

Seung-Yeon Ryoo

Curriculum Vitae

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Citizenship: Republic of Korea

Employment

- **Postdoctoral Researcher (incoming)** Starting Sep 2026
Hausdorff Center for Mathematics, University of Bonn, Bonn, Germany
- Postdoctoral Mentor: Karl-Theodor Sturm
- **Olga Taussky and John Todd Postdoctoral Scholar Teaching Fellow in Mathematics** Aug 2023 - Jul 2026
Division of Physics, Mathematics and Astronomy, California Institute of Technology, Pasadena, USA
- Postdoctoral Mentor: Thomas Hutchcroft

Education

- **Ph. D. in Mathematics.** Sep 2018 - May 2023
Princeton University, New Jersey, USA
- Thesis advisor: Assaf Naor
- Thesis title: "On the sharpness of the Assouad embedding theorem for finitely generated groups of polynomial growth and nilpotent Lie groups", available at Proquest.
- **B. Sc. in Mathematics.** Mar 2012 - Feb 2018
Seoul National University, Seoul, Korea
- Graduated *Summa Cum Laude* in 2018. GPA 4.26/4.3.

Research Interests

- Bi-Lipschitz and snowflake embeddings of metric spaces into Banach spaces.
- Poincaré inequalities on metric spaces.
- Analysis of mathematical models of synchronization.

Publications and Preprints

- [19] Relaxation dynamics of the inertial Winfree model (with Caiman Moreno-Earle and Grace To). Preprint available at <https://arxiv.org/abs/2605.01695>
- [18] Emergent behaviors of Winfree oscillators on special orthogonal group (with Seung-Yeal Ha, Chaejoo Lee, Eunjun Lee, Jaemoon Lee). Preprint available at <https://arxiv.org/abs/2604.24229>
- [17] On oscillator death in the Winfree model. Preprint available at <https://arxiv.org/abs/2601.01203>
- [16] Quantitative relaxation dynamics from generic initial configuration in the inertial Kuramoto model (with Hangjun Cho, Jiu-Gang Dong, and Seung-Yeal Ha). Preprint available at <https://arxiv.org/abs/2503.00720>
- [15] Asymptotics of Riemannian Lie groups with nilpotency step 2 (with Enrico Le Donne, Sebastiano Nicolussi Golo, and Luca Nalon). Preprint available at <https://arxiv.org/abs/2503.00560>
- [14] Inertia perturbation theory for the inertial Kuramoto model (with Hangjun Cho, Jiu-Gang Dong, and Seung-Yeal Ha). *SIAM J. Math. Anal.* **58**(4) 3669–3719 (2026). <https://doi.org/10.1137/25M1788567>
- [13] Quantitative nonembeddability of groups of polynomial growth into uniformly convex spaces. *J. Funct. Anal.* **291** 111491 (2026) <https://doi.org/10.1016/j.jfa.2026.111491>
- [12] Asymptotic formation and orbital stability of phase-locked states in Kuramoto–Lohe type synchronization models on Lie groups. *Commun. Math. Sci.* **23** 1221–1239 (2025). <https://dx.doi.org/10.4310/CMS.250517000730>

- [11] Embedding snowflakes of Carnot groups into bounded dimensional Euclidean spaces with optimal distortion. *Analysis & PDE*. **15** 1933–1990 (2022). <https://doi.org/10.2140/apde.2022.15.1933>
- [10] Constants of motion for the Lohe model with frustration and its applications to emergent dynamics (with Seung-Yeal Ha, Dohyun Kim and Hansol Park). *Physica D: Nonlinear Phenomena*. **416**, 132781 (2021). <https://doi.org/10.1016/j.physd.2020.132781>
- [9] Asymptotic phase-locking dynamics and critical coupling strength for the Kuramoto model (with Seung-Yeal Ha). *Commun. Math. Phys.* **377** 811–857 (2020). <https://doi.org/10.1007/s00220-020-03786-1>
- [8] On the relaxation dynamics of Lohe oscillators on some Riemannian manifolds (with Seung-Yeal Ha, Dongnam Ko). *J. Stat. Phys.* **172** 1427–1478 (2018) <https://doi.org/10.1007/s10955-018-2091-0>
- [7] Emergence of partial locking states from the ensemble of Winfree oscillators (with Seung-Yeal Ha, Dongnam Ko, Jinyeong Park). *Quart. Appl. Math.* **75** 39–68 (2017) <https://doi.org/10.1090/qam/1448>
- [6] Emergent dynamics of a generalized Lohe model on some class of Lie groups (with Seung-Yeal Ha, Dongnam Ko). *J. Stat. Phys.* **168** 171–207 (2017) <https://doi.org/10.1007/s10955-017-1797-8>
- [5] On the finiteness of collisions and phase-locked states for the Kuramoto model (with Seung-Yeal Ha, Hwa Kil Kim). *J. Stat. Phys.* **163**, 1394–1424 (2016) <https://doi.org/10.1007/s10955-016-1528-6>
- [4] Emergence of phase-locked states for the Kuramoto model in a large coupling regime (with Seung-Yeal Ha, Hwa Kil Kim). *Commun. Math. Sci.* **14** 1073–1091 (2016) <http://dx.doi.org/10.4310/CMS.2016.v14.n4.a10>
- [3] On the emergence and orbital stability of phase-locked states for the Lohe model (with Seung-Yeal Ha). *J. Stat. Phys.* **163**, 411–439 (2016) <https://doi.org/10.1007/s10955-016-1481-4>
- [2] Emergent dynamics of Winfree oscillators on locally coupled networks (with Seung-Yeal Ha, Dongnam Ko, Jinyeong Park). *J. Differential Equations* **260**, 4203–4236 (2016) <https://doi.org/10.1016/j.jde.2015.11.008>
- [1] Emergence of phase-locked states for the Winfree model in a large coupling regime (with Seung-Yeal Ha, Jinyeong Park). *Discrete and Continuous Dynamical Systems* **35**, 3417–3436 (2015) <http://dx.doi.org/10.3934/dcds.2015.35.3417>

Teaching and Grading

• Instructor at Caltech

- Ma 109c, Introduction to Geometry and Topology, Spring 2026 (Rating: 4.90/5, Department average: 4.60/5)
- Ma 109a, Introduction to Geometry and Topology, Fall 2025 (Rating: 4.65/5, Department average: 4.32/5)
- Ma 109c, Introduction to Geometry and Topology, Spring 2025 (Rating: 4.66/5, Department average: 4.44/5)
- Ma 157c, Topics in Geometry and Topology, Spring 2025 (Rating: 4.63/5, Department average: 4.44/5)
- Ma 191a, Selected Topics in Mathematics: Low-Dimensional Embeddings of Doubling Metrics, Fall 2024 (Rating: 4.62/5, Department average: 4.25/5)
- Ma 109c, Introduction to Geometry and Topology, Spring 2024 (Rating: 4.65/5, Department average: 4.25/5)
- Ma 157b, Riemannian Geometry, Spring 2024 (Rating: 4.92/5, Department average: 4.25/5)

• Teaching Assistant at Princeton University

- MAT 325, Analysis I: Fourier Analysis and Partial Differential Equations, Spring 2023 (grader)
- MAT 335, Analysis II: Complex Analysis, Fall 2022 (preceptor)
- MAT 325, Analysis I: Fourier Analysis and Partial Differential Equations, Spring 2022 (grader)
- MAT 425, Analysis III: Integration Theory and Hilbert Spaces, Fall 2021 (grader)
- MAT 325, Analysis I: Fourier Analysis and Partial Differential Equations, Spring 2021 (grader)
- MAT 335, Analysis II: Complex Analysis, Fall 2020 (preceptor)
- MAT 325, Analysis I: Fourier Analysis and Partial Differential Equations, Spring 2020 (grader)
- MAT 335, Analysis II: Complex Analysis, Fall 2019 (preceptor)

Seminar/Conference Organization

- **Metric Embeddings** Jul 2025
Co-organizers: Alexandros Eskenazis (Sorbonne Univ., Univ. of Cambridge), Assaf Naor (Princeton Univ.)
Location: American Institute of Mathematics, Pasadena, California, USA.
Homepage: <https://aimath.org/pastworkshops/metricembeddings.html>
- **Graduate Studnet Seminar** Sep 2019 - May 2020
Co-organizer: Vikram Giri (Princeton Univ.)
Location: Princeton University, Princeton, New Jersey, USA.
- **Workshop for Students in Analysis and PDE** Jul 2018
Co-organizers: Hyunseok Kim (Sogang Univ.), Hyunwoo Kwon (Sogang Univ), Young-Ran Lee (Sogang Univ.)
Location: Sogang University, Seoul, Korea.
Homepage: <https://sites.google.com/view/wsap2018>

Honors, Awards, and Fellowships

- **AMS–Simons Travel Grant** Jul 2023
American Mathematical Society, Simons Foundation
- **Overseas PhD Scholarship** Sep 2018 - Jun 2023
Korea Foundation for Advanced Studies
- **Centennial Fellowship in the Natural Sciences and Engineering** Sep 2018 - Jun 2022
Princeton University
- **Grand Prize - 35th University Students' Contest of Mathematics** Dec 2016
Korean Mathematical Society

Referee Work

- Communications in Mathematical Sciences, Dynamical Systems, Journal of Differential Equations, Journal of Global Optimization, Journal of Statistical Physics, Nonlinearity, and Physica D: Nonlinear Phenomena.

Outreach

- Organizer for the Gender minorities and Women in Physics, Mathematics and Astronomy program at Caltech 2024-2025
- Diversity Co-Chair of the Caltech Postdoctoral Association 2024-2025

Student Mentored

- Grace To Summer 2025
Caltech Summer Undergraduate Research Fellowship.

Membership in Professional Societies

- American Mathematical Society (AMS)
- Society for Industrial and Applied Mathematics (SIAM)
- Korean Mathematical Society (KMS)

Invited Talks and Visiting Positions

- **Embedding groups of polynomial growth into Euclidean space** Jun 2026
48th Summer Symposium in Real Analysis, Washington University in St. Louis, St. Louis, Missouri, USA
- **Metric geometry: a first look** Apr 2026
Undergraduate Math Club, Caltech, Pasadena, California, USA

- **Synchronization in the Winfree and Kuramoto models**

Analysis and PDE Seminar, Okinawa Institute of Technology, Okinawa, Japan.

Feb 2026
- **A conjectural low-dimensional embedding of doubling metric spaces**

Functional Analysis in the Pacific Northwest, University of Oregon, Oregon, USA.

Nov 2025
- **Group embeddings and coarse differentiation**

Spectral Gaps, Isaac Newton Institute for Mathematical Sciences, London, UK.

<https://www.youtube.com/watch?v=v67BLCKkve0>

Oct 2025
- **Sharpening the Assouad embedding theorem**

AMS Fall Southeastern Sectional Meeting, Tulane University, New Orleans, Louisiana, USA.

Oct 2025
- **Asymptotics of Riemannian Lie groups with nilpotency step 2**

2025 2K-GATE One day Geometric Topology Festival, Korea Institute for Advanced Studies, Seoul, Korea

Aug 2025
- **Sharpening the Assouad embedding theorem**

Virtual Seminar on Geometry and Topology, Korea Institute for Advanced Studies, Seoul, Korea

Aug 2025
- **Visiting Researcher**

Korea Institute for Advanced Studies, Seoul, Korea

Aug-Sep 2025
- **Embedding via heat kernels**

CRM-PIMS Summer School in Probability, University of British Columbia, Vancouver, British Columbia, Canada.

Jun 2025
- **Towards a sharp form of the Assouad embedding theorem**

Ohio River Analysis Meeting, University of Cincinnati, Cincinnati, Ohio, USA.

Mar 2025
- **Quantitative nonembeddability of nilpotent groups into uniformly convex spaces**

Winter School on Geometric Analysis, Geilo, Norway.

Mar 2025
- **Lipschitz Padded Nested Random Partitions**

20th Prairie Analysis Seminar, University of Kansas, Lawrence, Kansas, USA.

Oct 2024
- **Lipschitz Padded Nested Random Partitions**

Analysis Seminar, Korea Institute for Advanced Studies, Seoul, Korea.

Jul 2024
- **Quantitative nonembeddability of nilpotent groups into uniformly convex spaces**

University of Cincinnati Analysis Seminar, Cincinnati, Ohio, USA.

Nov 2023
- **Improving Assouad's theorem on nilpotent groups**

19th Prairie Analysis Seminar, Manhattan, Kansas, USA.

Nov 2023
- **Dorronsoro's theorem and vertical-versus-horizontal inequalities on Carnot groups**

AWM-MAA Invited Paper Session on Geometric Measure Theory, Harmonic Analysis, and Partial Differential Equations, Tampa, Florida, USA.

Aug 2023
- **Embedding finitely generated groups of polynomial growth into Euclidean space**

Virtual Seminar on Geometry and Topology, Korea Institute for Advanced Studies, Seoul, Korea.

Jul 2023
- **Visiting Researcher**

Korea Institute for Advanced Studies, Seoul, Korea

Jul 2023
- **Embedding balls in groups of polynomial growth into Euclidean space**

Sub-Riemannian Geometry and Beyond III, Centro De Giorgi, Pisa, Italy.

<https://www.youtube.com/watch?v=n0sQ7rZM2wE&t=6010s>

Jun 2023
- **On embedding finitely generated groups of polynomial growth into Euclidean spaces**

Analysis and PDE Seminar, University of California, Los Angeles, Los Angeles, USA.

Apr 2023

- **On embedding finitely generated groups of polynomial growth and nilpotent Lie groups into uniformly convex spaces** Dec 2022
Geometry and Geometric Analysis Working Group, New York University, New York, USA.
- **The correct exponent for the Gotsman–Linial conjecture, after D. Kane** Oct 2022
Computational Learning Theory and Fourier Analysis, online.
- **Vertical versus horizontal inequalities on nilpotent Lie groups and groups of polynomial growth** Aug 2022
Dynamics seminar, Seoul National University, Seoul, Korea.
- **Vertical versus horizontal inequalities on nilpotent Lie groups and groups of polynomial growth** Aug 2022
Virtual Seminar on Geometry and Topology, Korea Institute for Advanced Studies, Seoul, Korea.
- **Vertical versus horizontal inequalities on nilpotent Lie groups and groups of polynomial growth** Aug 2022
Concentration Week on Geometry and Analysis on Nonsmooth Spaces, Texas A&M University, Texas, USA.
- **A sharp form of the Assouad embedding theorem for Carnot groups** Aug 2022
Graduate Concentration Week on Metric Geometry, Texas A&M University, Texas, USA.
- **Two mathematical models of synchronization** Apr 2022
Program in Applied and Computational Sciences Graduate Student Seminar, Princeton University, New Jersey, USA.
- **Vertical versus horizontal inequalities on Carnot groups via a Dorronsoro theorem and Littlewood–Paley–Stein theory** Mar 2022
AMS Spring Central Virtual Sectional Meeting, Purdue University, Indiana, USA.
- **Dorronsoro’s theorem and vertical versus horizontal Poincaré inequalities on Carnot groups** Jan 2022
Workshop for Young Mathematicians in Korea, Seoul, Korea.
- **Talagrand’s influence inequality revisited, after D. Cordero-Erausquin and A. Eskenazis** Oct 2021
Discrete Analysis and Complexity of Quantum Algorithms, online.
- **A sharp form of Assouad’s embedding theorem for Carnot groups** May 2021
Online Asymptotic Geometric Analysis Seminar, online.
- **A sharp form of Assouad’s embedding theorem for Carnot groups** Mar 2021
AMS Spring Eastern Virtual Sectional Meeting, Brown University, Rhode Island, USA.
- **Embedding snowflakes of Carnot groups into bounded dimensional Euclidean spaces with optimal distortion** Aug 2020
HYKE-Hwarang Invited Talk, Seoul National University, Seoul, Korea.
- **Embedding metric spaces into ℓ^p** Feb 2020
Undergraduate (“Nullset”) colloquium, Princeton University, New Jersey, USA.
- **Krivine’s theorem and related results** Apr 2019
Graduate Student Seminar, Princeton University, New Jersey, USA.
- **Recent developments in the Assouad embedding theorem** Dec 2018
Graduate Student Seminar, Sogang University, Seoul, Korea.
- **On the Critical Coupling Strength of the Kuramoto model** Jul 2018
Workshop for students in Analysis and PDE, Sogang University, Seoul, Korea.
- **Emergent dynamics of a generalized Lohe model on some class of Lie groups** Aug 2017
Intercollegiate Undergraduate (“Stupid Mathematics”) Seminar, Sogang University, Seoul, Korea.
- **The Kuramoto model: a paradigm for synchronization** Aug 2016
Intercollegiate Undergraduate (“Stupid Mathematics”) Seminar, Sogang University, Seoul, Korea.

Other Experience

- **Military Service**

Sep 2013 - Sep 2015

Republic of Korea Air Force