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Appointments

2023–present **Assistant Professor**
Rutgers University, Robert Wood Johnson Medical School, Department of Biochemistry and Molecular Biology and Department of Medicine (secondary)
Other affiliations:

- Center for Advanced Biotechnology and Medicine (resident)
- Rutgers University Microbiome Program
- Member of graduate program faculty in Molecular Biosciences, Microbial Biology, Ecology and Evolution, Physics and Astronomy, and Quantitative Biomedicine

2018–2022 **Junior group leader (SNF Ambizione Fellow)**
ETH Zurich (Swiss Federal Institute of Technology), Department of Environmental Systems Science, Institute of Integrative Biology
Eawag (Swiss Federal Institute of Aquatic Science and Technology), Department of Environmental Microbiology

2014–2018 **Postdoctoral fellow (NIH Ruth L. Kirschstein NRSA Fellow)**
Harvard University, Department of Chemistry and Chemical Biology

Education

2014, Ph.D., Physics, Rutgers University

Advisor: Prof. Alexandre V. Morozov
Dissertation: "Biophysics and Stochastic Processes in Molecular Evolution"

2009, B.S., Physics and Mathematics (with honors and Concentration in Theoretical Physics), Stanford University

Honors advisor: Prof. Jay G. Wacker
Thesis: "A Model-Independent Search for New Physics at the Large Hadron Collider"

Publications

Preprints and publications under review

1. Held NA, Manhart M. (2024) "Are microbes colimited by multiple resources?" *EcoEvoRxiv* preprint, doi:10.32942/X2SK6W
2. Held NA, Krishna A, Crippa D, Dragan A, Manhart M. (2023) "Nutrient colimitation is a quantitative, dynamic property of microbial populations." *bioRxiv* preprint, doi:10.1101/2023.09.27.559472.
3. Ramoneda J, Ma Y, Schmidt J, Manhart M, Angst DC, Johnson DR. (2023) "Physical contacts between sparse biofilms promote plasmid transfer and generate functional novelty." *bioRxiv* preprint, doi:10.1101/2023.02.01.526699.
4. Gould E et al. (150 authors) (2023) "Same data, different analysts: variation in effect sizes due to analytical decisions in ecology and evolutionary biology." *EcoEvoRxiv* preprint, doi:10.32942/X2GG62.

Selected publications

5. Fink JW, Held NA, Manhart M. (2023) "Microbial population dynamics decouple growth response from environmental nutrient concentration." *Proc Natl Acad Sci USA* **120**:e2207295120.
6. Jasinska W,* Manhart M,* Lerner J, Gauthier L, Serohijos AWR, Bershtein S. (2020) "Chromosomal barcoding of *E. coli* populations reveals lineage diversity dynamics at high resolution." *Nat Ecol Evol* **4**:437–452. (* equal contribution)
7. Manhart M, Shakhnovich EI. (2018) "Growth tradeoffs produce complex microbial communities on a single limiting resource." *Nat Commun* **9**:3214.
8. Adkar BV, Manhart M, Bhattacharyya S, Tian J, Musharbash M, Shakhnovich EI. (2017) "Optimization of lag phase shapes the evolution of a bacterial enzyme." *Nat Ecol Evol* **1**:0149.
9. Manhart M, Morozov AV. (2015) "Protein folding and binding can emerge as evolutionary spandrels through structural coupling." *Proc Natl Acad Sci USA* **112**:1797–1802.

Additional publications

10. Fink JW, Manhart M. (2023) "How do microbes grow in nature? The role of population dynamics in microbial ecology and evolution." *Curr Opin Syst Biol* **36**:100470.
11. Manhart M, Bonhoeffer S. (2021) "The search for universality in evolutionary landscapes: Comment on 'From genotypes to organisms: State-of-the-art and perspectives of a cornerstone in evolutionary dynamics' by Susanna Manrubia, José A. Cuesta, et al." *Phys Life Rev* **39**:76–78.
12. Lin J, Manhart M, Amir A. (2020) "Evolution of microbial growth traits under serial dilution." *Genetics* **215**:767–777.
13. Gorter FA, Manhart M, Ackermann M. (2020) "Understanding the evolution of interspecies interactions in microbial communities." *Phil Trans R Soc B* **375**:20190256. (In special issue on "Conceptual challenges in microbial community ecology")
14. Kheir Gouda M, Manhart M, Balázsi G. (2019) "Evolutionary regain of lost gene circuit function." *Proc Natl Acad Sci USA* **116**:25162–25171.
15. Kion-Crosby WB, Manhart M, Morozov AV. (2019) "Inferring biophysical models of evolution from genome-wide patterns of codon usage." bioRxiv preprint doi:10.1101/578815.
16. Manhart M, Adkar BV, Shakhnovich EI. (2018) "Tradeoffs between microbial growth phases lead to frequency-dependent and non-transitive selection." *Proc R Soc B* **285**:20172459.
17. Springer SA, Manhart M, Morozov AV. (2016) "Separating spandrels from phenotypic targets of selection in adaptive molecular evolution." *Evolutionary Biology*, ed. P. Pontarotti. Springer: Switzerland.
18. Manhart M, Kion-Crosby W, Morozov AV. (2015) "Path statistics, memory, and coarse-graining of continuous-time random walks on networks." *J Chem Phys* **143**:214106.
19. González C, Ray JCJ, Manhart M, Adams RM, Nevozhay D, Morozov AV, Balázsi G. (2015) "Stress-response balance drives the evolution of a network module and its host genome." *Mol Syst Biol* **11**:827.
20. Bershtein S, Serohijos AWR, Bhattacharyya S, Manhart M, Choi J-M, Mu W, Zhou J, Shakhnovich EI. (2015) "Protein Homeostasis Imposes a Barrier on Functional Integration of Horizontally Transferred Genes in Bacteria." *PLoS Genet* **11**:e1005612.
21. Manhart M, Morozov AV. (2015) "Scaling properties of evolutionary paths in a biophysical model of protein adaptation." *Phys Biol* **15**:045001. (In special issue on "Evolution of Biological Molecules and Networks")
22. Haldane A, Manhart M, Morozov AV. (2014) "Biophysical Fitness Landscapes for Transcription Factor Binding Sites." *PLoS Comput Biol* **10**:e1003683.
23. Manhart M, Morozov AV. (2014) "Statistical Physics of Evolutionary Trajectories on Fitness Landscapes." *First-Passage Phenomena and Their Applications*, eds. R. Metzler, G. Oshanin, and S. Redner. World Scientific: Singapore.
24. Manhart M, Morozov AV. (2013) "Path-Based Approach to Random Walks on Networks Characterizes How Proteins Evolve New Functions." *Phys Rev Lett* **111**:088102. (Editors' Suggestion)
25. Manhart M, Haldane A, Morozov AV. (2012) "A universal scaling law determines time reversibility and steady state of substitutions under selection." *Theor Popul Biol* **82**:66–76.
26. Izaguirre E, Manhart M, Wacker JG. (2010) "Bigger, Better, Faster, More at the LHC." *J High Energ Phys* **12**:1–25.

Presentations

Invited talks

- Population Dynamics Seminar (Friedrich Schiller University of Jena), online (September 1, 2023)
- Seminar at the University of Helsinki (June 12, 2023)
- Seminar at the University of Turku (June 9, 2023)
- Seminar at the Technical University of Munich (June 7, 2023)
- Microbiology at Rutgers Symposium, Rutgers University (May 5, 2023)
- American Physical Society March Meeting, Las Vegas, NV (March 6–10, 2023)
- Graduate Program in Ecology and Evolution Seminar, Rutgers University (February 23, 2023)
- ENIGMA Seminar, Rutgers University (February 20, 2023)
- Forum on Economic Principles in Cell Physiology, online (February 7, 2023)
- Seminar at the Department of Physics of Complex Systems, Weizmann Institute of Science (November 14, 2022)
- Cologne Evolution Colloquium at the University of Cologne (October 26, 2022)
- Seminar at the Department of Chemistry, Pusan National University (November 11, 2021)
- Colloquium at the Department of Physics, University of Alberta (November 5, 2021)
- Seminar at the Center for Advanced Biotechnology and Medicine, Rutgers University (May 10, 2021)
- Seminar at the Department of Microbiology, University of Georgia (March 30, 2021)
- Seminar at the Max Planck Institute for Evolutionary Biology, Plön (February 23, 2021)
- Institut Henri Poincaré virtual conference on "Ecology and co-evolution: from models to data and back" (January 11–15, 2021)
- Seminar at the Structural and Computational Biology Unit, EMBL (November 10, 2020)
- Seminar at the Department of Computational Biology, University of Lausanne (October 21, 2020)
- Seminar at the Institute of Physics, EPFL (December 19, 2019)
- 23rd Evolutionary Biology Meeting, Marseilles, France (September 24–27, 2019)
- BIRS-CMO workshop on "Out-of-Equilibrium Processes in Evolution and Ecology," Oaxaca, Mexico (August 18–23, 2019)
- Seminar at the Biozentrum, University of Basel (February 18, 2019)
- Colloquium at the Department of Physics, University of Cincinnati (February 22, 2018)
- Seminar at the Laufer Center for Physical and Quantitative Biology, Stony Brook University (June 27, 2017)
- 9th European Conference on Mathematical and Theoretical Biology, Gothenberg, Sweden (June 15–19, 2014)
- Bauer Forum, FAS Center for Systems Biology, Harvard University (January 29, 2014)
- Biophysics theory symposium, Princeton University (November 20, 2013)
- American Physical Society April Meeting, Atlanta, GA (March 31 – April 3, 2012)

Contributed talks

- Workshop on "Microbial communities: current approaches and open challenges," Isaac Newton Institute, Cambridge (October 10–14, 2022)
- Microbial Ecology and Evolution Meeting on "Communities and Coevolution," Max Planck Institute for Evolutionary Biology, Plön (May 16–20, 2022)
- Virtual conference on "Stochastic Models and Experiments in Ecology and Biology" (June 22–25, 2021)
- Virtual EMBO Workshop on "Predicting Evolution" (June 14–16, 2021)
- American Physical Society March Meeting, Boston, MA (March 4–8, 2019)
- American Physical Society March Meeting, Los Angeles, CA (March 5–9, 2018)
- American Physical Society March Meeting, New Orleans, LA (March 13–17, 2017)
- Greater Boston Area Statistical Mechanics Meeting, Brandeis University (October 29, 2016)
- American Physical Society March Meeting, Denver, CO (March 3–7, 2014)
- 110th Statistical Mechanics Meeting, Rutgers University (December 15–17, 2013)
- American Physical Society March Meeting, Baltimore, MD (March 18–22, 2013)
- 108th Statistical Mechanics Meeting, Rutgers University (December 16–18, 2012)
- American Physical Society March Meeting, Boston, MA (February 27 – March 2, 2012)

Posters

- Gordon Research Conference on Applied and Environmental Microbiology, South Hadley, MA (July 16–21,

2023)
- 18th International Symposium on Microbial Ecology, Lausanne, Switzerland (August 15–19, 2022)
- Microbial Ecology and Evolution Virtual Conference (August 12–14, 2020)
- Conference on Evolutionary Systems Biology, Wellcome Genome Campus, UK (February 12–14, 2020)
- Gordon Research Conference on Molecular Mechanisms in Evolution, Easton, MA (June 9–14, 2019)
- Gordon Research Conference on Microbial Population Biology, Andover, NH (July 9–14, 2017)
- Gordon Research Conference on Molecular Mechanisms in Evolution, Easton, MA (June 11–16, 2017)
- 2nd American Society for Microbiology Conference on Experimental Microbial Evolution, Washington, DC (August 4–7, 2016)
- 22nd Boston Bacterial Meeting, Boston, MA (June 14–15, 2016)
- Conference on Populations, Evolution, and Physics, Aspen Center for Physics (January 3–8, 2016)
- DIMACS Workshop on Bio-computing, Genomics, and Epigenomics, Rutgers University (September 13, 2012)
- International Conference on Stochastic Processes in Systems Biology, Genetics, and Evolution, Rice University (August 21–25, 2012)
- 5th q-bio Conference on Cellular Information Processing, St. John's College (August 10–13, 2011)

Awards and Funding

Fellowships and grants

- Swiss National Science Foundation Ambizione grant (2018–2022)
- NIH Ruth L. Kirschstein NRSA Postdoctoral Fellowship (2015–2018)
- Rutgers University Excellence Fellowship (2009–2010)
- Rutgers University Henry C. Torrey Graduate Fellowship (2009–2010)

Travel awards

- American Physical Society DBIO Shirley Chan Student Travel Award (2014)
- American Physical Society FGSA Travel Award for Excellence in Graduate Research (2012)
- ICSP Travel Award (2012)

Teaching awards

- Rutgers University Graduate School-New Brunswick Dean's Award for Innovation (2012)
- Rutgers University Department of Physics and Astronomy Richard J. Plano Outstanding Teaching Assistant Award (2011)

Academic awards

- Stanford University Center for Teaching and Learning and Undergraduate Advising and Research Award for Excellence in Honors Thesis Presentation (2009)
- Highbridge Book Award in Mathematical Problem Solving for achievement on the William Lowell Putnam Mathematical Competition (2006)

Teaching experience

ETH Zurich

Teaching assistant
- Infectious Disease Dynamics (conducted oral exams and evaluated students; Spring 2021, Spring 2022)
- Environmental Biology (supervised projects on "forecasting evolution"; Fall 2020, Fall 2021)

Rutgers University

Co-instructor (developed and taught all aspects of the course, in collaboration with 3 graduate students)
- Physics 106: Concepts of Physics for Humanities and Social Science Students, ∼100 undergraduate students (Spring 2013)

Teaching assistant (led sections, graded assignments, held office hours)
- Physics 611: Statistical Mechanics, ∼10 graduate students (Spring 2012)
- Physics 567: Physics of Living Matter, ∼10 graduate students (Spring 2012)

- Physics 116: Extended Analytical Physics II (introductory physics for engineering students), ∼40 undergraduate students (Spring 2011)
- Physics 202: Extended General Physics II (introductory physics for life science students), ∼80 undergraduate students (Fall 2010)
- Physics 204: General Physics II (introductory physics for life science students), ∼40 undergraduate students (Summer 2010)

Lecturer

- "What physics and chemistry can tell us about evolutionary biology," Chemistry Counts seminar at La Salle University, ∼20 undergraduate students (November 18, 2016)
- "Biophysical modeling of gene expression," BioMaPS Interdisciplinary Boot Camp in Quantitative Biology, ∼20 graduate students (January 9, 2014)
- "What can physics say about life itself? Science at the interface of physics and biology," Rutgers Society of Physics Students, ∼40 undergraduate students (March 9, 2011)
- "What is the universe made of? Physics in the 21st century," I Have a Dream Foundation National Student Conference, ∼30 high school students (July 23, 2010)

Graduate student seminar speaker

- "Foldit: Discovering the Physics of Proteins through Gaming," ∼20 graduate students (April 4, 2013)
- "What Does the Renormalization Group Tell Us about Universality and Effective Theories in Population Genetics?," ∼20 graduate students (December 8, 2011)
- "Schrödinger's Dream: The Statistical Physics of Evolutionary Biology," ∼20 graduate students (December 6, 2010)
- "A Path Integral Approach to Molecular Evolution," ∼20 graduate students (July 20, 2010)
- "The Strange Case of the $1/x^2$ Potential," ∼20 graduate students (October 20, 2009)

Certificates

Certificate of Training in Physics Teaching (Fall 2011)

NJ State Correctional Facilities (Prison Teaching Initiative)

Co-instructor (gave lectures, graded assignments)

- BIO 114: Visualizing Environmental Science, ∼15 students (Spring 2012)
- MAT 037: Introduction to Algebra, ∼15 students (Fall 2011, Fall 2010, Spring 2010)
- MAT 135: Intermediate Algebra, ∼15 students (Spring 2011)

Mentoring experience

Postdoctoral fellows

- Duhita Sant, Rutgers University (summer 2023 – present)
- Rachana Rao Battaje, Rutgers University (summer 2023 – present)
- Justus Fink, Rutgers University (spring 2023 – present)

Ph.D. students

- Justus Fink, ETH Zurich (spring 2019 – fall 2023)

Master's students

- Jakob Löffler, ETH Zurich (fall 2021 – summer 2022)
- Aswin Krishna, ETH Zurich (spring 2021 – summer 2021)
- Alexander Stein, ETH Zurich (fall 2019)

Research assistants

- Tomas Lio Grudny, ETH Zurich (March 2022 – May 2023)
- Anastasia Dragan, ETH Zurich (October 2022 – March 2023)

Undergraduate (bachelor's) students

- Shivali Vanodia, Rutgers University (December 2023 – present)
- Dhru Desai, Rutgers University (June 2023 – present)

- Atharv Jayprakash, Rutgers University (January 2023 – present)
- Kevin Thomas, Rutgers University (January 2023 – May 2023)

High school students

- Arun Kalyanaraman, High Technology High School: "Biophysical models of protein evolution" (summer 2013 – summer 2014)
- Rishabh Pipada, West Windsor Plainsboro High School North: "Sequence-specificity of nucleosomal loop dynamics" (summer 2012)
- Aditya Bhagavathi, West Windsor Plainsboro High School North: "Exploring the limits of phylogenetic inference of protein energetics" (summer 2011)

Service activities

Professional activities

- Reviewer for *eLife*, *Nature Communications*, *Molecular Systems Biology*, *Molecular Biology and Evolution*, *mSystems*, *mSphere*, *Microbiome*, *PLOS Computational Biology*, *Physical Review Letters*, *Philosophical Transactions of the Royal Society B*, *Journal of the Royal Society Interface*, *Journal of Molecular Evolution*, *Physical Biology*, *Physica A*
- Co-organizer for the 2018 American Physical Society March Meeting focus sessions on "Evolutionary Systems Biology" and "Single-Cell Variability and Dynamics"
- Co-organizer for the Boston-area Physics of Living Systems Hangouts (2015–2017)
- Co-organizer for the Greater Boston Area Theoretical Chemistry Lecture Series (2015–2017)
- Co-organizer for the 2014 American Physical Society March Meeting invited session on "Physical Principles of Molecular Evolution"
- Blogger for Rutgers University Graduate School-New Brunswick: `rugradstudentblog.net` (2012–2014)
- Founding organizer for departmental TA training program, DELTA-P: Developing Educational Leaders among TAs in Physics (2010–2012)
- Founding organizer for SSPAR: Student Seminars in Physics and Astronomy at Rutgers (2009-2010)