

Kirill S. Korolev

Physics and Bioinformatics, Boston University, 44 Cummington Mall, Boston, MA 02215
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EDUCATION

Harvard University, Cambridge, MA

- **Ph.D. in theoretical condensed matter physics** May 2010
Thesis: Statistical physics of topological emulsions and expanding populations
Advisor: David R. Nelson

Moscow Institute of Physics and Technology (MIPT), Dolgoprudny, Russia

- **B.S. with highest honors in applied physics and applied mathematics** July 2005
Undergraduate thesis: Magnetization relaxation in monocrystals of YBaCuO
Advisor: L.S. Uspenskaya

APPOINTMENTS

- Assistant Professor, *Boston University* July 2013–present
- Pappalardo Postdoctoral Fellow, *MIT* 2010–2013
Advisors: Leonid A. Mirny and Jeff Gore
- Postdoctoral Fellow, *Harvard University* 2010
Advisor: David R. Nelson

AWARDS

- Cottrell Scholar Award 2017–2020
Research Corporation \$100,000 (direct)
- Simons Investigator in the Mathematical Modeling of Living Systems 2016–2021
Simons Foundation \$500,000 (direct)
- Scialog Molecules Come to Life Award 2017–2018
Moore Foundation \$50,000 (direct)
- Hariri Research Award, co-PI with Daniel Segre, *Hariri Institute for Computing* 2017
- Junior Faculty Fellow, *Hariri Institute for Computing* 2015–2018
- Scialog Fellow, *Research Corporation for Science Advancement* 2014–2016
- Pappalardo Postdoctoral Fellowship, *MIT* 2010–2013
- Certificate of Distinction in Teaching, *Harvard University* 2009
- Goldhaber Prize to an outstanding PhD candidate, *Harvard University* 2008
- Purcell Fellowship to incoming PhD students, *Harvard University* 2005–2006
- Scholarship for academic excellence, *MIPT* 2002–2005
- Gold medal International Physics Olympiad (IPhO) XXXII, Turkey 2001

TEACHING EXPERIENCE

Boston University

- Mathematical Physics Fall 2013–2017
- Dynamics and Evolution of Biological Networks Spring 2014–2017
- Bioinformatics Graduate Seminar Spring 2014–2017

Harvard University

- Departmental Teaching Fellow; Physics Department 2009–2010

Ran a training program in pedagogy for new Teaching Fellows

- Physical Sciences 2; Head Teaching Fellow Fall 2008
- Advanced Electromagnetism; Teaching Fellow Fall 2007
- Physical Sciences 3; Teaching Fellow Spring 2007
- Physical Sciences 2; Teaching Fellow Fall 2006
- Physics 1a; Teaching Fellow Summer 2006

ADVISING

Current

- Postdoctoral scholars: Robert Marsland
- Graduate students: Gabriel Birzu, Rajita Menon, Ashish Bino George
- Research assistants: Sakib Matin

Former

- Postdoctoral researchers: Feng Wang
- Master students: Michael Chernicoff
- Undergraduate students: Kohaku So, Quentin Hoarau, Peter Freese, Ivana Cvijovic, Xiangxi Gao, Vivek Ramanan, Brianna Richardson
- High school students: You Jin Reo, Alexander Smirnov, Luanna Ferreeira, Andrew Li, Adarsh Ramchandran, Sanjena Venkatesh, Raghav Jain

PROFESSIONAL ACTIVITIES

- Referee for Physical Review Letters, PNAS, eLife, Cell, Current Biology, Nature Communications, PLoS Computational Biology, Evolution, Proceedings of the Royal Society B, Europhysics Letters, Reviews of Modern Physics, Oikos, Trends in Cancer, Genetics, Physical Biology, Physical Review E, PLoS ONE, JSTAT, Nonlinearity Journal of the Royal Society Interface, Bulletin of Mathematical Biology, Journal of Mathematical Biology, Scientific Reports, ISME Journal, Cell Systems, Proceedings of the Royal Society Interface, New Journal of Physics
- Co-organized BU Theory in Biology Conference 2018
- Co-organized invited session at APS March meeting titled “Complex microbial communities” 2016
- Outreach lecture to 30 Boston area high school science teachers on the synergies between research in physics and biology 2014
- Organized Harvard Condensed Matter Theory Kid’s Seminar 2008–2010
- Helped organize Biannual Teaching Conference, Harvard University 2009
- Helped organize High School Physics Olympiads, Russia 2001–2004

SELECTED INVITED TALKS

- American Society for Microbiology Microbe Meeting, *Atlanta, GA* 2018
Effects of cellular chirality on competition and cooperation in microbial colonies
- Microbiome: Applications & Future, *Synthetic Biology Center, MIT* 2018
Theory & Microbiome
- American Physical Society March Meeting, *Los Angeles, CA* 2018
Neither pulled nor pushed: A new class of reaction diffusion waves
- Condensed Matter Kid’s Seminar, *Harvard University* 2018
Neither pulled nor pushed: A new class of reaction diffusion waves
- Fundamental problems in active matter, *Aspen Institute of Physics* 2018
Effects of Cellular Chirality on Competition and Cooperation in Microbial Colonies

- Biomathematics Seminar, *Harvard University* 2017
Evolution during range expansions of cooperatively growing populations
- Workshop on Systems Biology and Molecular Economy of Microbial Communities, *ICTP, Italy* 2017
The role of spatial structure in microbial interactions
- BU Microbiome Day, *Boston University* 2017
Statistical physics of microbial communities
- Bioinformatics and Computational Biology Seminar, *Worcester Polytechnic Institute* 2017
Mutations that slow down cancer
- Physics Department Colloquium, *University of Massachusetts, Boston* 2016
To grow or not to grow: From microtubules to cancer
- Center for Theoretical Biological Physics Seminar, *Rice University* 2016
Beyond the Standard Model of Growth: From Chiral Cells to Polymer Networks
- Widely Applied Mathematics *Harvard University* 2016
Survival of the chiral: Chiral microbes succeed by altering spatial structure
- Squishy Physics, *Harvard University* 2016
Assembly and control of large microtubule complexes
- XXIII Summer School Nicolás Cabrera, *Madrid, Spain* 2016
Phase transitions in populations dynamics of microbes and cancer
- Channing Network Science Seminar, *Harvard Medical School* 2016
Ecology and evolution of cancer tumors
- First MIT Meeting on Quantitative Ecology, *Massachusetts Institute of Technology* 2016
The games microbes play
- Populations, Evolution, and Physics, *Aspen Institute of Physics* 2016
Evolution during cooperative growth
- Center for Genomics and Computational Biology Seminar Series, *Duke University* 2015
The tug-of-war between deleterious and beneficial mutations in cancer
- Hariri Institute for Computing and Computational Science & Engineering, *Boston, MA* 2015
Why cancer is so rare?
- American Physical Society March Meeting, *San Antonio, TX* 2015
Diffusion-limited mutualism
- Digestive Disease Week, *Chicago* 2014
Community structure of bacteria in the human microbiome
- Biology Department Seminar Series, *Boston University* 2014
Evolutionary dynamics in cancer
- Physics Department Colloquium, *Emory University* 2013
Ecology and evolution of cancer tumors and expanding populations
- Biophysics Seminar Series, *Massachusetts Institute of Technology* 2013
Ecology and evolution of cancer tumors and expanding populations
- 15th Annual Greater Boston Area Statistical Mechanics Meeting, *Brandeis University* 2013
Dynamics of evolutionary innovations in cancer
- Workshop on Selection in Population Genetics, *Radcliffe Institute* 2012
Dangerous passengers: A closer look at deleterious mutations in evolutionary models of cancer
- Condensed Matter Seminar, *UMass Amherst* 2012
Statistical mechanics of genes in expanding microbial colonies
- Condensed Matter Theory Kid's Seminar, *Harvard University* 2012
Dangerous passengers: A closer look at deleterious mutations in evolutionary models of cancer
- Towards Unifying Concepts in the Physics of Aperiodic Systems, *Princeton University* 2011
Space, evolution, and the Petri dish: Statistical mechanics of stochastic demixing and deterministic mixing in microbial colonies
- Condensed Matter Seminar, *Virginia Tech* 2011
Space, evolution, and the Petri dish
- Pappalardo Symposium; and Faculty lunch, *MIT* 2011

- Genetic demixing in bacterial colonies 2011
- Mini Stat Mech Meeting, *UC Berkeley* 2011
- Genetic mixing and demixing in bacterial colonies
- Cells, Circuits, and Computation, *Harvard University* 2010
- Spatial assays for microbial evolution
- Center for the Physics of Living Cells, *UIUC* 2010
- Population genetics in a Petri dish
- Widely Applied Mathematics seminar, *Harvard University* 2009
- Genetic demixing and Fisher waves

MANUSCRIPTS IN PREPARATION

- Ashish George and Kirill S. Korolev, *Survival of the chiral: Chiral strains invade by altering spatial structure*, arXiv:1710.09459.
- Robert Marsland III, Wenping Cui, Joshua Goldford, Alvaro Sanchez, Kirill S. Korolev, and Pankaj Mehta, *Available energy fluxes drive a phase transition in the diversity, stability, and functional structure of microbial communities*, bioRxiv doi.org/10.1101/335893.
- Maxime Deforet, Carlos Carmona Fontaine, Kirill S. Korolev, and Joao B. Xavier, *Contribution of growth and dispersal to the evolution of expanding populations*, bioRxiv doi.org/10.1101/221390.
- Ching-Hao Wang, Sakib Matin, Ashish George, and Kirill S. Korolev, *Pinned, locked, pushed, and pulled traveling waves in structured environments*, bioRxiv doi.org/10.1101/341222.
- Mina Nazari, Xiaoqing Li, Mohammad Amin Alibakhshi, Haojie Yang, Kathleen Souza, Christopher Gillespie, Suryaram Gummuluru, Björn M. Reinhard, Kirill S. Korolev, Lawrence D. Ziegler, Qing Zhao, Meni Wanunu, Shyamsunder Erramilli, *Femtosecond Photonic Viral Inactivation Probed Using Solid-State Nanopores*, arXiv:1806.01463.

PEER-REVIEWED PUBLICATIONS

2018

- Gabriel Birzu, Oskar Hallatschek, and Kirill S. Korolev, *Fluctuations uncover a distinct class of traveling waves*, **PNAS** 201715737 (2018).
- Rajita Menon, Vivek Ramanan, and Kirill S. Korolev, *Interactions between species introduce spurious associations in microbiome studies*, **PLoS Computational Biology** 14, e1005939 (2018).

2017

- Ana B. Pavel and Kirill S. Korolev, *Genetic load makes cancer cells more sensitive to common drugs: evidence from Cancer Cell Line Encyclopedia*, **Scientific Reports** 7, 1938 (2017)
- Liselotte Jauffred, Rebecca Munk-Vejborg, Kirill S. Korolev, Stanley Brown, and Lene B. Oddershede, *Chirality in microbial biofilms is mediated by close interactions between the cell surface and the substratum*, **ISME Journal** 11, 1688-1701 (2017)
- Mohammad El Mouzan, Feng Wang, Mohammad Al Mofarreh, Rajita Menon, Ahmad Al Barrag, Kirill S. Korolev, Ahmad Al Sarkhy, Mona Al Asmi, Yassin Hamed, Anjum Saeed, Scot Dowd, Asaad Assiri, and Harland Winter, *Fungal microbiota profile in newly-diagnosed treatment-naive children with*

Crohn disease, **Journal of Crohn's and Colitis** 11, 586-592 (2017)

2016

- Keisuke Ishihara, [Kirill S. Korolev](#), Timothy J. Mitchison, *Physical basis of large microtubule aster growth*, **eLife** e19145 (2016)
- Saurabh R. Gandhi, Eugene A. Yurtsev, [Kirill S. Korolev](#) and Jeff Gore, *Range expansions transition from pulled to pushed waves as growth becomes more cooperative in an experimental microbial population*, **PNAS** 113, 6923 (2016)
- Feng Wang, Jess L. Kaplan, Benjamin D. Gold, Manoj K. Bhasin, Naomi L. Ward, Richard Keller-mayer, Barbara S. Kirschner, Melvin B. Heyman, Scot E. Dowd, Stephen B. Cox, Haluk Dogan, Blaire Steven, George D. Ferry, Stanley A. Cohen, Robert N. Baldassano, Christopher J. Moran, Elizabeth A. Garnett, Lauren Drake, Hasan H. Otu, Leonid A. Mirny, Towia A. Libermann, Harland S. Winter, and [Kirill S. Korolev](#), *Detecting microbial dysbiosis associated with pediatric Crohn disease despite the high variability of the gut microbiota*, **Cell Reports** 14, 945 (2016)

2015

- [Kirill S. Korolev](#), *Evolution arrests invasions of cooperative populations*, **Physical Review Letters** 115, 208104 (2015)
- Rajita Menon and [Kirill S. Korolev](#), *Public good diffusion limits microbial mutualism*, **Physical Review Letters** 114, 168102 (2015)
- Lei Dai, [Kirill S. Korolev](#), and Jeff Gore, *Relation between stability and resilience determines the performance of early warning signals under different environmental drivers*, **PNAS** 112, 10056 (2015)

2014

- Christopher D. McFarland, Leonid A. Mirny, and [Kirill S. Korolev](#), *Tug-of-war between driver and passenger mutations in cancer and other adaptive processes*, **PNAS** 111, 15138 (2014)
- [Kirill S. Korolev](#), Joao B. Xavier, and Jeff Gore, *Turning ecology and evolution against cancer*, **Nature Reviews Cancer** 14, 371 (2014)
- Peter D. Freese, [Kirill S. Korolev](#), Jose I. Jimenez, and Irene A. Chen, *Genetic drift suppresses bacterial conjugation in spatially structured populations*, **Biophysical Journal** 106, 944 (2014)

2013

- Manoshi S. Datta, [Kirill S. Korolev](#), Ivana Cvijovic, Carmel Dudley, and Jeff Gore, *Range expansion promotes cooperation in an experimental microbial metapopulation*, **PNAS** 110, 7354 (2013)
- Lei Dai, [Kirill S. Korolev](#), and Jeff Gore, *Slower recovery in space before collapse of connected populations*, **Nature** 496, 355 (2013)
- [Kirill S. Korolev](#), *The fate of cooperation during range expansions*, **PLOS Computational Biology** 9, e1002994 (2013)
- Christopher D. McFarland, [Kirill S. Korolev](#), Gregory V. Kryukov, Shamil Sunyaev, and Leonid A. Mirny, *The impact of deleterious passenger mutations on cancer progression*, **PNAS** 110, 2910 (2013)
- Maxim O. Lavrentovich, [Kirill S. Korolev](#), and David R. Nelson, *Radial Domany-Kinzel models with mutation and selection*, **Physical Review E** 87, 012103 (2013)

2012

- Lei Dai, Daan Vorselen, [Kirill S. Korolev](#), Jeff Gore, *Generic indicators for loss of resilience before tipping point leading to population collapse*, **Science** 336, 1175 (2012)

- [Kirill S. Korolev](#), Melanie J.I. Müller, Nilay Karahan, Andrew W. Murray, Oskar Hallatschek, and David R. Nelson, *Selective sweeps in growing microbial colonies*, **Physical Biology** 9, 026008 (2012)

2011

- [Kirill S. Korolev](#), Joao B. Xavier, David R. Nelson, and Kevin R. Foster, *A quantitative test of population genetics using spatiogenetic patterns in bacterial colonies*, **The American Naturalist** 178, 538 (2011)
- [Kirill S. Korolev](#) and David R. Nelson, *Competition and cooperation in one-dimensional stepping-stone models*, **Physical Review Letters** 107, 088103 (2011)

2005 - 2010

- [Kirill S. Korolev](#), Mikkel Avlund, Oskar Hallatschek, and David R. Nelson, *Genetic demixing and evolution in linear stepping stone models*, **Reviews of Modern Physics** 82, 1691 (2010)
- Oskar Hallatschek and [Kirill S. Korolev](#), *Fisher waves in the strong noise limit*, **Physical Review Letters** 103, 108103 (2009)
- [Kirill S. Korolev](#) and David R. Nelson, *Defect-mediated emulsification in two dimensions*, **Physical Review E** 77, 051702 (2008)
- L.S. Uspenskaya, [Kirill S. Korolev](#), and P.N. Yarykin, *Peculiarity of magnetization relaxation in finite size superconductors*, **Physica C** 423, 181 (2005)