# CURRICULUM VITAE - SUNGHAN RO

sunghanro@fas.harvard.edu
Department of Physics, Harvard University
Cambridge, Massachusetts 02138, USA

## PERSONAL DETAILS

**Language** *Korean*, **Native Speaker**
*English*, **Advanced**

## EDUCATION

**Korea Advanced Institute of Science and Technology** **Daejeon, Republic of Korea**
**B.S. Physics** **2008 - 2013**

**Korea Advanced Institute of Science and Technology** **Daejeon, Republic of Korea**
**Ph.D. Physics (Advisor: Yong Woon Kim)** **2013 - 2019**
**Integrated master's/doctoral program**
**Thesis title: A study on the effects of shapes and interactions of objects in the stochastic dynamical systems**

## HONORS AND AWARDS

**Postdoctoral overseas training program** **2019-2020**
**National Research Foundation of Korea**

**Young Statistical Physicist Award** **2019**
**Korean Physical Society**

**Joong-Hoon Shin Scholarship** **2019**
**Outstanding dissertation award of KAIST for doctoral graduates of physics and nanoscience**

**Excellent presentation award** **2018**
**2018 Korean physical society spring meeting**

**Global Ph.D. Fellowship** **2013-2017**
**National Research Foundation of Korea**

## RESEARCH EXPERIENCE

**Harvard University** **Cambridge, Massachusetts USA**
**Assistant Professor** **07/01/25 - Present**

**Harvard University** **Cambridge, Massachusetts, USA**
**Research Scientist** **07/01/24 - 06/30/25**

**MIT** **Cambridge, Massachusetts, USA**
**Postdoctoral associate; Advisor: Julien Tailleur** **09/01/22 - 06/30/24**

**Technion - Israel Institute of Technology** **Haifa, Israel**
**Postdoctoral fellow; Advisors: Dov Levin, Yariv Kafri, and Guy Bunin** **09/01/19 - 08/31/22**

**Korea Advanced Institute of Science and Technology** **Daejeon, Republic of Korea**
**Graduate Researcher; Advisor: Yong Woon Kim** **2013 - 2019**

**Korea Institute of Science and Technology Information** **Daejeon, Republic of Korea**
**Participant; High Energy Physics Team, lead by Kihyeon Cho** **2011**

## RESEARCH INTERESTS

- **Collective phenomena in nonequilibrium systems, such as active matter**
- **Information-theoretic quantification of order in systems both in- and out-of-equilibrium**
- **Stochastic systems: Systems governed by Langevin- and Fokker-Planck-type equations, barrier-crossing problem and the first-passage dynamics of random walkers**
- **Complex biological systems: membraneless organelles formed by phase separation of polymers, emergent interactions between polyelectrolytes mediated by counterions, and nuclear pore complex**

## FULL PUBLICATION LIST

**(* equally contributed)**

1. **A. Al-Hiyasat, Sunghan Ro, J. Tailleur.** *A Cold Tracer in a Hot Bath: In and Out of Equillibrium*. **Phys. Rev, Lett. 136, 117104 (2026).**
2. **A. Al-Hiyasat, Sunghan Ro, J. Tailleur.** *Statistical Mechanics of a Cold Tracer in a Hot Bath*. **Phys. Rev. E 113, 034127 (2026).**
3. **E. Lake and Sunghan Ro.** *Squeezing Codes: Robust Fluctuation-Stabilized Memories*. **arXiv:2509.20730 (2025).**
4. **J. Metzger, Sunghan Ro, J. Tailleur.** *Exceptions to the Ratchet Principle in Active and Passive Stochastic Dynamics*. **arXiv:2503.11902 (2025).**
5. **J. Metzger, Sunghan Ro, J. Tailleur.** *Revisiting the Ratchet Principle: When Hidden Symmetries Prevent Steady Currents*. **arXiv:2412.07851 (2025).**
6. **O. Granek, Y. Kafri, M. Kardar, Sunghan Ro, J. Tailleur, A. Solon.** *Colloquium: Inclusions, Boundaries and Disorder in Scalar Active Matter*. **Rev. Mod. Phys. 96, 031003 (2024).**
7. **J. H. Han, E. Lake, and Sunghan Ro.** *Scaling and localization in multipole-conserving diffusion*. **Phys. Rev. Lett. 132, 137102 (2024, Editors' Suggestion).**
8. **N. Rana, R. Chatterjee, Sunghan Ro, D. Levine, S. Ramaswamy, and P. Perlekar.** *Defect turbulence in a dense suspension of polar, active swimmers*. **Phys. Rev. E 109, 024603 (2024).**
9. **B. Benvegnen, O. Granek, Sunghan Ro, R. Yaacoby, H. Chaté, Y. Kafri, D. Mukamel, A. Solon, and J. Tailleur.** *Metastability of Discrete-Symmetry Flocks*. **Phys. Rev. Lett., 131, 218301 (2023, Editors' Suggestion).**
10. **Sunghan Ro, J. Yi, and Y. W. Kim.** *Target searches of interacting Brownian particles*. **Phys. Rev. E 107, 064143 (2023).**
11. **T. Agranov, Sunghan Ro, Y. Kafri, and V. Lecomte.** *Macroscopic fluctuation theory and current fluctuations in active lattice gases*. **SciPost Physics 14(3), 045 (2023).**
12. **Sunghan Ro*, B. Guo*, A. shih, T V. Phan, R. H. Austin, S. Martiniani, D. Levine, and P. M. Chaikin.** *Model-free measurement of local entropy production and extractable work in active matter*. **Phys. Rev. Lett., 129, 220601 (2022, Editors' Suggestion).**
13. **Sunghan Ro and Y. W. Kim.** *Optimal searcher distribution for parallel random target searches*. **Phys. Rev. E 106, 024101 (2022).**

14. **Y. Ben Dor*, Sunghan Ro*, Y. Kafri, M. Kardar, J. Tailleur.** *Disordered boundaries destroy bulk phase separation in scalar active matter*. **Phys. Rev. E 105, 044603 (2022, Editors' Suggestion).**

15. **T. Agranov, Sunghan Ro, Y. Kafri, and V. Lecomte.** *Exact fluctuating hydrodynamics of active lattice gasses – Typical fluctuations*. **J. Stat. Mech. 083208 (2021).**

16. **Sunghan Ro, Y. Kafri, M. Kardar, and J. Tailleur.** *Disorder-Induced Long-Ranged Correlations in Scalar Active Matter*. **Phys. Rev. Lett. 126, 048003 (2021).**

17. **M. Cha, Sunghan Ro, and Y. W. Kim.** *Condensation of Rodlike Counterions on a Charged Cylinder*. **J. Korean Phys. Soc. 77, 811 (2020).**

18. **Y. Kang, J. Yi, and Sunghan Ro.** *Entropy production and energy exchange by transferring quantum particles between canonical initial states*. **J. Korean Phys. Soc. 76, 788 (2020).**

19. **M. Cha*, Sunghan Ro*, and Y. W. Kim.** *Rodlike counterions near charged cylinders: Counterion condensation and intercylinder interaction*. **Phys. Rev. Lett. 121, 058001 (2018).**

20. **Sunghan Ro, A. Gopinathan, and Y. W. Kim.** *Interactions between a fluctuating polymer barrier and transport factors together with enzyme action are sufficient for selective and rapid transport through the nuclear pore complex*. **Phys. Rev. E 98, 012403 (2018).**

21. **Sunghan Ro and Y. W. Kim.** *Parallel random target searches in a confined space*. **Phys. Rev. E 96, 012143 (2017).**

22. **Sunghan Ro, J. Yi, and Y. W. Kim.** *Chiral separation by flows: The role of flow symmetry and dimensionality*. **Sci. Rep. 6, 35144 (2016).**

23. **Sunghan Ro, J. Yi, and Y. W. Kim.** *Analysis of diffusion trajectories of anisotropic objects*. **J. Chem. Phys. 142, 214302 (2015).**

## TEACHING EXPERIENCE

**Harvard University** **Cambridge, Massachusetts USA**
**Lecturer; Physics 262/Applied Physics 284: Statistical Mechanics** **Fall 2025**

**Harvard University** **Cambridge, Massachusetts USA**
**Lecturer; Physics 269R: Topics on Statistical Mechanics and Physical Biology** **Spring 2025**

**Harvard University** **Cambridge, Massachusetts USA**
**Lecturer; Physics 262/Applied Physics 284: Statistical Mechanics** **Fall 2024**

**MIT** **Cambridge, Massachusetts USA**
**Teaching Assistant; IAP 8.08/8.S421: Statistical Mechanics 2** **Winter 2024**

**Korea Advanced Institute of Science and Technology** **Daejeon, Republic of Korea**
**Teaching Assistant; Special Topics in Physics (Theoretical Biophysics)** **Fall 2014**

**Korea Advanced Institute of Science and Technology** **Daejeon, Republic of Korea**
**Teaching Assistant; Introduction to Nanobiology** **Spring 2014**

## MENTORING

**Lara Braverman** — **with David Nelson, 2025 - Present**
**Harvard University** — **Cambridge, Massachusetts, USA**

**Sabrina Chern** — **2024 - Present**
**Harvard University** — **Cambridge, Massachusetts, USA**

**Final project mentor of Statistical Physics of Fields by Mehran Kardar** — **Spring 2023**
**MIT** — **Cambridge, Massachusetts, USA**

**Amer Al-Hiyasat** — **with Julien Tailleur, 2022 - 2024**
**MIT** — **Cambridge, Massachusetts, USA**

**Jessica Metzger** — **with Julien Tailleur, 2022 - 2024**
**MIT** — **Cambridge, Massachusetts, USA**

## PRESENTATIONS

1. *Multipole-Conserving Diffusion*. **East Asia Joint Seminars on Statistical Physics 2025, Seoul (October, 2025).**
2. *Stability of Flocks with Discrete and Continuous Symmetry*. **Emergence and Self-Organization in Biological Systems, Munich (August, 2025).**
3. *Multipole-Conserving Diffusion*. **Seminar at Max-Planck Institute of Dynamics and Self-Organization, Göttingen (August, 2025).**
4. *Stability of Flocks with Discrete and Continuous Symmetry*. **Self-assembly and organization in non-equilibrium systems, Telluride (June, 2025).**
5. *Diffusion with center of mass conservation*. **APS Global Physics Summit, Anaheim (March, 2025).**
6. *Fate of Motility-Induced Phase Separation in Quenched Disorder*. **SMaLS seminar at University of California, Santa Barbara (March, 2025).**
7. *Flocks vs. Droplets: Metastability and Restored Stability in Active Flocks*. **Physics Colloquium at University of Chicago (February, 2025).**
8. *Information-Theoretic Measure of Time Irreversibility*. **DAIKIN International Symposium on Physics of Intelligence, Tokyo University (November, 2024).**
9. *Fate of Motility-Induced Phase Separation in Quanched Disorder*. **Applied Physics and Applied Mechanics Colloquium at Harvard University (November, 2024).**
10. *Principles and recent developments in statistical mechanics*. **Seminar at Gwangju Institute of Science and Technology, (November, 2024).**
11. *Multipole-conserving diffusion*. **Soft Condensed Matter Seminar Series, Harvard University, (September, 2024).**
12. **(invited)** *Far-reaching impact of boundaries and disorder on scalar active matter*. **2024 CECAM workshop, Active Matter: Interfaces and Boundaries, Beijing (April, 2024).**
13. *Metastability of Discrete-Symmetry Flocks*. **2024 APS March Meeting, Minneapolis (March, 2024).**

14. *Target searches by Brownian particles*. **Table talk at Grater Boston Area Statistical Mechanics Meeting, MIT (Oct, 2023).**

15. *The far-reaching impact of disorder on bulk behavior of scalar active matter*. **Oral presentation in Statphys28, Japan (Aug, 2023).**

16. *Metastability of discrete-symmetry flocks*. **Poster presentation in Perspectives on Non-Equilibrium Statistical Mechanics: The 45th anniversary Symposium of Yamada Science Foundation. Yukawa Institute for Theoretical Physics, Kyoto University (Aug, 2023).**

17. *The far-reaching impact of disorder on bulk behavior of scalar active matter*. **Oral presentation in Frontiers in nonequilibrium physics: active matter, topology and beyond. Yukawa Institute for Theoretical Physics, Kyoto University (Aug, 2023)**

18. *Metastability of discrete-symmetry flocks*. **Seminar in PLS Short Talks, MIT (June, 2023).**

19. **(invited)** *Fate of scalar active matter in the presence of disorder*. **Colloquium in Seoul National University-Center for Theoretical Physics (March, 2023).**

20. **(invited)** *Fate of motility-induced phase separation in disordered boundaries*. **Seminar in CMT Kid's seminar, Harvard University (Feb, 2023).**

21. **(invited)** *Fate of motility-induced phase separation in disordered boundaries*. **Oral presentation in The 3rd workshop on stochasticity and fluctuations in small systems, APCTP (Nov, 2022).**

22. *Macroscopic phase of active matter depends on the boundary conditions*. **Table talk at Grater Boston Area Statistical Mechanics Meeting, UMass-Amherst (Oct, 2022).**

23. *Fate of motility-induced phase separation in quenched disorder*. **Seminar in PLS Short Talks, MIT (Sep, 2022).**

24. **(invited)** *Target search by many random walkers*. **Seminar in center for soft matter research, New York University (2022).**

25. **(invited)** *Long-ranged effects of disorder on active systems*. **Seminar in Korea Institute for Advanced Study (2021).**

26. *Disorder-induced long-ranged correlations in scalar active matter*. **Oral presentation in 2021 Korean Physical Society spring meeting, South Korea (2021).**

27. *The impact of quenched disorder on scalar active matter*. **Oral presentation in Israel Physical Society conference 2021, Israel (2021).**

28. **(invited)** *The impact of quenched disorder on scalar active matter*. **Oral presentation in Statistical Mechanics Day XII, Weizmann Institute of Science (2020).**

29. **(invited)** *Role of order statistics and interactions in the first-passage dynamics*. **Oral presentation in Korea Institute for Advanced Study (2019).**

30. **(invited) Sunghan Ro and Y. W. Kim. (title translated from Korean)** *The role of shapes in interactions of objects in the stochastic dynamical systems*. **Oral presentation in 2019 KPS Spring Meeting, South Korea (2019).**

31. **Sunghan Ro and Y. W. Kim.** *Parallel random target searching by multiple searchers in a confined space*. **Short talk presentation in 120th Statistical Mechanics Conference, New Jersey (2018).**

32. **Sunghan Ro and Y. W. Kim.** *Target searches by multiple random walkers in a confined space*. **Poster presentation in APCTP-KIAS Workshop on "Motors and Engines", South Korea (2018).**

33. **Sunghan Ro and Y. W. Kim.** *Parallel random target searches in a confined space*. **Oral presentation in 2018 KPS Spring Meeting, South Korea (2018).**

34. **Sunghan Ro, J. Yi, and Y. W. Kim.** *Analysis of diffusion trajectories of anisotropic objects*. **Poster presentation in 2016 Korea Global Ph.D. Fellows Annual Conference: Beyond Disciplinary Boundaries, South Korea (2016).**

35. **Sunghan Ro, J. Yi, and Y. W. Kim.** *Analysis of diffusion trajectories of anisotropic objects*. **Oral presentation in 2016 KPS Fall Meeting, South Korea (2016).**

36. **Sunghan Ro, J. Yi, and Y. W. Kim.** *Chiral separation by creeping flows*. **Poster presentation in The 26th IUPAP International conference on Statistical Physics, France (2016).**

37. **Sunghan Ro, J. Yi, and Y. W. Kim.** *The role of flow symmetry and singularity in chiral separation*. **Oral presentation in 2016 KPS Spring Meeting, South Korea (2016).**

38. **Sunghan Ro and Y. W. Kim.** *Separation of chiral objects using optimal flow patterns*, **Poster presentation in The Search for a New Methodology in Academic Research, South Korea (2014).**

39. **Sunghan Ro and Y. W. Kim.** *Separation of chiral objects using optimal flow patterns*, **Poster presentation in Surmounting the Insurmountable, South Korea (2014).**

40. **Sunghan Ro and Y. W. Kim.** *Separation of microscopic chiral objects*, **Oral presentation in Workshop on Statistical Physics of Complex Systems, South Korea (2014).**

41. **Sunghan Ro and Y. W. Kim.** *Separation of Chiral objects in flow*, **Poster presentation in The 25th IUPAP International conference on Statistical Physics, South Korea (2013).**