Seppe Kuehn, Ph.D.

Curriculum Vitae

Center for the Physics of Evolving Systems
Center for Living Systems
National Institute for Theory and Mathematics in Biology
Institute for Biophysical Dynamics
Department of Ecology and Evolution
University of Chicago
Gordon Center for Integrative Science
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CURRENT POSITION

Associate Prof. (tenured)	Department of Ecology and Evolution	University of Chicago	7/2024 - present
Core Member	Center for the Physics of Evolving Systems	University of Chicago	7/2020 - present
Member	Institute for Biophysical Dynamics	University of Chicago	8/2021 - present
Member	Center for Living Systems	University of Chicago	9/2023 - present
Co-theme leader	NITMB	University of Chicago	9/2023 - present

EDUCATION & POSITIONS

Assistant Professor	Department of Ecology and Evolution	University of Chicago	2020 - 2023
Assistant Professor	Department of Physics	U. of Illinois at Urbana-Champaign	2016 - 2020
Res. Assist. Prof.	Department of Physics	U. of Illinois at Urbana-Champaign	2014 - 2016
Post Doctoral	Biology	Rockefeller University (with S. Leibler)	2007 - 2013
Ph.D.	Chemistry	Cornell University (with J. Marohn)	2007
B.S.	Physics	Beloit College	2000

PUBLICATIONS *corresponding author. † first author

Community Metabolism

1. "Functional regimes define the response of the soil microbiome to environmental change" Kiseok Keith Lee†, Siqi Liu†, Kyle Crocker, David R. Huggins, Mikhail Tikhonov*, Madhav Mani*, **Seppe Kuehn***. ***Nature***, (2025).
2. "Inferring resource competition in microbial communities from time series" Xiaowen Chen, Kyle Crocker, **Seppe Kuehn***, Aleksandra Walczak*, Thierry Mora*. ***PRXLife***, (2025).
3. "Collective microbial effects drive toxin bioremediation and enable rational design" Mahmoud Yousef†, Kiseok K. Lee, Jonathan Tang, **Seppe Kuehn***. In revision ***Nature Microbiology***, (2025).
4. "Microbial functional guilds respond cohesively to rapidly fluctuating environments" Kyle Crocker†, Abigail Skwara†, Rathi Kannan, Arvind Murugan, **Seppe Kuehn***. ***ISME Journal***, (2025).
5. Statistical design of a synthetic microbiome that clears a multi-drug resistant gut pathogen. Rita A. Oliveira, Bipul Pandey, Kiseok Lee, Mahmoud Yousef, Robert Y. Chen, Conrad Triebold, Emma McSpadden, Fidel Haro, Valeryia Aksianiuk, Ramaswamy Ramanujam, **Seppe Kuehn**, Arjun S. Raman. In submission, (2024).
6. "Genomic patterns in the global soil microbiome emerge from microbial interactions." Kyle Crocker†, Milena Chakraverti-Wuerthwein, Zeqian Li, Madhav Mani, Karna Gowda*, **Seppe Kuehn***. ***Nature Microbiology***, (2024).

7. "Robustness of microbiome function." Kiseok Keith Lee*, Yeonwoo Park, Seppe Kuehn. ***Current Opinion in Systems Biology***, (2023). (Invited review)

8. "Environmental modulators of algae-bacteria interactions at scale" Chandana Gopalakrishnappa, Zeqian Li, and **Seppe Kuehn***. ***Cell Systems***, (2024). (Cover feature)

9. "Statistical prediction of microbial metabolic traits from genomes" Zeqian Li, Ahmed Selim, Seppe Kuehn*. ***PLoS Computational Biology***, (2023).

10. "Learning the functional landscape of microbial communities" Abby Skwara, Karna Gowda, Mahmoud Yousef, Juan Diaz-Colunga, Alvaro Sanchez, Mikhail Tikhonov*, and **Seppe Kuehn***. ***Nature Ecology & Evolution***, (2023).

11. "Algae drive convergent bacterial community assembly when nutrients are scarce." Kaumudi Prabhakara and **Seppe Kuehn***. ***iScience***, (2023).

12. "The community-function landscape of microbial consortia." Alvaro Sanchez*, Djordje Bajic, Juan Diaz-Colunga, Abigail Skwara, Jean Vila, and **Seppe Kuehn**. ***Cell Systems***, (2023). (Invited review)

13. "Genomic structure predicts metabolite dynamics in microbial communities." Karna Gowda, Derek Ping, Madhav Mani*, and **Seppe Kuehn***. ***Cell***, (2022).

14. "An ensemble approach to the structure-function problem in microbial communities." Chandana Gopalakrishnappa, Karna Gowda, Kaumudi Prabhakara, and **Seppe Kuehn***. ***iScience***, (2022). (Invited review)

15. "Closed microbial communities self-organize to persistently cycle carbon." Luis Miguel de Jesus Astacio, Kaumudi Prabhakara, Zeqian Li, Harry Mickalide and **Seppe Kuehn***. ***PNAS***, (2021).

Population Dynamics

1. "Evolution of generalists by phenotypic plasticity." David T. Fraebel, Karna Gowda, Madhav Mani and **Seppe Kuehn***. ***iScience***, (2020).

2. "Hitchhiking, collapse and contingency in phage infections of migrating bacterial populations." Derek Ping, Tong Wang, David T. Fraebel, Sergei Maslov, Kim Sneppen, **Seppe Kuehn***. ***The ISME Journal***, (2020).

3. "Massively parallel screening of synthetic microbial communities." Jared Kehe, Anthony Kulesa, Anthony Ortiz, Cheri M Ackerman, Sri Gowtham Thakku, Daniel Sellers, **Seppe Kuehn**, Jeff Gore, Jonathan Friedman, Paul C Blainey. ***PNAS***, (2019).

4. "Higher-order interaction inhibits bacterial invasion of a phototroph-predator microbial community." Harry Mickalide, **Seppe Kuehn***. ***Cell Systems***, (2019). (Cover feature)

5. "Frequency- and amplitude-dependent microbial population dynamics during cycles of feast and famine." Jason Merritt and **Seppe Kuehn***. ***Physical Review Letters***, (2018).

6. "Quantitative high-throughput population dynamics in continuous-culture by automated microscopy." Jason Merritt and **Seppe Kuehn***. ***Scientific Reports***, (2016).

7. "Strongly deterministic population dynamics in closed microbial communities." Zak Frentz†, **Seppe Kuehn**† and Stanislas Leibler. ***Physical Review X***, (2015).

8. "Microbial population dynamics by digital in-line holographic microscopy." Zak Frentz†, **Seppe Kuehn**†, Doeke Hekstra, and Stanislas Leibler, ***Review of Scientific Instruments*** (2010).

Behavior & Evolution

1. "Biophysical constraints determine the selection of chemotaxis phenotypes during directed evolution." Hongyan Shih, Harry Mickalide, David T. Fraebel, Nigel Goldenfeld*, and **Seppe Kuehn***. ***Physical Biology***, (2018).
2. "Environment determines evolutionary trajectory in a constrained phenotypic space." David T. Fraebel, Harry Mickalide, Diane Schnitkey, Jason Merritt, Thomas Kuhlman, and **Seppe Kuehn***. ***eLife***, (2017).
3. "Dynamic structure of locomotor behavior in walking fruit flies." Alexander Y. Katsov, Limor Freifield, Mark Horowitz, **Seppe Kuehn** and Thomas R. Clandinin. ***eLife***, (2017).
4. "Behavioral diversity in microbes and low-dimensional phenotypic spaces." David Jordan†, **Seppe Kuehn**†, Eleni Ketifori, and Stanislas Leibler. ***PNAS***, (2013).

Condensed Matter & Chemical Physics

1. "Quantifying electric field gradient fluctuations over polymers using ultrasensitive cantilevers." Showkat M. Yazdanian, Nikolas Hoepker, **Seppe Kuehn**, Roger F. Loring, and John A. Marohn. ***Nano Letters***, (2009).
2. "Advances in mechanical detection of magnetic resonance." **Seppe Kuehn**, Steven A. Hickman, and John A. Marohn, ***J. Chemical Physics***, (2008).
3. "Dielectric fluctuations and the origins of noncontact friction." **Seppe Kuehn**, Roger F. Loring, and John A. Marohn, ***Physical Review Letters***, (2006).
4. "Noncontact dielectric friction." **Seppe Kuehn**, John A. Marohn, and Roger F. Loring, ***J. Physical Chemistry B Letters***, (2006). (Cover feature)
5. "Force-gradient detected nuclear magnetic resonance." Sean R. Garner, **Seppe Kuehn**, Jahan M. Dawlaty, Neil E. Jenkins, and John A. Marohn, ***Applied Physics Letters***, (2004).
6. "Batch fabrication and characterization of ultrasensitive cantilevers." Neil E. Jenkins, Lauren P. DeFlores, Jack Allen, Tse Nga Ng, Sean R. Garner, **Seppe Kuehn**, Jahan M. Dawlaty and John A. Marohn, ***J. Vacuum and Science Technology B*** (2004).
7. "The direct production of CO(v=1-9) in the reaction of O(^{3}P) with the ethyl radical." Jonathan P. Reid, Timothy P. Marcy, **Seppe Kuehn**, and Stephen R. Leone. ***J. Chemical Physics***, (2000).

HONORS, AWARDS, & KEYNOTES

NSF CAREER	National Science Foundation	2024
Scialog Fellow	Research Corp/Moore Foundation	2014
Helen Hay Whitney Fellow	HHWF	2009
Tunis Wentink Award. Outstanding Ph.D. thesis.	Cornell University	2007
Wachter Prize for excellence in Physical Chemistry	Cornell University	2005
Phi Beta Kappa	Beloit College	2000

Selected Plenary & Keynote Talks:

Rutgers Innovators in Microbiome Research (Named symposium)	Rutgers Univ.	2025
NWO Physics of Life (Plenary)	Utrecht, Netherlands	2025
SMEEB Workshop (Keynote)	L'Aquila, Italy	2024
Cold Spring Harbor Microbiome Conference (Invited Speaker)	Cold Spring Harbor, NY	2024
Simons Foundation, Function of Evolving Systems (Invited Speaker)	New York, NY	2024

SELECTED INVITED TALKS

- 3/2025 Invited speaker. Environmental science seminar. University of Amsterdam. Amsterdam, The Netherlands.
- 3/2025 Colloquium speaker. AMOLF. Amsterdam, The Netherlands.
- 2/2025 Invited speaker. École Normale Supérieure. Paris, France.
- 2/2025 Invited speaker. Evolution and Ecology seminar. University of Helsinki. Helsinki, Finland.
- 6/2024. Invited speaker. Systems biology. New York University. New York, NY.
- 6/2024 Invited speaker. Channing Microbiome Seminar Series. Harvard Medical School, Boston, MA.
- 2/2024 Invited speaker. Division of Microbial Ecology. The University of Vienna. Vienna, Austria.
- 09/2023 Invited speaker. Department of Civil Engineering. MIT.
- 08/2023 Invited speaker. Gordon Research Conference on Collective Behavior. Maine.
- 3/2023 Invited speaker. American Physical Society March Meeting. Las Vegas.
- 2/2023 Invited speaker. Carnegie Institute. Palo Alto, CA.
- 1/2023 Invited speaker. Princeton Center for Theoretical Science workshop on Microbial Communities.
- 5/2022 Invited speaker. Max Planck Institute for Evolutionary Biology. Workshop on Microbial Communities.
- 2/2022 Invited speaker. qBio/Department of Physics. The University of California, San Diego.
- 3/2021 Invited speaker. Department of Physics. The University of Florida. (virtual)
- 11/2020 Student invited colloquium. Center for the Physics of Biological Function. Princeton University. (virtual)
- 6/2020. Invited talk. Max Planck Institute for Evolutionary Biology. Plon, Germany. (virtual)
- 5/2020. Invited talk. Microbial ecology seminar. Free University Berlin. Berlin, Germany. (virtual)
- 8/2019 Participant. Workshop: Out of Equilibrium Processes in Ecology and Evolution. Banff International Research Station. Oaxaca Casa de Matematica. Oaxaca, Mexico.
- 3/2019 Invited Speaker. Quantitative Biology Seminar. TU Delft. Delft, The Netherlands.
- 12/2018 Invited Speaker. Colloquium. Department of Ecology and Evolution, University of Chicago.
- 3/2018 Invited speaker. March Meeting of the American Physical Society. Los Angeles, CA.
- 3/2018 Invited instructor. Evolution of diversity. Les Houches School of Physics. Les Houches, France.
- 7/2017 Participant. Kavli Institute for Theoretical Physics (KITP). Program in Ecology and Evolution. University of California at Santa Barbara.
- 1/2016. Widely Applied Math Seminar. School of Engineering and Applied Sciences. Harvard University.
- 10/2015. Working group: Information theory, ecosystems and Schrodinger's paradox. Santa Fe Institute.

INTERDISCIPLINARY COLLABORATIONS

- **Physics ↔ Ecology**: Co-led theory–experiment work on microbial community dynamics with Madhav Mani (Northwestern), Vincenzo Vitelli (University of Chicago), and Mikhail Tikhonov (WashU).
- **Statistical Physics ↔ Ecology**: Joint development of guild inference frameworks with Aleksandra Walczak and Thierry Mora (École Normale Supérieure, Paris).
- **Ecology ↔ Medicine**: Collaborative projects with Arjun Raman (School of Medicine, University of Chicago) on synthetic gut microbiomes for pathogen clearance.
- **Environmental Microbiology ↔ Biophysics**: Co-organized workshops with Otto Cordero (MIT) and developed new approaches to carbon cycling with Pamela Weisenhorn (Argonne National Lab) through the UChicago Climate and Energy Initiative.

PROFESSIONAL SERVICE

- Reviewer for ∼15 manuscripts per year in ***Cell***, ***PNAS***, ***Nature Microbiology***, ***Cell Systems***, ***Nature Ecology & Evolution***, ***Science Advances***, ***Nature Communications***, ***PRXLife***, ***Phys. Rev. X***, ***Cell Reports***, ***PLoS Biology***, ***PLoS Comp. Biology***.
- Organizer. Workshop on energetics in microbial communities. National Institute for Theory and Mathematics in Biology. 2025.
- Organizer. Workshop on microbial communities. National Institute for Theory and Mathematics in Biology. 2024.
- Guest editor. Current Opinions in Microbiology. Special issue. 2023.
- Guest editor. PNAS. 2022, 2024.
- Panelist. Systems and Synthetic Biology. Biology directorate. National Science Foundation. 2021, 2024, 2025.
- Organizer. Ecology and evolution in microbial communities. Workshop. Kavli Institute for Theoretical Physics. University of California, Santa Barbara. 2021.
- Midwest qBio workshop. Co-organizer. University of Illinois at Urbana-Champaign. 2018.
- Ad hoc reviewer for domestic and international funding agencies: New Zealand (Marsden and Snow), Netherlands Scientific Organization, Human Science Frontiers, European Research Council, US Department of Defense, Israel Science Foundation, National Science Foundation.

FUNDING

- $150,000. UChicago Climate and Energy Initiative. Co-PI with Pamela Weisenhorn (Argonne) 2024-2026. $100,000 to my lab.
- $1,250,000. NSF Systems and Synthetic Biology, CAREER Award. 2024-2029.
- $1,800,000. R01 National Institute of General Medical Sciences, NIH. 2023-2028.
- $14,000,000. NSF Physics Frontier Center (member). 2023-2028. Approximately $70,000 per year to my lab.
- National Institute for Theory and Mathematics in Biology. Simons/NSF. $50M Center Scientific leader. ∼100 faculty. Approximately $100,000 per year to my lab.
- $750,000 Department of Defense, Army Research Office. Co-PI with Mikhail Tikhonov (WashU, Physics). Approximately $500,000 to my lab. 2025-2028.

MENTORING

I have mentored trainees across physics, biology, medicine, and engineering, with alumni now in academia, biotech, and data science.

- **PhD students**: 16 total at the University of Chicago and UIUC (Physics, Biophysics, Systems Biology, MD/PhD, Ecology & Evolution, Molecular Engineering). 8 alumni have moved on, including roles at top biotech startups (*BillionToOne, CVS Data Science, Natera*); 2 are postdocs at *MIT* and *Boston University*.
- **Undergraduates**: 12 across Biology, Physics, Chemistry, and Computer Science. Of 7 graduates, 5 are now in PhD programs (*UChicago, UCSD, Tufts, Purdue*).
- **Postdocs and staff**: 7 postdocs, 1 research scientist, 1 lab manager. Alumni outcomes include tenure-track faculty at *Ohio State University*, senior group leader at *Max Planck*, and teaching faculty at *Northeastern*. Four postdocs and the research scientist remain active in the lab.

OUTREACH & EDUCATION

Committed to broadening participation in science across levels, from K–12 classrooms to undergraduate teaching and public engagement.

- **K–12 Education & Teacher Training:** Established classroom program linking beekeeping and mathematics for 4th–5th graders (Chicago, 2025). Developed modules for biology teachers integrating calculus into biological education, Math for America (New York, 2025). Lectured on the mathematics of microbiomes for high school teachers, Math for America (New York, 2024).
- **Undergraduate Curriculum Innovation:** Designed new data science course for biology undergraduates (UChicago, 2023). Created new lab course in quantitative biology for physics majors (UIUC, 2019). Developed new undergraduate course in theoretical biological physics (UIUC, 2018). Initiated and led qBio Summer School for incoming physics students (UIUC, 2015–2019).
- **Public Engagement:** South Side Science Festival, hands-on microbial activities for the public (UChicago, 2022–present). Saturday Physics for Everyone, lecture on evolutionary dynamics (Urbana, 2018). *Microbiomes and Microscopes*, interactive display at a local music festival (Urbana, 2017). Monthly local news TV appearances demonstrating at-home experiments with children, WCIA-TV (2016–2018).