Allard**, L. Hébert-Dufresne, V. Marceau, and L. J. Dubé, *J. Math. Biol.* 69, 1627–1660 (2014) [10]
- *A system-level model for the microbial regulatory genome*, A. N. Brooks, D. J. Reiss, **A. Allard**, W.-J. Wu, D. M. Salvanha, C. L. Plaisier, S. Chandrasekaran, M. Pan, A. Kaur, and N. S. Baliga, *Mol. Syst. Biol.* 10, 740 (2014) [37]
- *Coexistence of phases and the observability of random graphs*, **A. Allard**, L. Hébert-Dufresne, J.-G. Young, and L. J. Dubé, *Phys. Rev. E* 89, 022801 (2014) [4]
  - ★ Featured in the *Editors' Suggestions* section of *Phys. Rev. E*.
- *Percolation on random networks with arbitrary  $k$ -core structure*, L. Hébert-Dufresne<sup>4</sup>, **A. Allard**<sup>4</sup>, J.-G. Young, and L. J. Dubé, *Phys. Rev. E* 88, 062820 (2013) [21]
- *Global efficiency of local immunization of complex networks*, L. Hébert-Dufresne<sup>4</sup>, **A. Allard**<sup>4</sup>, J.-G. Young<sup>4</sup>, and L. J. Dubé, *Sci. Rep.* 3, 2171 (2013) [78]
- *Bond percolation on a class of correlated and clustered random graphs*, **A. Allard**, L. Hébert-Dufresne, P.-A. Noël, V. Marceau, and L. J. Dubé, *J. Phys. A* 45, 405005 (2012) [23]



- *Exact solution of bond percolation on small arbitrary graphs*, **A. Allard**, L. Hébert-Dufresne, P.-A. Noël, V. Marceau, and L. J. Dubé, *EPL* 98, 16001 (2012) [8]
- *Propagation on networks: An exact alternative perspective*, P.-A. Noël, **A. Allard**, L. Hébert-Dufresne, V. Marceau, and L. J. Dubé, *Phys. Rev. E* 85, 031118 (2012) [22]
- *Structural preferential attachment: Stochastic process for the growth of scale-free, modular and self-similar systems*, L. Hébert-Dufresne, **A. Allard**, V. Marceau, P.-A. Noël, and L. J. Dubé, *Phys. Rev. E* 85, 026108 (2012) [12]
- *Structural preferential attachment: Network organization beyond the link*, L. Hébert-Dufresne, **A. Allard**, V. Marceau, P.-A. Noël, and L. J. Dubé, *Phys. Rev. Lett.* 107, 158702 (2011) [35]
- *Modeling the dynamical interaction between epidemics on overlay networks*, V. Marceau, P.-A. Noël, L. Hébert-Dufresne, **A. Allard**, and L. J. Dubé, *Phys. Rev. E* 84, 026105 (2011) [107]
- *Propagation dynamics on networks featuring complex topologies*, L. Hébert-Dufresne, P.-A. Noël, V. Marceau, **A. Allard**, and L. J. Dubé, *Phys. Rev. E* 82, 036115 (2010) [38]  
 ★ Also in the *Virtual Journal of Biological Physics Research*, issue 7, vol. 20 (2010).
- *Adaptive networks: Coevolution of disease and topology*, V. Marceau, P.-A. Noël, L. Hébert-Dufresne, **A. Allard**, and L. J. Dubé, *Phys. Rev. E* 82, 036116 (2010) [179]  
 ★ Also in the *Virtual Journal of Biological Physics Research*, issue 7, vol. 20 (2010).
- *Heterogeneous bond percolation on multitype networks with an application to epidemic dynamics*, **A. Allard**, P.-A. Noël, L. J. Dubé, and B. Pourbohloul, *Phys. Rev. E* 79, 036113 (2009) [94]  
 ★ Also in the *Virtual Journal of Biological Physics Research*, issue 7, vol. 17 (2009).

## Book chapters

- *A new approach to international trade from Network Geometry: The World Trade Atlas 1870-2013*, G. García-Pérez, M. Boguñá, **A. Allard**, and M. Á. Serrano, in *Networks of International Trade and Investment: Understanding globalization through the lens of network analysis*, S. Gorgoni, A. Amighini, and M. Smith (Eds.), Vernon Press, pp. 71–112 (2018) ISBN:978-1-62273-065-0
- *The Social Zombie: Modelling undead outbreaks on social networks*, L. Hébert-Dufresne, P.-A. Noël, V. Marceau, **A. Allard**, and L. J. Dubé, in *Mathematical Modelling of Zombies*, R. Smith? (Ed.), University of Ottawa Press, pp. 149–170 (2014) ISBN:978-0-77662-210-1

## Scientific outreach

- *Des ponts d'Euler à la grippe aviaire: De l'abstraction mathématique à la réalité sociale des épidémies*<sup>6</sup>, **A. Allard**, P.-A. Noël, and L. J. Dubé, *Accromath* 4 (winter-spring 2009)

## Selected presentations<sup>7</sup>

- *An introduction to the methodologies for studying complex networks* (oral), Scientific Retreat of the thematic project 1 (TP1) – Sentinelle Nord, Forêt Montmorency, Québec, 2019
- *Three tales about percolation on real complex networks* (oral), International Conference on Complex Networks, Tarragona, Spain, 2019
- *Modeling with Random Networks* (oral, Joint talk with L. Hébert-Dufresne), Complex Networks Winter Workshop, Québec, Québec, 2018

<sup>6</sup>From Euler bridges to avian flu: From mathematical abstraction to the social reality of epidemics.

<sup>7</sup>Invited presentations are denoted with a filled circle.

- *Les réseaux complexes: un paradigme unificateur et transformateur pour comprendre la relation dynamique/structure des systèmes complexes* (oral), Centre de recherche CERVO, Québec, Québec, 2018
- *Les réseaux complexes: un paradigme unificateur et transformateur pour comprendre la relation dynamique/structure des systèmes complexes* (oral), Institut de biologie intégrative et des systèmes, Université Laval, Québec, Québec, 2018
- *The hyperbolic brain: A geometric approach to network neuroscience* (oral), Sentinelle Nord Annual Meeting, Québec, Québec, 2018
- *Double epidemic threshold and the potential of the Zika virus as a sustained STI* (oral), BIFI International Conference, Zaragoza, Spain, 2018
- *The effective navigable geometry of the brain* (oral), Mapping Complexity: Foundations and Applications of Network Geometry workshop (MACFANG-17), Barcelona, Spain, 2017
- *The effective navigable geometry of the brain* (oral), International School and Conference on Network Science, Indianapolis, Indiana, 2017
- *Towards an effective structure of complex networks and its contributions to epidemiology and neuroscience* (oral), Network Science Institute, Boston, Massachusetts, 2017
- *The geometric nature of weights in real complex networks* (oral), Conference on Complex Systems (CCS 2016), Amsterdam, The Netherlands, 2016
- *The hidden geometry of complex weighted networks* (oral), 8th International Conference on Discrete Models of Complex Systems (Summer Solstice 2016), Aveiro, Portugal, 2016
- *Unveiling the hidden geometry of weighted networks* (oral), International School and Conference on Network Science (TOPONETS15), Zaragoza, Spain, 2015
- *Exploring the hidden metric space of complex networks* (oral), Santa Fe Institute, Santa Fe, New Mexico, 2015
- *Percolation on clustered and correlated random graphs: General formalism and applications* (poster), International School and Conference on Network Science, Copenhagen, Denmark, 2013
- *Bond and site percolation on clustered and correlated random graphs* (oral), Joint CRM-Imperial College School and Workshop in Complex Systems, Barcelona, Spain, 2013
- *Unveiling hidden communities through cascading detection on network structures* (oral), 2nd International Conference on Complex Sciences, Santa Fe, New Mexico, 2012
- *Exact solution of bond percolation on small arbitrary graphs* (oral), International School and Conference on Network Science, Evanston, Illinois, 2012
- *Using network organization to hinder propagation in structured populations* (poster), International School and Conference on Network Science, Evanston, Illinois, 2012
- *Multitype modular networks as a model of clustered social networks* (poster), International School and Conference on Network Science, Boston & Cambridge, Massachusetts, 2010
- *Heterogeneous Bond Percolation on Complex Networks: Application to Epidemiology* (poster), Canadian Association of Physicists Congress, Québec City, 2008
- ★ Third place at the student competition.